FAIRCHILD SEMICONDUCTOR

MADE IN FAIRCHILD

THE LINEAR INTEGRATED CIRCUITS DATA CATALOG

LINEAR LINEAR LINEAR LINEAR

FEBRUARY 1973

LINEAR LINEAR LINEAR

CONTENTS AND SECTION SELECTOR

INTRODUCTION 1

NUMERICAL INDEX 2

OPERATIONAL AMPLIFIERS 3

COMPARATORS 4

VOLTAGE REGULATORS 5

COMPUTER/INTERFACE 6

CONSUMER 7

TRANSISTOR/DIODE ARRAYS/ANALOG SWITCHES 8

PACKAGE OUTLINES 9

ORDER INFORMATION 10

MIL-M-38510/MIL-STD-883 11

DICE 12

INDUSTRY CROSS REFERENCE GUIDE 13

APPLICATION INFORMATION 14

Each Product
Section Contains The
Following Categories
Organized By Function
Index
Selection Guide
Data Sheets
Glossary

LINEAR LINEAR LINEAR LINEAR

The Linear Integrated Circuits Data Catalog

Since its founding in 1957, Fairchild has grown from the original group of eight scientist/engineers to a worldwide industry leader. Large modern plants in Mountain View and San Rafael, California; Shiprock, New Mexico; and South Portland, Maine are complemented by off-shore facilities in Australia, Germany, Hong Kong, Korea, Mexico and Singapore.

Total Linear Capability is a reality at Fairchild Analog Products. Fairchild is the largest and most experienced manufacturer of linear devices in the world and takes pride in its ability to design and mass produce linear products which meet the needs of a large and diverse industry. Over the years, Fairchild's unique combination of design talent and production expertise has resulted in the most comprehensive line of linear microcircuits ever assembled.

This advanced line of products is backed by years of production experience — experience which enables Fairchild to maintain the position of leadership it has enjoyed since the delivery of the first order for μA709 operational amplifiers in the early 1960s.

The tremendous possibilities inherent in silicon Planar* technology are still not exhausted and forward-thinking research continues at Fairchild. This type of research made possible the industry's first linear integrated circuit, the first consumer-oriented linear device, the first "universal" operational amplifier, and the first monolithic voltage regulator.

Fairchild's advanced technological capability and vast production experience combined make possible the most advanced, most reliable, and lowest cost line of linear integrated circuits in the industry today. The fact that the name "Fairchild" has always been synonymous with quality, reliability, and leadership is no mere coincidence, and the fact that Fairchild will remain in this position is not just a promise, but a pledge to Total Linear Capability.

Fairchild Semiconductor
464 Ellis Street
Mountain View, California 94040

FAIRCHILD
SEMICONDUCTOR

*Planar is a patented Fairchild process.

Made: https://chipdatas.com

LINEAR LINEAR LINEAR LINEAR

CONTENTS AND SECTION SELECTOR

NUMERICAL INDEX 2

OPERATIONAL AMPLIFIERS 3

COMPARATORS 4

VOLTAGE REGULATORS 5

COMPUTER/INTERFACE 6

CONSUMER 7

TRANSISTOR/DIODE ARRAYS/ANALOG SWITCHES 8

PACKAGE OUTLINES 9

ORDER INFORMATION 10

MIL-M-38510/MIL-STD-883 11

DICE 12

INDUSTRY CROSS REFERENCE GUIDE 13

APPLICATION INFORMATION 14

DEVICES	DESCRIPTION	PAGE
μA702	Wideband DC Amplifier	3-9
μA703	RF-IF Amplifier	7-9
μA704	Television Sound System	7-96
μA705	Dual Channel Power Audio Amplifier	7-96
μA706	5 Watt Audio Amplifier	7-11
μA709	High Performance Operational Amplifier	3-16
μA710	High Speed Differential Comparator	4-5
μA711	Dual Comparator	4-9
μA715	High Speed Operational Amplifier	3-23
μA720	AM Radio System	7-16
μA722	10-Bit Current Source	6-9
μA723	Precision Voltage Regulator	5-7
μA725	Instrumentation Operational Amplifier	3-30
μA726	Temperature-Controlled Differential Pair	8-3
μA727	Temperature-Controlled Differential Preamplifier	3-39
μA728	Precision Voltage Reference	5-44
μA730	Differential Amplifier	3-43
μA732	FM Stereo Multiplex Decoder	7-21
μA733	Differential Video Amplifier	6-12
μA734	Precision Voltage Comparator	4-13
μA739	Dual Low Noise Audio Preamplifier	7-24
μA740	FET Input Operational Amplifier	3-49
μA741	Frequency Compensated Operational Amplifier	3-53
μA741A	Frequency Compensated Operational Amplifier	3-60
μA741E	Frequency Compensated Operational Amplifier	3-60
μA742	Zero Crossing AC Trigger-Trigac	7-28
μA746	Chroma Demodulator	7-32
μA747	Dual Frequency Compensated Operational Amplifier	3-65
μA747A	Dual Frequency Compensated Operational Amplifier	3-72
μA747E	Dual Frequency Compensated Operational Amplifier	3-72
μA748	High Performance Operational Amplifier	3-77
μA749	Dual Audio Preamplifier	7-36
μA750	Dual Comparator Subsystem	4-20
μA753	FM Gain Block	7-44
μA757	Gain Controlled IF Amplifier	7-47
μA758	Phase Locked Loop FM Stereo Multiplex Decoder	7-53
μA760	High Speed Differential Comparator	4-24
μA767	FM Stereo Multiplex Decoder	7-57
μA768	FM Stereo Multiplex Decoder	7-21
μA769	FM Stereo Multiplex Decoder	7-57
μA771	Instrumentation Amplifier	3-138
μA772	High Slew Rate Operational Amplifier	3-138
μA776	Multi-Purpose Programmable Operational Amplifier	3-84
μA777	Precision Operational Amplifier	3-93

DEVICE	DESCRIPTION	PAGE
μA780	Chroma Subcarrier Regenerator (Phase Locked Loop)	7-60
μA781	Gain Controlled IF Amplifier	7-66
μA786	PAL TV Chroma Demodulator	7-71
μA791	Power Operational Amplifier	3-100
μA796	Double-Balanced Modulator/Demodulator	7-74
μA7350	Tachometer Subsystem	7-97
μA7351	Triple Operational Amplifier	7-97
μA7805	Three Terminal Positive Voltage Regulator	5-14
μA7806	Three Terminal Positive Voltage Regulator	5-14
μA7808	Three Terminal Positive Voltage Regulator	5-14
μA7812	Three Terminal Positive Voltage Regulator	5-14
μA7815	Three Terminal Positive Voltage Regulator	5-14
μA7818	Three Terminal Positive Voltage Regulator	5-14
μA7824	Three Terminal Positive Voltage Regulator	5-14
μA78M05	Three Terminal Positive Voltage Regulator	5-45
μA78M06	Three Terminal Positive Voltage Regulator	5-45
μA78M08	Three Terminal Positive Voltage Regulator	5-45
μA78M12	Three Terminal Positive Voltage Regulator	5-45
μA78M15	Three Terminal Positive Voltage Regulator	5-45
μA78M20	Three Terminal Positive Voltage Regulator	5-45
μA78M24	Three Terminal Positive Voltage Regulator	5-45
μA78N00	Three Terminal Negative Voltage Regulators	5-51
μA78T00	Tracking Voltage Regulators	5-44
SH0013	Two-Phase MOS Clock Driver	6-126
SH2001	High Voltage, High Current Driver	6-131
SH2002	DTL High Power Driver	6-135
SH2200	High Voltage, High Current Driver	6-139
SH3002	SPDT Analog Switch	8-22
SH8090	10-Bit D/A Converter	6-143
TBA510	Chroma Processing Circuit	7-98
TBA920	Horizontal Oscillator, Phase Comparator and Sync Separator	7-99
TBA970	Television Video Amplifier	7-99
8T13	Dual Single-Ended Line Driver	6-114
8T14	Triple Line Receiver	6-117
8T23	Dual Single-Ended Line Driver	6-120
8T24	Triple Line Receiver	6-123
101	General Purpose Operational Amplifier	3-106
101A	General Purpose Operational Amplifier	3-109
102	Voltage Follwer	3-127
104	Negative Voltage Regulator	5-25
105	Voltage Regulator	5-30
107	General Purpose Operational Amplifier	3-116
108	Super Beta Operational Amplifier	3-121
108A	Super Beta Operational Amplifier	3-121

DEVICE	DESCRIPTION	PAGE
109	Five Volt Regulator	5-36
110	Voltage Follower	3-127
111	Voltage Comparator	4-29
201	General Purpose Operational Amplifier	3-106
201A	General Purpose Operational Amplifier	3-109
207	General Purpose Operational Amplifier	3-116
208	Super Beta Operational Amplifier	3-121
208A	Super Beta Operational Amplifier	3-121
209	Five Volt Regulator	5-36
301A	General Purpose Operational Amplifier	3-109
302	Voltage Follower	3-127
304	Negative Voltage Regulator	5-25
305	Voltage Regulator	5-30
305A	Voltage Regulator	5-30
307	General Purpose Operational Amplifier	3-116
308	Super Beta Operational Amplifier	3-121
308A	Super Beta Operational Amplifier	3-121
309	Five Volt Regulator	3-36
310	Voltage Follower	3-127
311	Voltage Comparator	4-29
376	Voltage Regulator	5-30
1326	Chroma Demodulator	7-100
1458	Internally Compensated, High Performance Dual Monolithic Operational Amplifier	3-132
1458C	Internally Compensated, High Performance Dual Monolithic Operational Amplifier	3-132
1558	Internally Compensated, High Performance Dual Monolithic Operational Amplifier	3-132
2136	FM IF Amplifier & Detector	7-101
3018	Transistor Array	8-6
3018A	Transistor Array	8-6
3019	Diode Array	8-6
3026	Transistor Array	8-6
3036	Transistor Array	8-6
3039	Diode Array	8-6
3045	Transistor Array	8-6
3046	Transistor Array	8-6
3054	Transistor Array	8-6
3064	TV Automatic Fine Tuning Circuit	7-78
3065	TV Sound System	7-82
3066	TV Chroma Processor	7-85
3067	Chroma Demodulator	7-89
3075	FM IF Amplifier-Limiter, Detector, Audio Preamplifier	7-92
3076	FM Gain Block	7-101
3086	Transistor Array	8-6

DEVICE	DESCRIPTION	PAGE
7524	Two Channel Core Memory Sense Amplifier	6-87
7525	Two Channel Core Memory Sense Amplifier	6-87
9307	Seven Segment Decoder	6-18
9317B	Seven Segment Decoder/Driver	6-19
9317C	Seven Segment Decoder/Driver	6-19
9368	Seven Segment Decoder/Driver/Latch	6-20
9369	Seven Segment Decoder/Driver/Latch	6-21
9370	Seven Segment Decoder/Driver/Latch	6-22
9614	Dual Differential Line Driver	6-23
9615	Dual Differential Line Receiver	6-27
9616	Triple EIA RS-232-C/MIL-STD-188C Line Driver	6-31
9617	Triple EIA RS-232-C Line Receiver	6-34
9620	Dual Differential Line Receiver	6-36
9621	Dual Line Driver	6-42
9622	Dual Line Receiver	6-48
9624	Dual TTL, MOS Interface Element	6-52
9625	Dual TTL, MOS Interface Element	6-52
9627	Dual EIA RS-232-C/MIL-STD-188C Line Receiver	6-57
9650	4-Bit Current Source	6-60
9660	Seven Segment Decoder/Programmable Current Driver	6-146
9661	Quad Programmable Current Segment Driver	6-146
9662	LED/Lamp Digit Driver	6-147
9663	LED/Lamp Digit Driver	6-147
55107A	Dual Line Receiver	6-69
55108A	Dual Line Receiver	6-69
55109	Dual Line Driver	6-75
55110	Dual Line Driver	6-75
55325	Memory Driver	6-79
75107A	Dual Line Receiver	6-69
75108A	Dual Line Receiver	6-69
75109	Dual Line Driver	6-75
75110	Dual Line Driver	6-75
75325	Memory Driver	6-79
75450A	5 V Dual Peripheral Driver	6-91
75451A	5 V Dual Peripheral Driver	6-91
75452	5 V Dual Peripheral Driver	6-91
75453	5 V Dual Peripheral Driver	6-91
75454	5 V Dual Peripheral Driver	6-91
75460A	5 V Dual Peripheral Driver	6-91
75461A	5 V Dual Peripheral Driver	6-91
75462A	5 V Dual Peripheral Driver	6-91
75463A	5 V Dual Peripheral Driver	6-91
75464A	5 V Dual Peripheral Driver	6-91
75491	MOS to LED Segment and Digit Driver	6-110
75492	MOS to LED Segment and Digit Driver	6-110

Fairchild cannot assume responsibility for use of any circuitry described other than circuitry entirely embodied in a Fairchild product.
No other circuit patent licenses are implied.

LINEAR

CONTENTS AND SECTION SELECTOR

OPERATIONAL AMPLIFIERS 3

COMPARATORS 4

VOLTAGE REGULATORS 5

COMPUTER/INTERFACE 6

CONSUMER 7

TRANSISTOR/DIODE ARRAYS/ANALOG SWITCHES 8

PACKAGE OUTLINES 9

ORDER INFORMATION 10

MIL-M-38510/MIL-STD-883 11

DICE 12

INDUSTRY CROSS REFERENCE GUIDE 13

APPLICATION INFORMATION 14

INDEX

Selection Guide 3-4

DATA SHEETS

General Purpose

μA702 Wideband DC Amplifier 3-9
μA709 High Performance Operational Amplifier 3-16
μA730 Differential Amplifier 3-43
μA739 Dual Low Noise Audio Preamplifier 7-24
μA741 Frequency Compensated Operational Amplifier 3-53
μA741A Frequency Compensated Operational Amplifier 3-60
μA741E Frequency Compensated Operational Amplifier 3-60
μA747 Dual Frequency Compensated Operational Amplifier 3-65
μA747A Dual Frequency Compensated Operational Amplifier 3-72
μA747E Dual Frequency Compensated Operational Amplifier 3-72
μA748 High Performance Operational Amplifier 3-77
μA749 Dual Audio Preamplifier 7-36
μA776 Multi-Purpose Programmable Operational Amplifier 3-84
μA777 Precision Operational Amplifier 3-93
101 General Purpose Operational Amplifier 3-106
101A General Purpose Operational Amplifier 3-109
102 Voltage Follower 3-127
107 General Purpose Operational Amplifier 3-116
110 Voltage Follower 3-127
201 General Purpose Operational Amplifier 3-106
201A General Purpose Operational Amplifier 3-109
207 General Purpose Operational Amplifier 3-116
301A General Purpose Operational Amplifier 3-109
302 Voltage Follower 3-127
307 General Purpose Operational Amplifier 3-116
310 Voltage Follower 3-127
1458 Internally Compensated, High Performance Dual Monolithic Operational Amplifier 3-132
1458C Internally Compensated, High Performance Dual Monolithic Operational Amplifier 3-132
1558 Internally Compensated, High Performance Dual Monolithic Operational Amplifier 3-132

Low Input Current/Low Drift

μA725 Instrumentation Operational Amplifier 3-30
μA727 Temperature-Controlled Differential Preamplifier ... 3-39
μA740 FET Input Operational Amplifier 3-49
μA771 Instrumentation Amplifier 3-138

GENERAL PURPOSE							HIGH POWER	LOW POWER
			COMPENSATED					
307	310	μA741	μA741E	μA776	μA747	1458	μA791	μA776
	Voltage Follower	Industry Standard	High Performance	Programable I_{SET} = 15 μA	Dual Industry Standard	Dual	1 Amp	150 μW Programable I_{SET} = 1.5 μA
7.5	7.5	6.0	3.0	6.0	6.0	6.0	6.0	6.0
50	–	200	30	25	200	200	200	6.0
250	7.0	500	80	50	500	500	500	10
25	$.999 \times 10^{-3}$	20	50	50	20	20	20	50
±5.0 ±18	±5.0 ±18	±5.0 ±18	±5.0 ±22	±1.2 ±18	±5.0 ±18	±5.0 ±18	±5.0 ±18	±1.2 ±18
1.0	20	1.0	1.0	1.0	1.0	1.0	0.2	0.2
0.5 0.5 0.5	30 – –	0.5 0.5 0.5	0.7 0.7 0.7	0.7 0.7 0.7	0.5 0.5 0.5	0.5 0.5 0.5	0.5 1.0 6.0	0.1 0.1 0.1
±15 ±30	±10 –	±15 ±30	±15 ±30	±15 ±30	±15 ±30	±15 ±30	±15 ±30	±15 ±30
6.0	10	7.0	3.0	3.0	7.0	7.0	15	3.0
X	X	X	X	X	X		X	X
X	X	X	X	X	X	X	X	X
X	X	X	X	X	X	X		X
					X	X		

3

GENERAL PURPOSE							HIGH POWER	LOW POWER
			COMPENSATED					
107	110	μA741	μA741A	μA776	μA747	1558	μA791	μA776
	Voltage Follower	Industry Standard	High Performance	Programable I_{SET} = 15 μA	Dual Industry Standard	Dual	1 Amp	150 μW Programable I_{SET} = 1.5 μA
2.0	4.0	5.0	3.0	5.0	5.0	5.0	5.0	5.0
10	–	200	30	15	200	200	200	3.0
75	3.0	500	80	50	500	500	500	7.5
50	$.999 \times 10^{-3}$	50	50	50	50	50	50	50
±5.0 ±20	±5.0 ±18	±5.0 ±22	±5.0 ±22	±1.2 ±18	±5.0 ±22	±5.0 ±22	±5.0 ±22	±1.2 ±18
1.0	20	1.0	1.0	1.0	1.0	1.0	0.2	0.2
0.5 0.5 0.5	30 – –	0.5 0.5 0.5	0.6 0.6 0.6	0.7 0.7 0.7	0.5 0.5 0.5	0.5 0.5 0.5	0.5 1.0 6.0	0.1 0.1 0.1
±15 ±30	±10 –	±15 ±30	±15 ±30	±15 ±30	±15 ±30	±15 ±30	±15 ±30	±15 ±30
3.0 15	6.0	7.0	5.0 15	3.0	7.0	7.0	10	3.0
	X	X	X	X	X		X	X
X	X	X	X	X	X	X	X	X
X	X	X	X	X	X	X	X	X
					X	X		

SELECTION GUIDE FOR COMMERCIAL OPERATIONAL AMPLIFIERS

		HIGH ACCURACY INSTRUMENTATION						
		LOW BIAS CURRENT						
		FET	BIPOLAR		SUPER BETA			
		μA740	μA776	μA777	208	308	208A	308A
		High Z_{IN} 10^{12} Ω High Slew Rate	Low Power I_{SET} = 1.5 μA					
Input Offset Voltage	Max (mV)	100	6.0	7.5	2.0	7.5	0.5	0.5
Input Offset Current	Max (nA)	0.3	6.0	50	0.2	1.0	0.2	1.0
Input Bias Current	Max (nA)	2.0	10	250	2.0	7.0	2.0	7.0
Voltage Gain	Min (V/mV)	25	50	25	50	15	80	80
Operating Supply Voltage Range	Min (V)	±5.0	±1.2	±5.0	±5.0	±5.0	±5.0	±5.0
	Max (V)	±22	±18	±20	±20	±18	±20	±20
Unity Gain Bandwidth	Typ (MHz)	3.0	0.2	1.0	1.0	1.0	1.0	1.0
Slew Rate A_{CL} = 1	Typ (V/μs)	6.0	0.1	0.5	0.3	0.3	0.3	0.3
A_{CL} = −1		6.0	0.1	6.0	0.6	0.6	0.6	0.6
A_{CL} = 10		6.0	0.1	2.0	–	–	–	–
Input Voltage Range	Max (V)	±15	±15	±15	±15	±15	±15	±15
Differential Input Voltage	Max (V)	±30	±30	±30	±0.5	±0.5	±0.5	±0.5
Input Offset Voltage Drift	Typ (μV/°C)	20	3.0	3.0	3.0	6.0	1.0	1.0
	Max (μV/°C)	–	–	–	15	30	5.0	5.0
Offset Adjust		X	X	X				
Output Short Circuit Protection		X	X	X	X	X	X	X
Compensated		X	X					

SELECTION GUIDE FOR MILITARY OPERATIONAL AMPLIFIERS

		HIGH ACCURACY INSTRUMENTATION				
		LOW BIAS CURRENT				
		FET	BIPOLAR		SUPER BETA	
		μA740	μA776	μA777	108	108A
		High Z_{IN} 10^{12} Ω High Slew Rate	Low Power I_{SET} = 1.5 μA			
Input Offset Voltage	Max (mV)	20	5.0	2.0	2.0	0.5
Input Offset Current	Max (nA)	0.15	3.0	10	0.2	0.2
Input Bias Current	Max (nA)	0.2	7.5	75	2.0	2.0
Voltage Gain	Min (V/mV)	50	50	50	50	80
Operating Supply Voltage Range	Min (V)	±5.0	±1.2	±5.0	±5.0	±5.0
	Max (V)	±22	±18	±20	±20	±20
Unity Gain Bandwidth	Typ (MHz)	3.0	0.2	1.0	1.0	1.0
Slew Rate A_{CL} = 1	Typ (V/μs)	6.0	0.1	0.5	0.3	0.3
A_{CL} = −1		6.0	0.1	6.0	0.6	0.6
A_{CL} = 10		6.0	0.1	2.0	–	–
Input Voltage Range	Max (V)	±15	±15	±15	±15	±15
Differential Input Voltage	Max (V)	±30	±30	±30	±0.5	±0.5
Input Offset Voltage Drift	Typ (μV/°C)	20	3.0	3.0	3.0	1.0
	Max (μV/°C)	–	–	15	15	5.0
Offset Adjust		X	X	X		
Output Short Circuit Protection		X	X	X	X	X
Compensated		X	X			

HIGH ACCURACY INSTRUMENTATION							HIGH SPEED					
LOW DRIFT												
OP AMPS					PREAMPS							
μA725C	μA725E	μA741E	208A	308A	μA726	μA727	μA715	μA748	μA776	μA777	301A	310
					I_C = 10 μA Temp. 0 to +85°C	Temp. −20 to +85°C		Feed-Forward	Programable I_{SET} = 500 μA	Feed-Forward	Feed-Forward	Voltage Follower
2.5	0.5	3.0	0.5	0.5	3.0	10	7.5	6.0	6.0	7.5	7.5	7.5
35	5.0	30	100	1.0	100	25	250	200	6.0	50	50	–
125	75	80	300	7.0	300	75	1500	500	10	250	250	7.0
250	1000	50	–	80	–	0.06	10	20	50	25	25	$.999 \times 10^{-3}$
±3.0	±3.0	±5.0	±5.0	±5.0	±5.0	±9.0	±6.0	±5.0	±1.2	±5.0	±5.0	±5.0
±22	±22	±22	±18	±20	±18	±18	±18	±18	±18	±20	±20	±18
1.0	1.0	1.0	1.0	1.0	20	1.0	65	1.0	1.2	1.0	1.0	20
–	–	0.6	0.3	0.3	–	–	18	0.5	15	0.5	0.5	30
–	–	0.6	0.6	0.6	–	–	100	6.0	15	6.0	15	–
–	–	0.6	–	–	–	–	38	2.0	15	2.0	5.0	–
±22	±22	±15	±15	±15	±30	±10	±15	±15	±15	±15	±15	±15
±22	±22	±30	±0.5	±0.5	±5.0	±15	±15	±30	±30	±30	±30	–
0.5	0.5	4.0	1.0	1.0	0.2	0.6	6.0	7.0	3.0	3.0	6.0	10
5.0	2.0	15	5.0	5.0	1.0	1.5						
X	X	X		X	X		X	X	X	X	X	X
X	X	X		X	X	X		X	X	X	X	X
		X			X							

HIGH ACCURACY INSTRUMENTATION						HIGH SPEED					
LOW DRIFT											
OP AMPS				PREAMPS							
μA725	μA725A	μA741A	108A	μA726	μA727	μA715	μA748	μA776	μA777	101A	110
				I_C = 10 μA			Feed-Forward	Programable I_{SET} = 500 μA	Feed-Forward	Feed-Forward	Voltage Follower
1.0	0.5	3.0	0.5	2.5	10	5.0	5.0	5.0	2.0	2.0	4.0
20	5.0	30	0.2	50	15	250	200	3.0	10	10	–
100	75	80	2.0	150	40	750	500	7.5	75	75	3.0
1000	1000	50	80	–	0.06	15	50	50	50	50	$.999 \times 10^{-3}$
±3.0	±3.0	±5.0	–	±5.0	±9.0	±6.0	±5.0	±1.2	±5.0	±5.0	±5.0
±22	±22	±22	±20	±18	±18	±18	±22	±18	±20	±20	±18
1.0	1.0	1.0	1.0	20	1.0	65	1.0	1.2	1.0	1.0	20
–	–	0.6	0.3	–	–	18	0.5	15	0.5	0.5	30
–	–	0.6	0.6	–	–	100	6.0	15	6.0	6.0	–
–	–	0.6	–	–	–	38	2.0	15	2.0	2.0	–
±22	±22	±15	±15	±30	±10	±15	±15	±15	±15	±15	±15
±22	±22	±30	±0.5	±5.0	±15	±15	±30	±30	±30	±30	–
0.5	0.5	3.0	1.0	0.2	0.6	6.0	7.0	3.0	3.0	3.0	6.0
5.0	2.0	15	5.0	1.0	1.5					15	
X	X	X		X		X	X	X	X	X	X
X	X	X	X	X	X		X	X	X	X	X
		X		X							

μA702

WIDEBAND DC AMPLIFIER

FAIRCHILD LINEAR INTEGRATED CIRCUIT

GENERAL DESCRIPTION – The μA702 is a monolithic DC Amplifier constructed using the Fairchild Planar* epitaxial process. It is intended for use as an operational amplifier in analog computers, as a prevision instrumentation amplifier, or in other applications requiring a feedback amplifier useful from dc to 30 MHz.

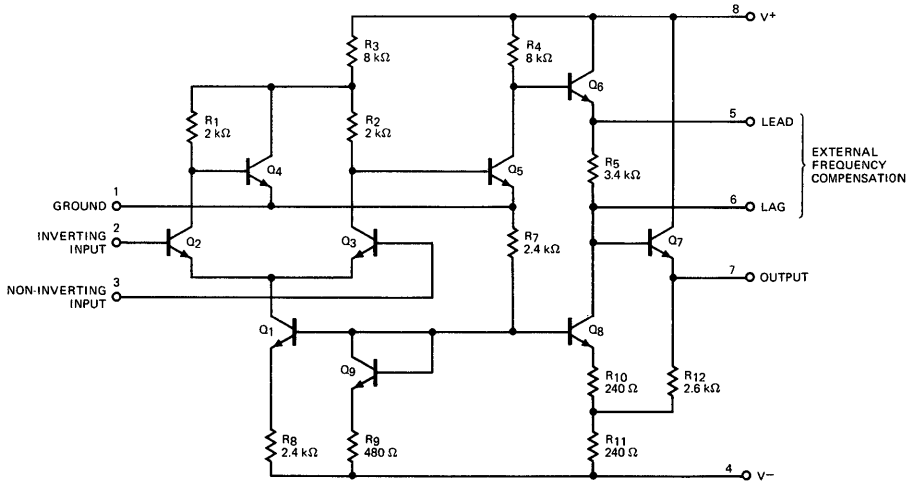
- **LOW OFFSET VOLTAGE**
- **LOW OFFSET VOLTAGE DRIFT**
- **WIDE BANDWIDTH – 20 MHz TYP.**
- **HIGH SLEW RATE – 5 V/μs TYP.**

ABSOLUTE MAXIMUM RATINGS

Voltage Between V^+ and V^- Terminals	21 V
Peak Output Current	50 mA
Differential Input Voltage	±5.0 V
Input Voltage	+1.5 V to −6.0 V
Internal Power Dissipation (Note)	
Metal Can	500 mW
DIP	670 mW
Flatpak	570 mW
Operating Temperature Range	
Military (702)	−55°C to +125°C
Commercial (702C)	0°C to +70°C
Storage Temperature Range	−65°C to +150°C
Lead Temperature (Soldering, 60 seconds)	300°C

NOTE
Rating applies to ambient temperature up to 70°C. Above 70°C ambient derate linearly at 6.3mW/°C for Metal Can, 8.3mW/°C for DIP and 7.1mW/°C for the Flatpak.

EQUIVALENT CIRCUIT

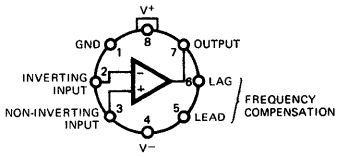


Pin numbers are shown for Metal Can only.

CONNECTION DIAGRAMS

8-LEAD METAL CAN
(TOP VIEW)

PACKAGE OUTLINE 5B



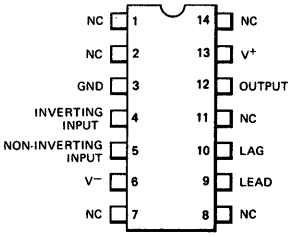
NOTE: Pin 4 connected to case.

ORDER INFORMATION

TYPE	PART NO.
702	702HM
702C	702HC

14-LEAD DIP
(TOP VIEW)

PACKAGE OUTLINE 6A

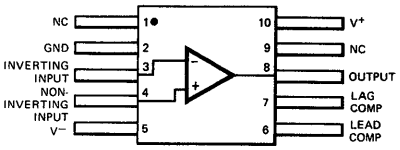


ORDER INFORMATION

TYPE	PART NO.
702	702DM
702C	702DC

10-LEAD FLATPAK
(TOP VIEW)

PACKAGE OUTLINE 3F



ORDER INFORMATION

TYPE	PART NO.
702	702FM

*Planar is a patented Fairchild process.

3

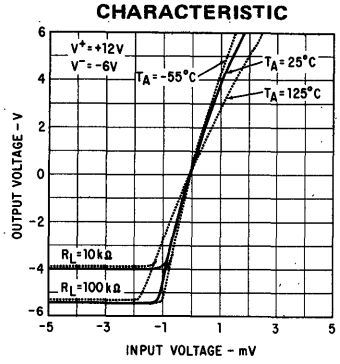
702

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise specified)

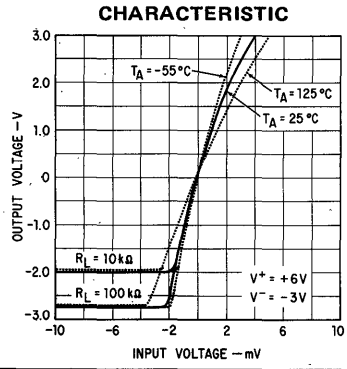
PARAMETER		CONDITIONS	V_+ = 12.0 V, V_- = −6.0 V MIN.	TYP.	MAX.	V_+ = 6.0 V, V_- = −3.0 V MIN.	TYP.	MAX.	UNITS
Input Offset Voltage		$R_S \leq 2\ k\Omega$		0.5	2.0		0.7	3.0	mV
Input Offset Current				180	500		120	500	nA
Input Bias Current				2.0	5.0		1.2	3.5	μA
Input Resistance			16	40		22	67		kΩ
Input Voltage Range			−4.0		+0.5	−1.5		+0.5	V
Common Mode Rejection Ratio		$R_S \leq 2\ k\Omega$, f ≤ 1 kHz	80	100		80	100		dB
Large Signal Voltage Gain		$R_L \geq 100\ k\Omega$, V_{OUT} = ±5.0 V	2500	3600	6000				
		$R_L \geq 100\ k\Omega$, V_{OUT} = ±2.5 V				600	900	1500	
Output Resistance				200	500		300	700	Ω
Supply Current		V_{OUT} = 0		5.0	6.7		2.1	3.3	mA
Power Consumption		V_{OUT} = 0		90	120		19	30	mW
Transient Response (unity-gain)	Risetime	C_I = 0.01 μF, R_I = 20 Ω, $R_L \geq 100\ k\Omega$, V_{IN} = 10 mV		25	120				ns
	Overshoot	$C_L \leq 100$ pF		10	50				%
Transient Response (x100 gain)	Risetime	C_3 = 50 pF, $R_L \geq 100\ k\Omega$,		10	30				ns
	Overshoot	V_{IN} = 1 mV		20	40				%
The following specifications apply for −55°C ≤ T_A ≤ +125°C:									
Input Offset Voltage		$R_S \leq 2\ k\Omega$			3.0			4.0	mV
Average Temperature Coefficient of Input Offset Voltage		R_S = 50 Ω, T_A = 25°C to +125°C		2.5	10		3.5	15	μV/°C
		R_S = 50 Ω, T_A = 25°C to −55°C		2.0	10		3.0	15	μV/°C
Input Offset Current		T_A = +125°C		80	500		50	500	nA
		T_A = −55°C		400	1500		280	1500	nA
Average Temperature Coefficient of Input Offset Current		T_A = 25°C to +125°C		1.0	5.0		0.7	4.0	nA/°C
		T_A = 25°C to −55°C		3.0	16		2.0	13	nA/°C
Input Bias Current		T_A = −55°C		4.3	10		2.6	7.5	μA
Input Resistance			6.0			8.0			kΩ
Common Mode Rejection Ratio		$R_S \leq 2\ k\Omega$, f ≤ 1 kHz	70	95		70	95		dB
Supply Voltage Rejection Ratio		V_+ = 12 V, V_- = −6 V to V_+ = 6 V, V_- = −3 V $R_S \leq 2\ k\Omega$		75	200		75	200	μV/V
Large Signal Voltage Gain		$R_L \geq 100\ k\Omega$, V_{OUT} = ±5.0 V	2000		7000				
		$R_L \geq 100\ k\Omega$, V_{OUT} = ±2.5 V				500		1750	
Output Voltage Swing		$R_L \geq 100\ k\Omega$	±5.0	±5.3		±2.5	±2.7		V
		$R_L \geq 10\ k\Omega$	±3.5	±4.0		±1.5	±2.0		V
Supply Current		T_A = +125°C, V_{OUT} = 0		4.4	6.7		1.7	3.3	mA
		T_A = −55°C, V_{OUT} = 0		5.0	7.5		2.1	3.9	mA
Power Consumption		T_A = +125°C, V_{OUT} = 0		80	120		15	30	mW
		T_A = −55°C, V_{OUT} = 0		90	135		19	35	mW

TYPICAL PERFORMANCE CURVES FOR 702

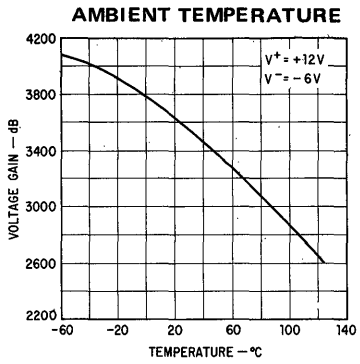
VOLTAGE TRANSFER CHARACTERISTIC



VOLTAGE TRANSFER CHARACTERISTIC



VOLTAGE GAIN AS A FUNCTION OF AMBIENT TEMPERATURE



702C

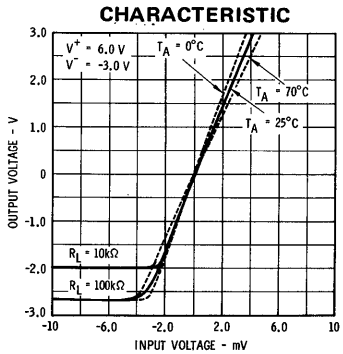
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise specified)

PARAMETER		CONDITIONS	V_+ = 12.0 V, V_- = −6.0 V MIN.	TYP.	MAX.	V_+ = 6.0 V, V_- = −3.0 V MIN.	TYP.	MAX.	UNITS
Input Offset Voltage		$R_S \leq 2\,k\Omega$		1.5	5.0		1.7	6.0	mV
Input Offset Current				0.5	2.0		0.3	2.0	μA
Input Bias Current				2.5	7.5		1.5	5.0	μA
Input Resistance			10	32		16	55		kΩ
Input Voltage Range			−4.0		+0.5	−1.5		+0.5	V
Common Mode Rejection Ratio		$R_S \leq 2\,k\Omega$, f ≤ 1 kHz	70	92		70	92		dB
Large Signal Voltage Gain		$R_L \geq 100\,k\Omega$, V_{OUT} = ±5.0 V	2000	3400	6000				
		$R_L \geq 100\,k\Omega$, V_{OUT} = ±2.5 V				500	800	1500	
Output Resistance				200	600		300	800	Ω
Supply Current		V_{OUT} = 0		5.0	6.7		2.1	3.3	mA
Power Consumption		V_{OUT} = 0		90	120		19	30	mW
Transient Response (unity gain)	Risetime	C_I = 0.01 μF, R_I = 20 Ω, $R_L \leq 100\,k\Omega$, V_{IN} = 10 mV		25	120				ns
	Overshoot	$C_L \leq 100$ pF		10	50				%
Transient Response (x100 gain)	Risetime	C_3 = 50 pF, $R_L \geq 100\,k\Omega$, V_{IN} = 1 mV		10	30				ns
	Overshoot			20	40				%
The following specifications apply for 0°C ≤ T_A ≤ +70°C:									
Input Offset Voltage		$R_S \leq 2\,k\Omega$			6.5			7.5	mV
Average Temperature Coefficient of Input Offset Voltage		R_S = 50 Ω, T_A = +70°C to 0°C		5.0	20		7.5	25	μV/°C
Input Offset Current					2.5			2.5	μA
Average Temperature Coefficient of Input Offset Current		T_A = 25°C to +70°C		4.0	10		3.0	8.0	nA/°C
		T_A = 25°C to 0°C		6.0	20		5.5	18	nA/°C
Input Bias Current		T_A = 0°C		4.0	12		2.7	8	μA
Input Resistance			6.0	18		9.0	27		kΩ
Common Mode Rejection Ratio		$R_S \leq 2\,k\Omega$, f ≤ 1 kHz	65	86		65	86		dB
Supply Voltage Rejection Ratio		V_+ = 12 V, V_- = 6 V to V_+ = 6 V, V_- = 3 V, $R_S \leq 2\,k\Omega$		90	300		90	300	μV/V
Large Signal Voltage Gain		$R_L \geq 100\,k\Omega$, V_{OUT} = ±5.0 V	1500		7000				
		$R_L \geq 100\,k\Omega$, V_{OUT} = ±2.5 V				400		1750	
Output Voltage Swing		$R_L \geq 100\,k\Omega$	±5.0	±5.3		±2.5	±2.7		V
		$R_L \geq 10\,k\Omega$	±3.5	±4.0		±1.5	±2.0		V
Supply Current		V_{OUT} = 0		5.0	7.0		2.1	3.9	mA
Power Consumption		V_{OUT} = 0		90	125		19	35	mW

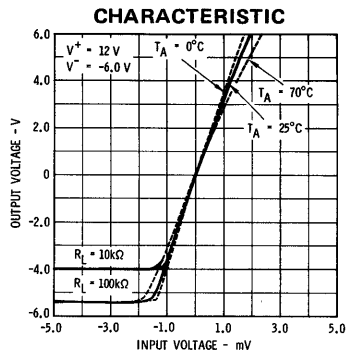
3

TYPICAL PERFORMANCE CURVES FOR 702C

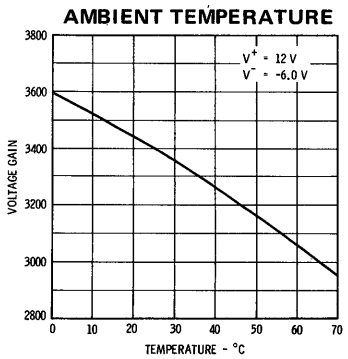
VOLTAGE TRANSFER CHARACTERISTIC



VOLTAGE TRANSFER CHARACTERISTIC

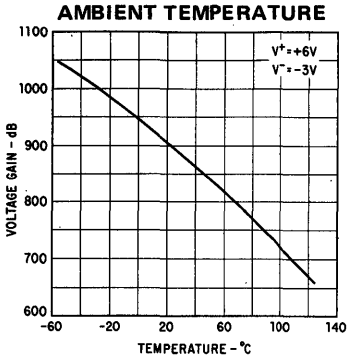


VOLTAGE GAIN AS A FUNCTION OF AMBIENT TEMPERATURE

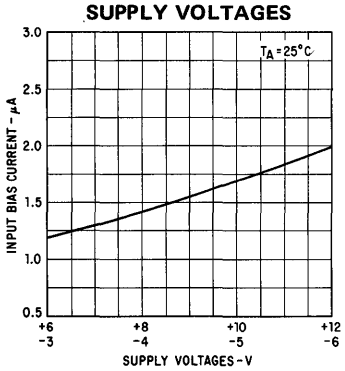


TYPICAL PERFORMANCE CURVES FOR 702

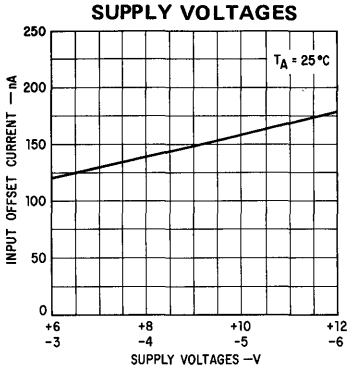
VOLTAGE GAIN AS A FUNCTION OF AMBIENT TEMPERATURE



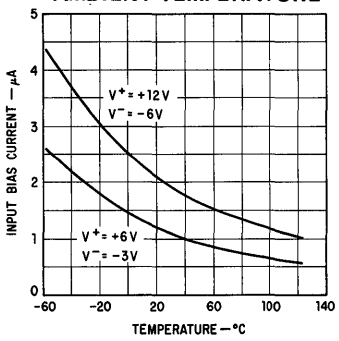
INPUT BIAS CURRENT AS A FUNCTION OF SUPPLY VOLTAGES



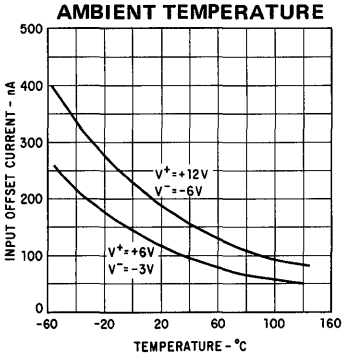
INPUT OFFSET CURRENT AS A FUNCTION OF SUPPLY VOLTAGES



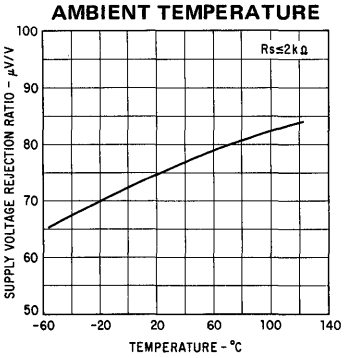
INPUT BIAS CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



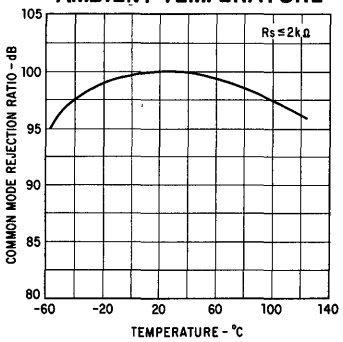
INPUT OFFSET CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



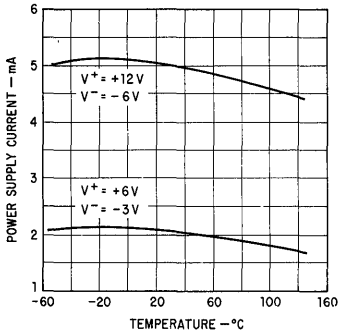
SUPPLY VOLTAGE REJECTION RATIO AS A FUNCTION OF AMBIENT TEMPERATURE



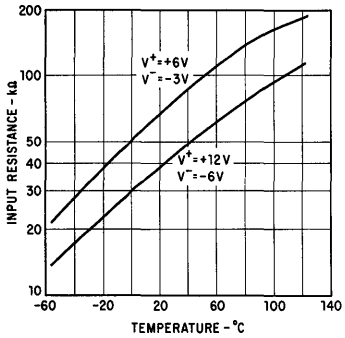
COMMON MODE REJECTION RATIO AS A FUNCTION OF AMBIENT TEMPERATURE



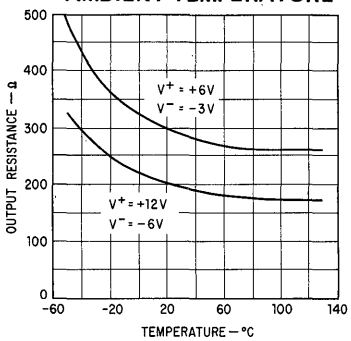
POWER SUPPLY CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



INPUT RESISTANCE AS A FUNCTION OF AMBIENT TEMPERATURE

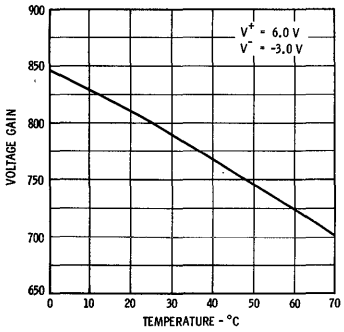


OUTPUT RESISTANCE AS A FUNCTION OF AMBIENT TEMPERATURE

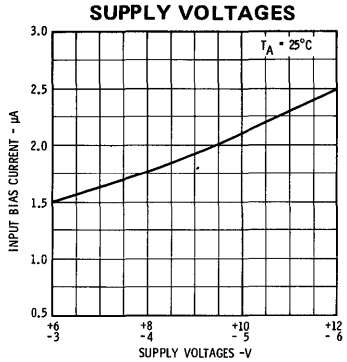


TYPICAL PERFORMANCE CURVES FOR 702C

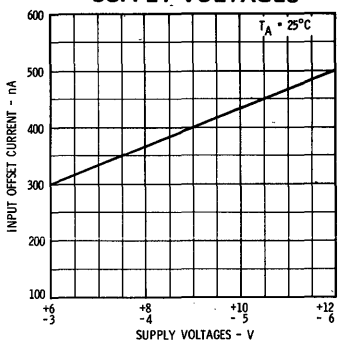
VOLTAGE GAIN AS A FUNCTION OF AMBIENT TEMPERATURE



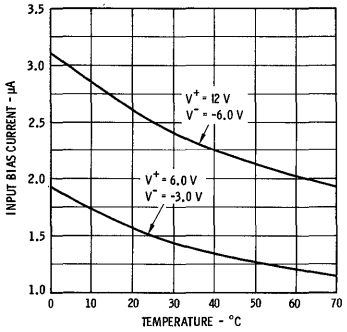
INPUT BIAS CURRENT AS A FUNCTION OF SUPPLY VOLTAGES



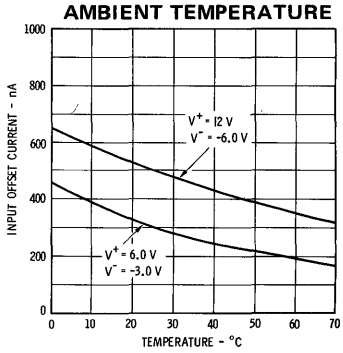
INPUT OFFSET CURRENT AS A FUNCTION OF SUPPLY VOLTAGES



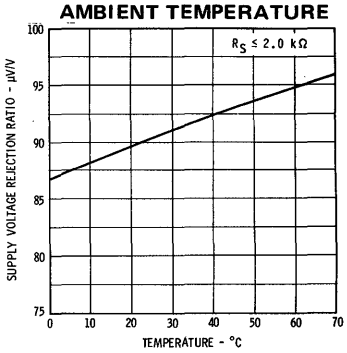
INPUT BIAS CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



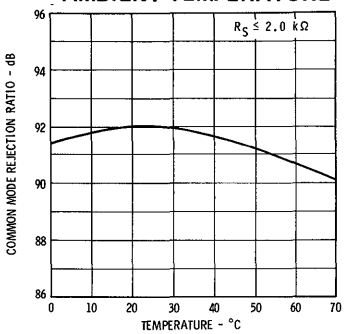
INPUT OFFSET CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



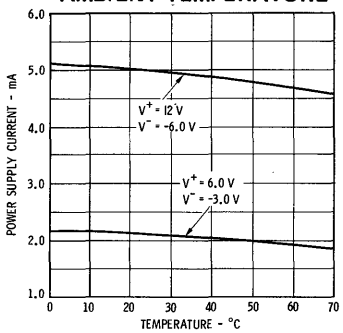
SUPPLY VOLTAGE REJECTION RATIO AS A FUNCTION OF AMBIENT TEMPERATURE



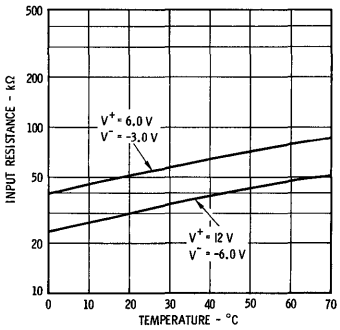
COMMON MODE REJECTION RATIO AS A FUNCTION OF AMBIENT TEMPERATURE



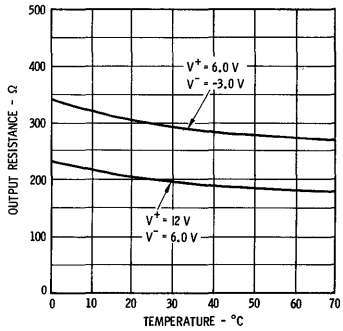
POWER SUPPLY CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



INPUT RESISTANCE AS A FUNCTION OF AMBIENT TEMPERATURE



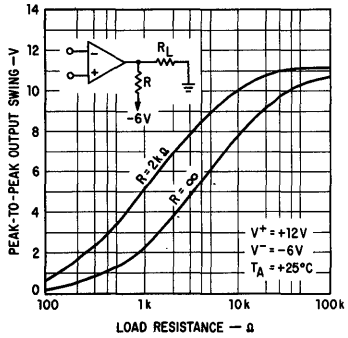
OUTPUT RESISTANCE AS A FUNCTION OF AMBIENT TEMPERATURE



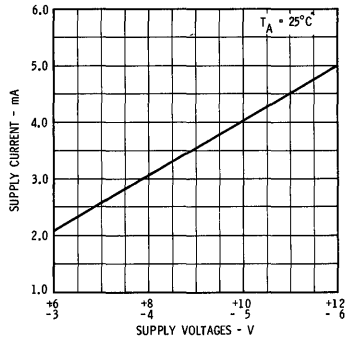
3

TYPICAL PERFORMANCE CURVES FOR 702 AND 702C

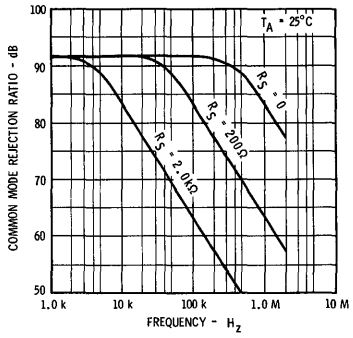
OUTPUT VOLTAGE SWING AS A FUNCTION OF LOAD RESISTANCE



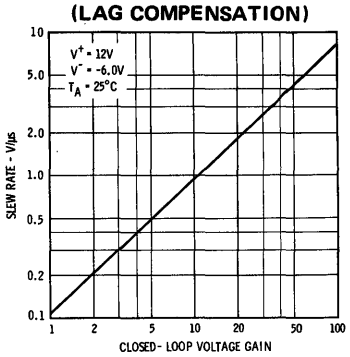
SUPPLY CURRENT AS A FUNCTION OF SUPPLY VOLTAGES



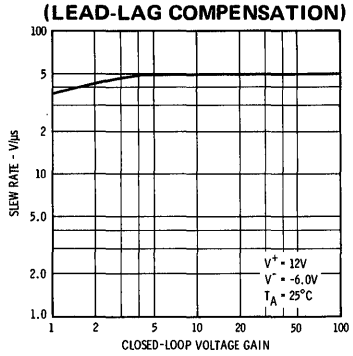
COMMON MODE REJECTION RATIO AS A FUNCTION OF FREQUENCY



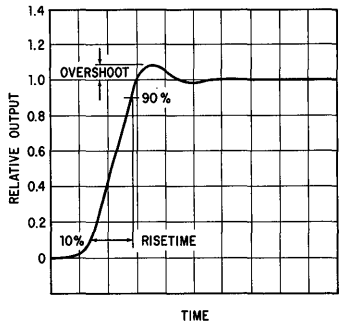
SLEW RATE AS A FUNCTION OF CLOSED-LOOP VOLTAGE GAIN (LAG COMPENSATION)



SLEW RATE AS A FUNCTION OF CLOSED-LOOP VOLTAGE GAIN (LEAD-LAG COMPENSATION)

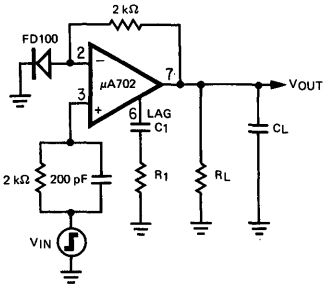


TRANSIENT RESPONSE

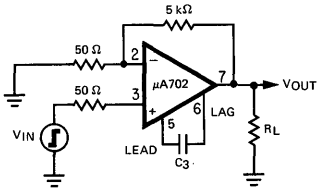


TRANSIENT RESPONSE TEST CIRCUITS

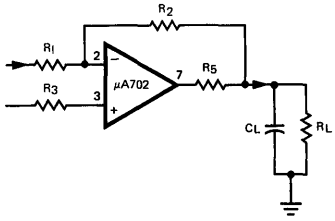
UNITY-GAIN AMPLIFIER (LAG COMPENSATION)



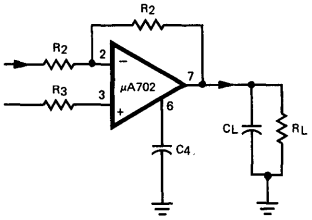
X100 AMPLIFIER (LEAD COMPENSATION)



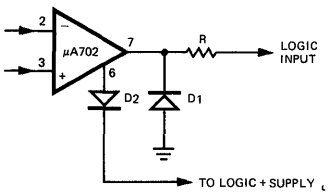
SERIES RESISTANCE LIMITING*



OUTPUT RISE-TIME LIMITING*



LOGIC COMPATIBILITY

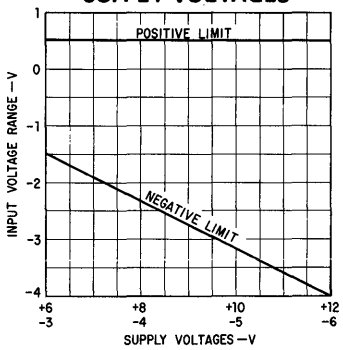


*Peak Current Limiting with Capacitive Loads.

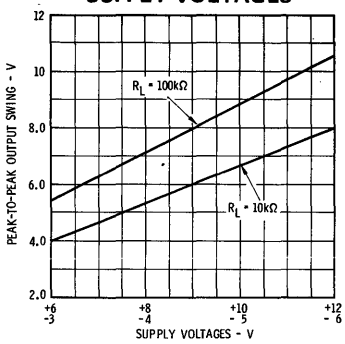
Pin numbers are shown for Metal Can only.

TYPICAL PERFROMANCE CURVES FOR 702 AND 702C

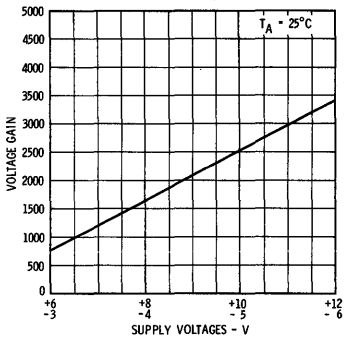
INPUT VOLTAGE RANGE AS A FUNCTION OF SUPPLY VOLTAGES



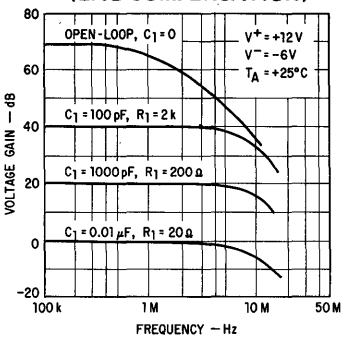
OUTPUT VOLTAGE SWING AS A FUNCTION OF SUPPLY VOLTAGES



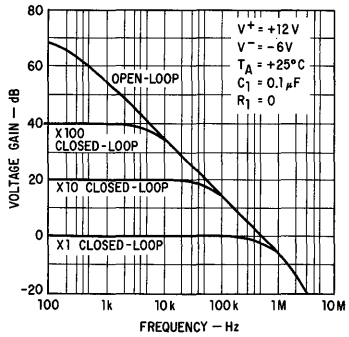
VOLTAGE GAIN AS A FUNCTION OF SUPPLY VOLTAGES



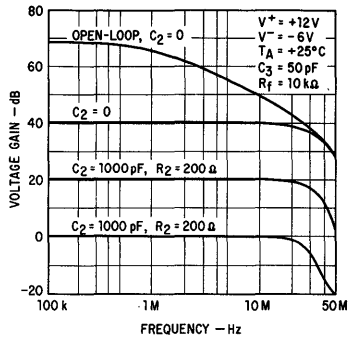
FREQUENCY RESPONSE FOR VARIOUS CLOSED-LOOP GAINS (LAG COMPENSATION)



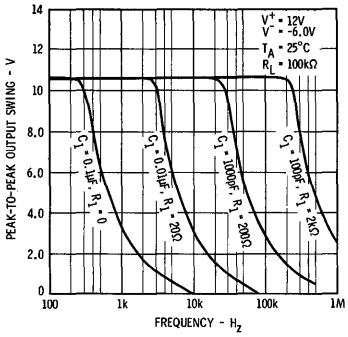
FREQUENCY RESPONSE WITH CONSERVATIVE COMPENSATION NETWORK



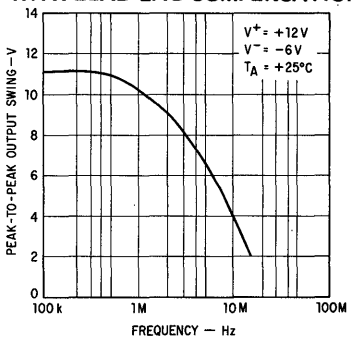
FREQUENCY RESPONSE FOR VARIOUS CLOSED-LOOP GAINS (LEAD-LAG COMPENSATION)



OUTPUT VOLTAGE SWING AS A FUNCTION OF FREQUENCY FOR VARIOUS LAG COMPENSATION NETWORKS

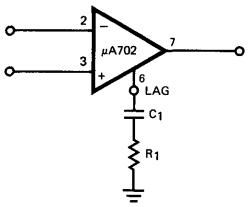


OUTPUT VOLTAGE SWING AS A FUNCTION OF FREQUENCY WITH LEAD-LAG COMPENSATION

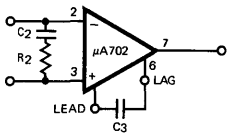


FREQUENCY COMPENSATION CIRCUITS

LAG COMPENSATION



LEAD-LAG COMPENSATION



Pin numbers are shown for Metal Can only.

μA709

HIGH PERFORMANCE OPERATIONAL AMPLIFIER

FAIRCHILD LINEAR INTEGRATED CIRCUITS

GENERAL DESCRIPTION — The μA709 is a monolithic High Gain Operational Amplifier constructed using the Fairchild Planar* epitaxial process. It features low offset, high input impedance, large input common mode range, high output swing under load and low power consumption. The device displays exceptional temperature stability and will operate over a wide range of supply voltages with little degradation of performance. The amplifier is intended for use in dc servo systems, high impedance analog computers, low level instrumentation applications and for the generation of special linear and nonlinear transfer functions.

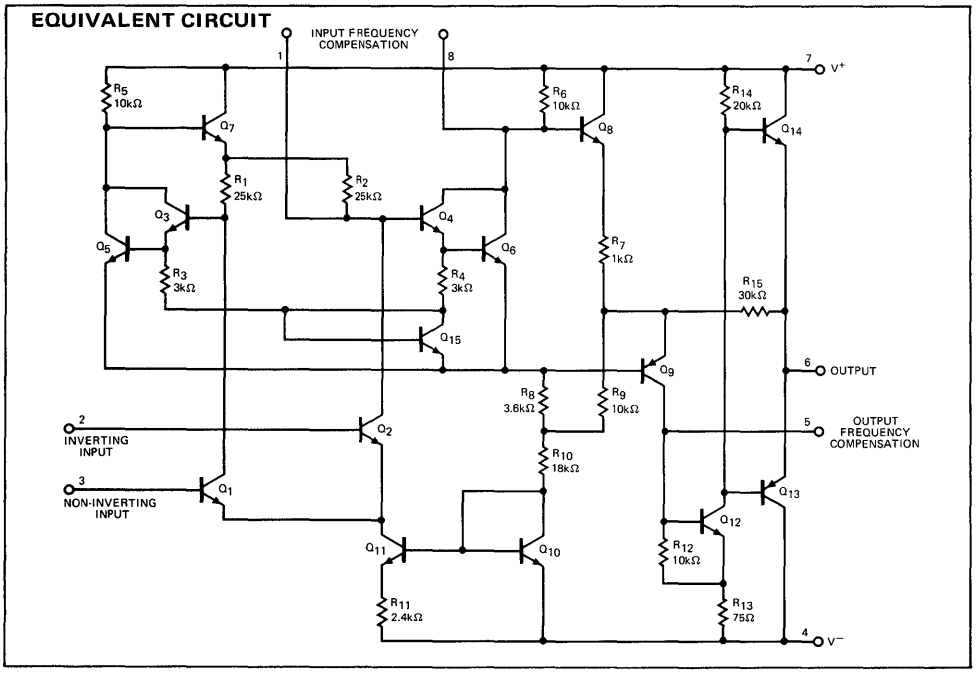
ABSOLUTE MAXIMUM RATINGS

Supply Voltage	±18 V
Internal Power Dissipation (Note)	
Metal Can	500 mW
DIP	670 mW
Flatpak	570 mW
Differential Input Voltage	±5.0 V
Input Voltage	±10 V
Storage Temperature Range	
Metal Can, DIP, and Flatpak	−65°C to +150°C
Operating Temperature Range	
Military (709A and 709)	−55°C to +125°C
Commercial (709C)	0°C to +70°C
Lead Temperature	
Metal Can, DIP and Flatpak (Soldering 60 seconds)	300°C
Output Short Circuit Duration	5 seconds

NOTE

Rating applies to ambient temperature up to 70°C. Above 70°C ambient derate linearly at 6.3 mW/°C for Metal Can, 8.3 mW/°C for DIP and 7.1 mW/°C for the Flatpak.

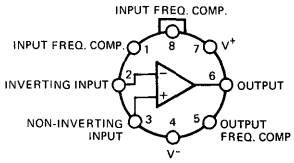
EQUIVALENT CIRCUIT



CONNECTION DIAGRAMS

8-LEAD METAL CAN
(TOP VIEW)

PACKAGE OUTLINE 5B



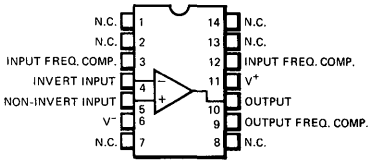
NOTE: Pin 4 connected to case

ORDER INFORMATION

TYPE	PART NO.
709A	709AHM
709	709HM
709C	709HC

14-LEAD DIP
(TOP VIEW)

PACKAGE OUTLINE 6A

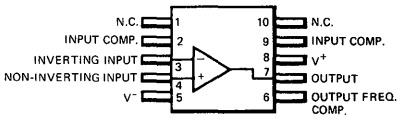


ORDER INFORMATION

TYPE	PART NO.
709A	709ADM
709	709DM
709C	709DC

10-LEAD FLATPAK
(TOP VIEW)

PACKAGE OUTLINE 3F



ORDER INFORMATION

TYPE	PART NO.
709A	709AFM
709	709FM

*Planar is a patented Fairchild process.

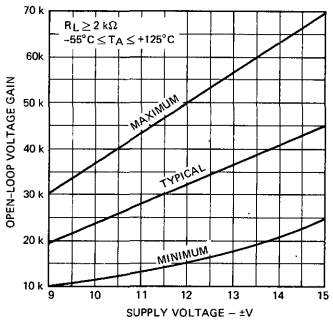
709A

ELECTRICAL CHARACTERISTICS (T_A = +25°C, ±9 V ≤ V_S ≤ ±15 V unless otherwise specified)

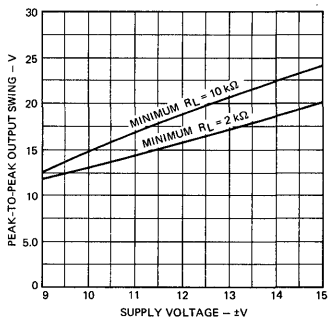
PARAMETER (see definitions)		CONDITIONS	MIN.	TYP.	MAX.	UNITS
Input Offset Voltage		$R_S \leq 10$ kΩ		0.6	2.0	mV
Input Offset Current				10	50	nA
Input Bias Current				100	200	nA
Input Resistance			350	700		kΩ
Output Resistance				150		Ω
Supply Current		V_S = ±15 V		2.5	3.6	mA
Power Consumption		V_S = ±15 V		75	108	mW
Transient Response	Risetime	V_S = ±15 V, V_{IN} = 20 mV, R_L = 2 kΩ, C_1 = 5 nF, R_1 = 1.5 kΩ, C_2 = 200 pF, R_2 = 50Ω $C_L \leq 100$ pF			1.5	μs
	Overshoot				30	%
The following specifications apply for −55°C ≤ T_A ≤ +125°C:						
Input Offset Voltage		$R_S \leq 10$ kΩ			3.0	mV
Average Temperature Coefficient of Input Offset Voltage		R_S = 50Ω, T_A = +25°C to +125°C		1.8	10	μV/°C
		R_S = 50Ω, T_A = +25°C to −55°C		1.8	10	μV/°C
		R_S = 10 kΩ, T_A = +25°C to +125°C		2.0	15	μV/°C
		R_S = 10 kΩ, T_A = +25°C to −55°C		4.8	25	μV/°C
Input Offset Current		T_A = +125°C		3.5	50	nA
		T_A = −55°C		40	250	nA
Average Temperature Coefficient of Input Offset Current		T_A = +25°C to +125°C		0.08	0.5	nA/°C
		T_A = +25°C to −55°C		0.45	2.8	nA/°C
Input Bias Current		T_A = −55°C		300	600	nA
Input Resistance		T_A = −55°C	85	170		kΩ
Input Voltage Range		V_S = ±15 V	±8.0			V
Common Mode Rejection Ratio		$R_S \leq 10$ kΩ	80	110		dB
Supply Voltage Rejection Ratio		$R_S \leq 10$ kΩ		40	100	μV/V
Large Signal Voltage Gain		V_S = ±15 V, $R_L \geq 2$ kΩ, V_{OUT} = ±10 V	25,000		70,000	V/V
Output Voltage Swing		V_S = ±15 V, $R_L \geq 10$ kΩ	±12	±14		V
		V_S = ±15 V, $R_L \geq 2$ kΩ	±10	±13		V
Supply Current		T_A = +125°C, V_S = ±15 V		2.1	3.0	mA
		T_A = −55°C, V_S = ±15 V		2.7	4.5	mA
Power Consumption		T_A = +125°C, V_S = ±15 V		63	90	mW
		T_A = −55°C, V_S = ±15 V		81	135	mW

PERFORMANCE CURVES FOR 709A

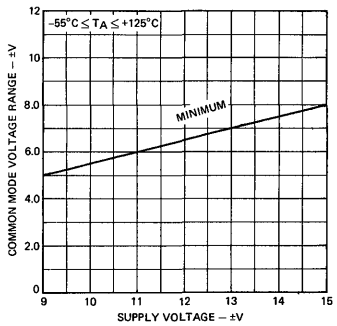
VOLTAGE GAIN



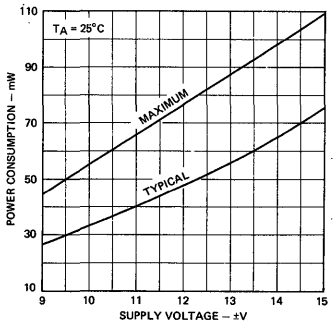
OUTPUT VOLTAGE SWING



INPUT COMMON MODE VOLTAGE RANGE



POWER CONSUMPTION



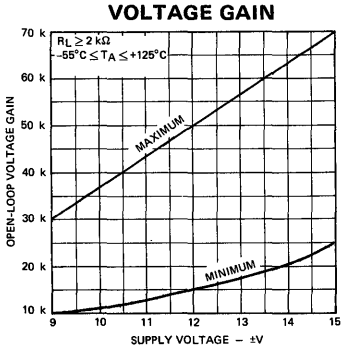
709

ELECTRICAL CHARACTERISTICS (T_A = +25°C, ±9 V ≤ V_S ≤ ±15 V unless otherwise specified)

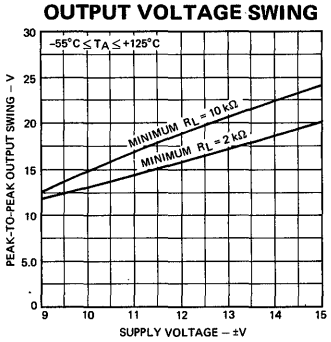
PARAMETER (see definitions)		CONDITIONS	MIN.	TYP.	MAX.	UNITS
Input Offset Voltage		$R_S \leq 10$ kΩ		1.0	5.0	mV
Input Offset Current				50	200	nA
Input Bias Current				200	500	nA
Input Resistance			150	400		kΩ
Output Resistance				150		Ω
Power Consumption		V_S = ±15 V		80	165	mW
Transient Response	Risetime	V_{IN} = 20 mV, R_L = 2 kΩ, C_1 = 5000 pF, R_1 = 1.5 kΩ, C_2 = 200 pF, R_2 = 50Ω		0.3	1.0	μs
	Overshoot	$C_L \leq 100$ pF		10	30	%
The following specifications apply for −55°C ≤ T_A ≤ +125°C:						
Input Offset Voltage		$R_S \leq 10$ kΩ			6.0	mV
Average Temperature Coefficient of Input Offset Voltage		R_S = 50Ω		3.0		μV/°C
		$R_S \leq 10$ kΩ		6.0		μV/°C
Large Signal Voltage Gain		V_S = ±15 V, $R_L \geq 2$ kΩ, V_{OUT} = ±10 V	25,000	45,000	70,000	V/V
Output Voltage Swing		V_S = ±15 V, $R_L \geq 10$ kΩ	±12	±14		V
		V_S = ±15 V, $R_L \geq 2$ kΩ	±10	±13		V
Input Voltage Range		V_S = ±15 V	±8.0	±10		V
Common Mode Rejection Ratio		$R_S \leq 10$ kΩ	70	90		dB
Supply Voltage Rejection Ratio		$R_S \leq 10$ kΩ		25	150	μV/V
Input Offset Current		T_A = +125°C		20	200	nA
		T_A = −55°C		100	500	nA
Input Bias Current		T_A = −55°C		0.5	1.5	μA
Input Resistance			40	100		kΩ

PERFORMANCE CURVES FOR 709

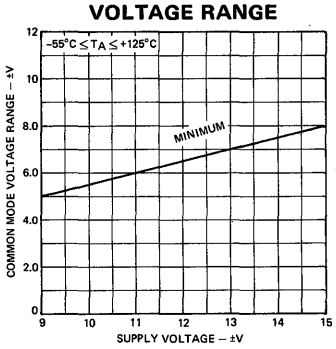
VOLTAGE GAIN



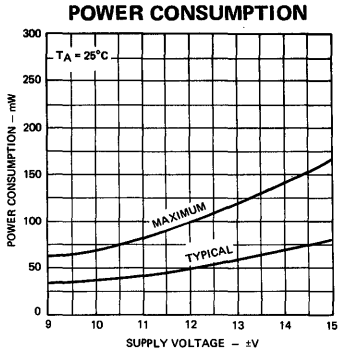
OUTPUT VOLTAGE SWING



INPUT COMMON MODE VOLTAGE RANGE



POWER CONSUMPTION



709C

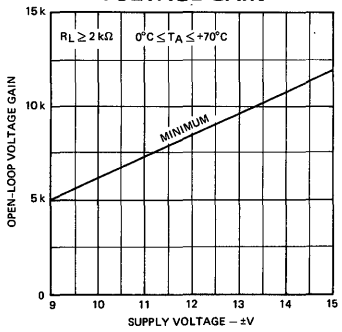
ELECTRICAL CHARACTERISTICS (V_S = ±15 V, T_A = 25°C unless otherwise specified)

PARAMETER (see definitions)		CONDITIONS	MIN.	TYP.	MAX.	UNITS
Input Offset Voltage		$R_S \leq 10$ kΩ, ±9 V $\leq V_S \leq$ ±15 V		2.0	7.5	mV
Input Offset Current				100	500	nA
Input Bias Current				0.3	1.5	μA
Input Resistance			50	250		kΩ
Output Resistance				150		Ω
Large Signal Voltage Gain		$R_L \geq 2$ kΩ, V_{OUT} = ±10 V	15,000	45,000		V/V
Output Voltage Swing		$R_L \geq 10$ kΩ	±12	±14		V
		$R_L \geq 2$ kΩ	±10	±13		V
Input Voltage Range			±8.0	±10		V
Common Mode Rejection Ratio		$R_S \leq 10$ kΩ	65	90		dB
Supply Voltage Rejection Ratio		$R_S \leq 10$ kΩ		25	200	μV/V
Power Consumption				80	200	mW
Transient Response	Risetime	V_{IN} = 20 mV, R_L = 2 kΩ, C_1 = 5000 pF, R_1 = 1.5 kΩ, C_2 = 200 pF, R_2 = 50Ω $C_L \leq 100$ pF		0.3		μs
	Overshoot			10		%
The following specifications apply for 0°C $\leq T_A \leq$ +70°C:						
Input Offset Voltage		$R_S \leq 10$ kΩ, ±9 V $\leq V_S \leq$ ±15 V			10	mV
Input Offset Current					750	nA
Input Bias Current					2.0	μA
Large Signal Voltage Gain		$R_L \geq 2$ kΩ, V_{OUT} = ±10 V	12,000			V/V
Input Resistance			35			kΩ

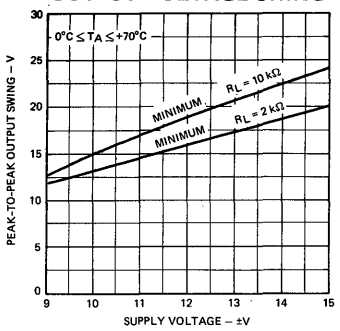
3

PERFORMANCE CURVES FOR 709C

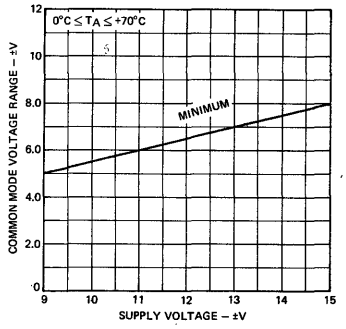
VOLTAGE GAIN



OUTPUT VOLTAGE SWING

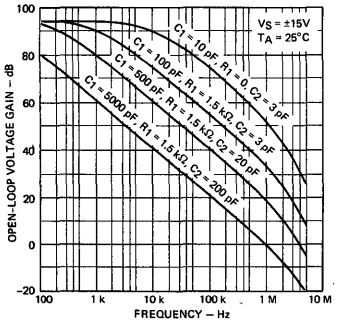


INPUT COMMON MODE VOLTAGE RANGE

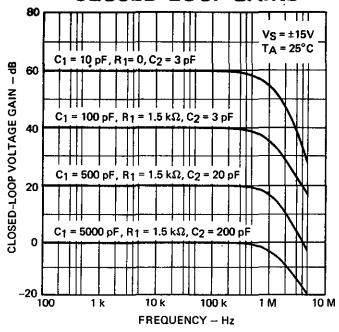


FREQUENCY COMPENSATION CURVES FOR ALL TYPES

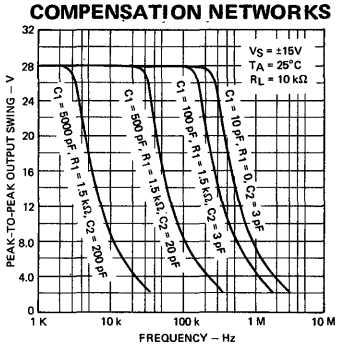
OPEN-LOOP FREQUENCY RESPONSE FOR VARIOUS VALUES OF COMPENSATION



FREQUENCY RESPONSE FOR VARIOUS CLOSED-LOOP GAINS

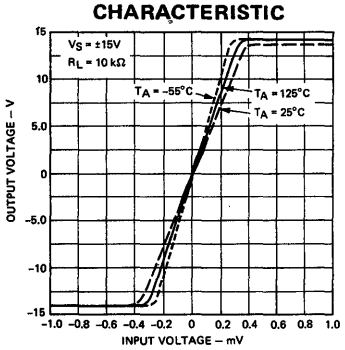


OUTPUT VOLTAGE SWING AS A FUNCTION OF FREQUENCY FOR VARIOUS COMPENSATION NETWORKS

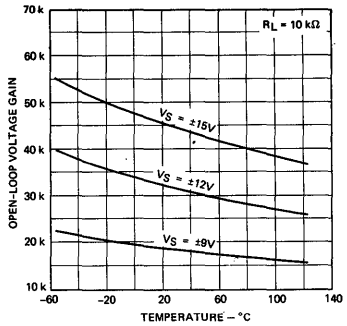


TYPICAL PERFORMANCE CURVES FOR 709A

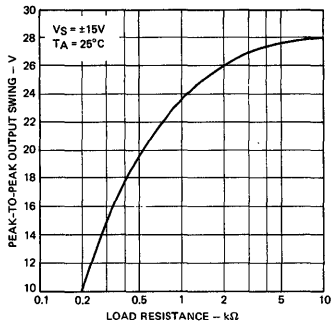
VOLTAGE TRANSFER CHARACTERISTIC



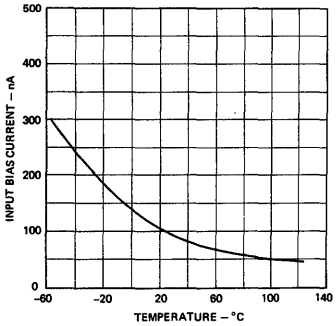
VOLTAGE GAIN AS A FUNCTION OF AMBIENT TEMPERATURE



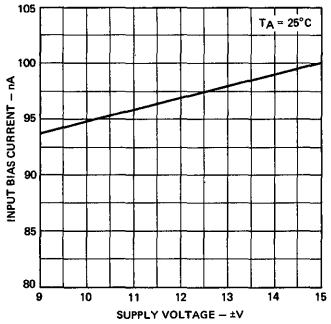
OUTPUT VOLTAGE SWING AS A FUNCTION OF LOAD RESISTANCE



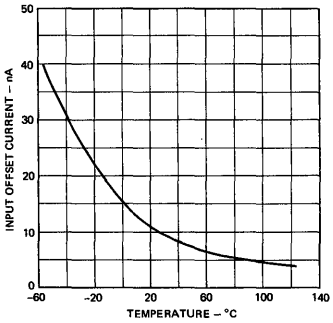
INPUT BIAS CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



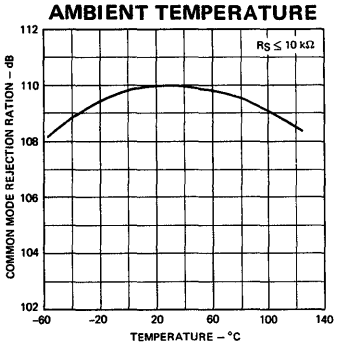
INPUT BIAS CURRENT AS A FUNCTION OF SUPPLY VOLTAGE



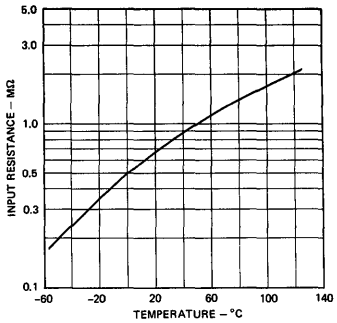
INPUT OFFSET CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



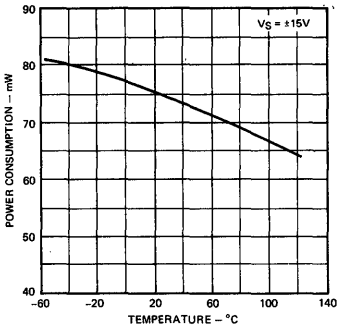
COMMON MODE REJECTION RATIO AS A FUNCTION OF AMBIENT TEMPERATURE



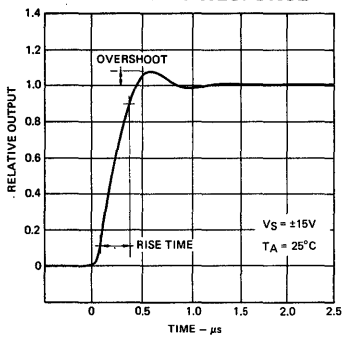
INPUT RESISTANCE AS A FUNCTION OF AMBIENT TEMPERATURE



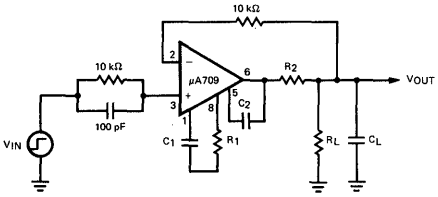
POWER CONSUMPTION AS A FUNCTION OF AMBIENT TEMPERATURE



TRANSIENT RESPONSE

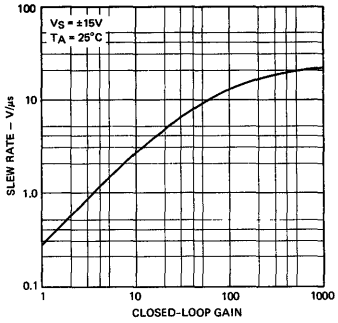


TRANSIENT RESPONSE TEST CIRCUIT



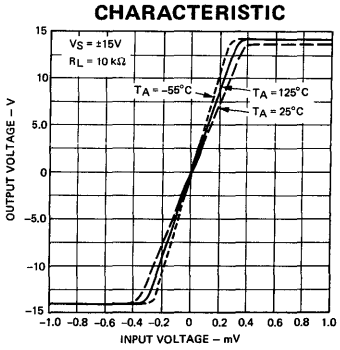
Pin numbers only apply to metal can package.

SLEW RATE AS A FUNCTION OF CLOSED-LOOP GAIN USING RECOMMENDED COMPENSATION NETWORKS

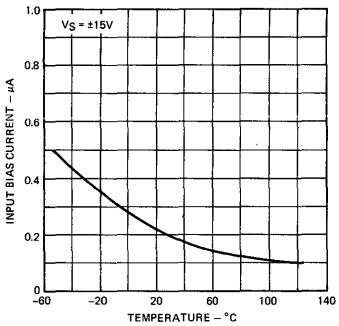


TYPICAL PERFORMANCE CURVES FOR 709 AND 709C

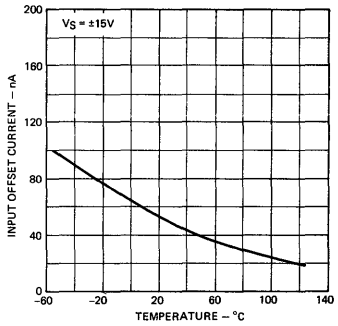
VOLTAGE TRANSFER CHARACTERISTIC



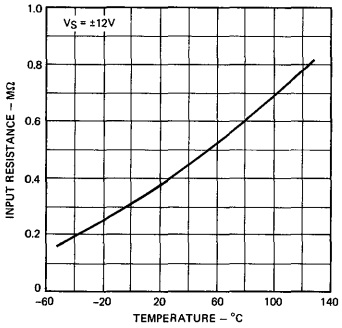
INPUT BIAS CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



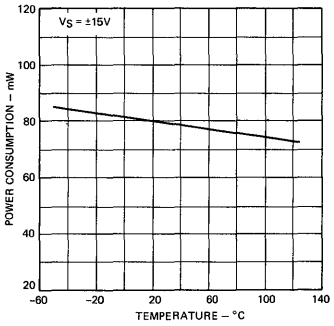
INPUT OFFSET CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



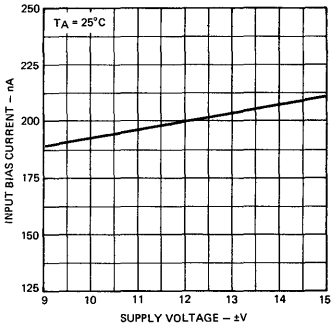
INPUT RESISTANCE AS A FUNCTION OF AMBIENT TEMPERATURE



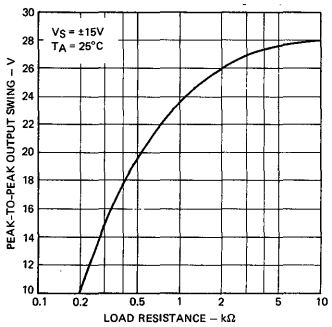
POWER CONSUMPTION AS A FUNCTION OF AMBIENT TEMPERATURE



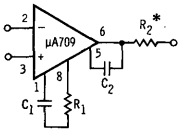
INPUT BIAS CURRENT AS A FUNCTION OF SUPPLY VOLTAGE



OUTPUT VOLTAGE SWING AS A FUNCTION OF LOAD RESISTANCE

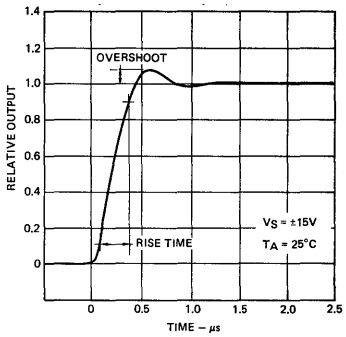


FREQUENCY COMPENSATION CIRCUIT



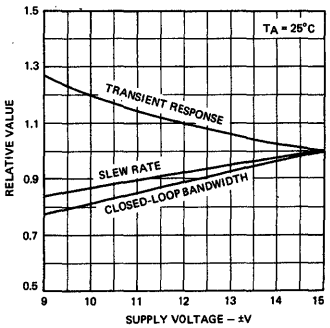
* Use $R_2 = 50\ \Omega$ when the amplifier is operated with capacitive loading.

TRANSIENT RESPONSE

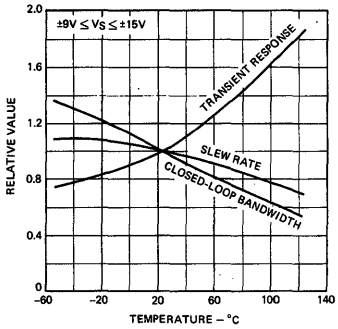


TYPICAL PERFORMANCE CURVES FOR 709 AND 709C

FREQUENCY CHARACTERISTICS AS A FUNCTION OF SUPPLY VOLTAGE

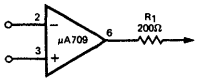


FREQUENCY CHARACTERISTICS AS A FUNCTION OF AMBIENT TEMPERATURE

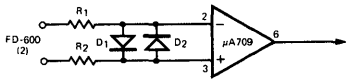


PROTECTION CIRCUITS

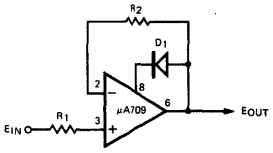
OUTPUT SHORT-CIRCUIT PROTECTION



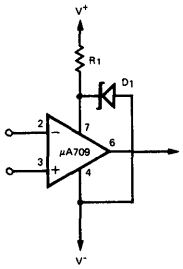
INPUT BREAKDOWN PROTECTION



LATCH-UP PROTECTION



SUPPLY OVERVOLTAGE PROTECTION



Pin numbers only apply to metal can package.

μA715
HIGH SPEED OPERATIONAL AMPLIFIER
FAIRCHILD LINEAR INTEGRATED CIRCUITS

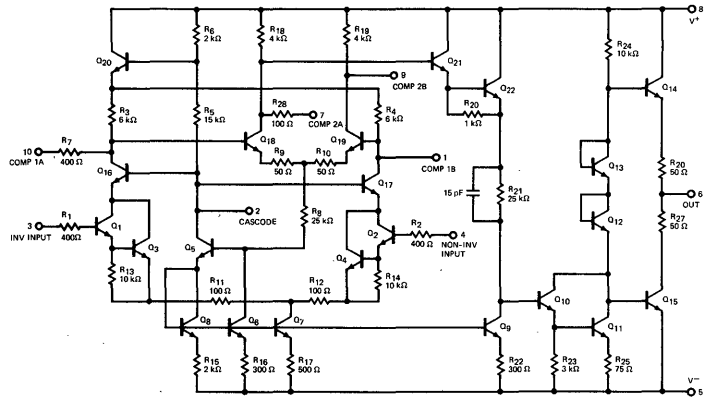
GENERAL DESCRIPTION — The μA715 is a High Speed, High Gain, monolithic Operational Amplifier constructed using the Fairchild Planar* epitaxial process. It is intended for use in a wide range of applications where fast signal acquisition or wide bandwidth is required. The μA715 features fast settling time, high slew rate, low offsets, and high output swing for large signal applications. In addition, the device displays excellent temperature stability and will operate over a wide range of supply voltages. The μA715 is ideally suited for use in A to D and D to A converters, active filters, deflection amplifiers, video amplifiers, phase locked loops, multiplexed analog gates, precision comparators, sample and holds, and general feedback applications requiring dc wide bandwidth operation.

- **HIGH SLEW RATE . . . . . 100 V/μs**
- **FAST SETTLING TIME . . . . . 300 ns**
- **WIDE BANDWIDTH . . . . . 65 MHz**
- **WIDE OPERATING SUPPLY RANGE**
- **WIDE INPUT VOLTAGE RANGES**

ABSOLUTE MAXIMUM RATINGS

Supply Voltage	±18 V
Internal Power Dissipation (Note 1)	
Metal Can	500 mW
DIP	670 mW
Differential Input Voltage	±15 V
Input Voltage (Note 2)	±15 V
Storage Temperature Range	
Metal Can, DIP	−65°C to +150°C
Operating Temperature Range	
Military (715)	−55°C to +125°C
Commercial (715C)	0°C to +70°C
Lead Temperature (Soldering, 60 Seconds)	
Metal Can, DIP	300°C

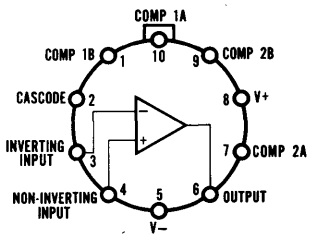
EQUIVALENT CIRCUIT



All Pin numbers shown refer to 10-lead TO-5 package

CONNECTION DIAGRAMS

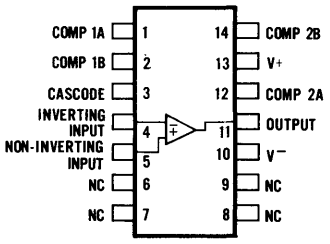
10-LEAD METAL CAN
(TOP VIEW)
PACKAGE OUTLINE 5F



ORDER INFORMATION

TYPE	PART NO.
715	715HM
715C	715HC

14-LEAD DIP
(TOP VIEW)
PACKAGE OUTLINE 6A



ORDER INFORMATION

TYPE	PART NO.
715	715DM
715C	715DC

Notes on following pages.

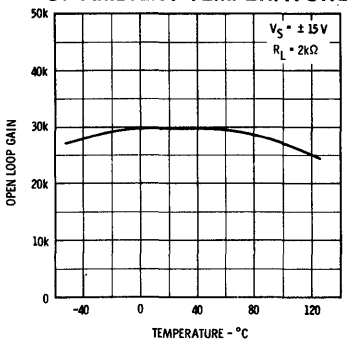
*Planar is a patented Fairchild process.

ELECTRICAL CHARACTERISTICS FOR 715 (V_S = ±15 V, T_A = 25°C unless otherwise specified)

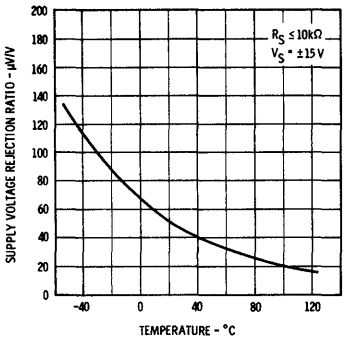
PARAMETER		CONDITIONS	MIN.	TYP.	MAX.	UNITS
Input Offset Voltage		$R_S \leq 10$ kΩ		2.0	5.0	mV
Input Offset Current				70	250	nA
Input Bias Current				400	750	nA
Input Resistance				1.0		MΩ
Input Voltage Range			±10	±12		V
Large Signal Voltage Gain		$R_L \geq 2$ kΩ, V_{OUT} = ±10 V	15,000	30,000		
Output Resistance				75		Ω
Supply Current				5.5	7.0	mA
Power Consumption				165	210	mW
Acquisition Time (Unity Gain)		V_{OUT} = +5 V		800		ns
Settling Time (Unit Gain)				300		ns
Transient Response (Unity Gain)	Risetime	V_{IN} = 400 mV		30	60	ns
	Overshoot			25	40	%
Slew Rate		Av = 100		70		V/μs
		Av = 10		38		V/μs
		Av = 1 (non-inverting)	15	18		V/μs
		Av = 1 (inverting)		100		V/μs
The following apply for −55°C ≤ T_A ≤ +125°C:						
Input Offset Voltage		$R_S \leq 10$ kΩ			7.5	mV
Input Offset Current		T_A = +125°C			250	nA
		T_A = −55°C			800	nA
Input Bias Current		T_A = +125°C			750	nA
		T_A = −55°C			4.0	μA
Common Mode Rejection Ratio		$R_S \leq 10$ kΩ	74	92		dB
Supply Voltage Rejection Ratio		$R_S \leq 10$ kΩ		45	300	μV/V
Large Signal Voltage Gain		$R_L \geq 2$ kΩ, V_{OUT} = ±10 V	10,000			
Output Voltage Swing		$R_L \geq 2$ kΩ	±10	±13		

TYPICAL PERFORMANCE CURVES FOR 715

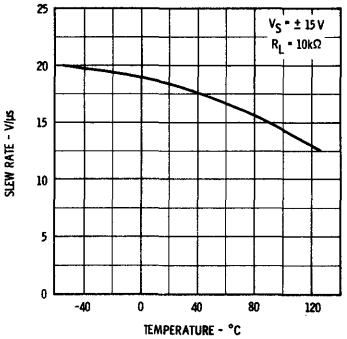
OPEN LOOP GAIN AS A FUNCTION OF AMBIENT TEMPERATURE



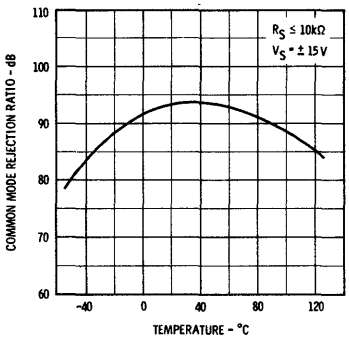
SUPPLY VOLTAGE REJECTION RATIO AS A FUNCTION OF AMBIENT TEMPERATURE



SLEW RATE AS A FUNCTION OF TEMPERATURE



COMMON MODE REJECTION RATIO AS A FUNCTION OF AMBIENT TEMPERATURE

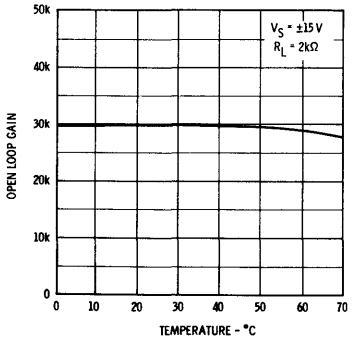


ELECTRICAL CHARACTERISTICS FOR 715C (V_S = ±15 V, T_A = 25°C unless otherwise specified)

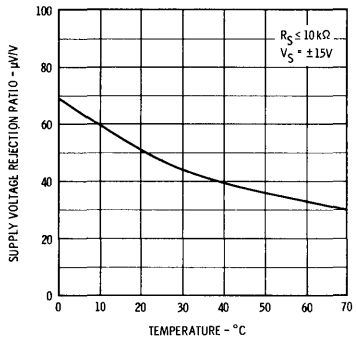
PARAMETER		CONDITIONS	MIN.	TYP.	MAX.	UNITS
Input Offset Voltage		$R_S \leq 10$ kΩ		2.0	7.5	mV
Input Offset Current				70	250	nA
Input Bias Current				0.4	1.5	μA
Input Resistance				1.0		MΩ
Input Voltage Range			±10	±12		V
Common Mode Rejection Ratio		$R_S \leq 10$ kΩ	74	92		dB
Supply Voltage Rejection Ratio		$R_S \leq 10$ kΩ		45	400	μV/V
Large Signal Voltage Gain		$R_L \geq 2$ kΩ, V_{OUT} = ±10 V	10,000	30,000		
Output Resistance				75		Ω
Supply Current				5.5	10	mA
Power Consumption				165	300	mW
Acquisition Time (Unity Gain)		V_{OUT} = +5 V		800		ns
Settling Time (Unity Gain				300		ns
Transient Response (Unity Gain)	Risetime	V_{IN} = 400 mV		30	75	ns
	Overshoot			25	50	%
Slew Rate		Av = 100		70		V/μs
		Av = 10		38		V/μs
		Av = 1 (non-inverting)	10	18		V/μs
		Av = 1 (inverting)		100		V/μs
The following apply for 0°C ≤ T_A ≤ +70°C:						
Input Offset Voltage		$R_S \leq 10$ kΩ			10	mV
Input Offset Current		T_A = +70°C			250	nA
		T_A = 0°C			750	nA
Input Bias Current		T_A = +70°C			1.5	μA
		T_A = 0°C			7.5	μA
Large Signal Voltage Gain		$R_L \geq 2$ kΩ, V_{OUT} = ±10 V	8,000			
Output Voltage Swing		$R_L \geq 2$ kΩ	±10	±13		V

TYPICAL PERFORMANCE CURVES FOR 715C

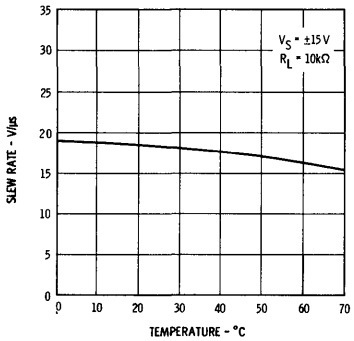
OPEN LOOP GAIN AS A FUNCTION OF AMBIENT TEMPERATURE



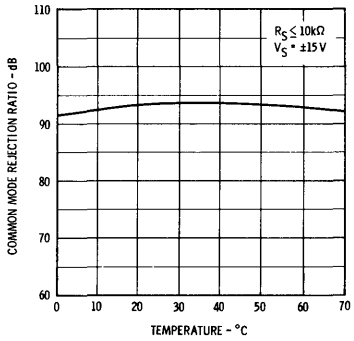
SUPPLY VOLTAGE REJECTION RATIO AS A FUNCTION OF AMBIENT TEMPERATURE



SLEW RATE AS A FUNCTION OF TEMPERATURE



COMMON MODE REJECTION RATIO AS A FUNCTION OF AMBIENT TEMPERATURE



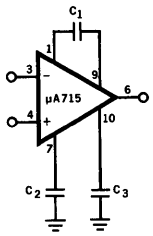
TYPICAL PERFORMANCE CURVES FOR 715 AND 715C

NON-INVERTING COMPENSATION COMPONENTS VALUES

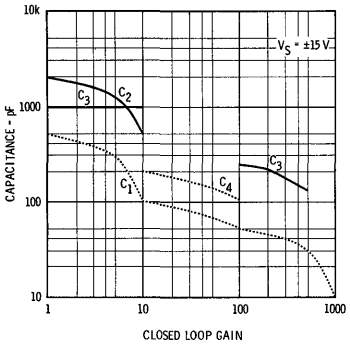
CLOSED LOOP GAIN	C_1	C_2	C_3
1000	10 pF	—	—
100	50 pF	—	250 pF
10 *	100 pF	500 pF	1000 pF
1	500 pF	2000 pF	1000 pF

*For Gain 10, compensation may be simplified by removing C_2, C_3 and adding a 200 pF capacitor (C_4) between Pin 7 and 10.

FREQUENCY COMPENSATION CIRCUIT

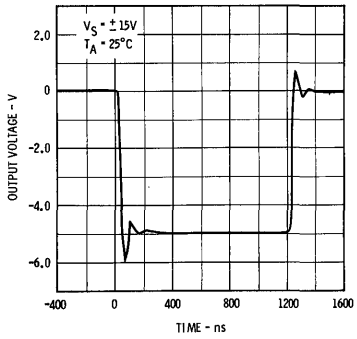


SUGGESTED VALUES OF COMPENSATION CAPACITORS AS A FUNCTION OF THE CLOSED LOOP GAIN

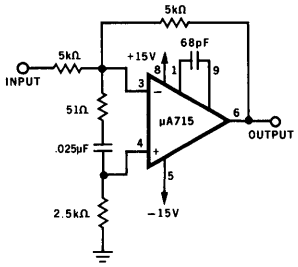


INVERTING UNITY GAIN

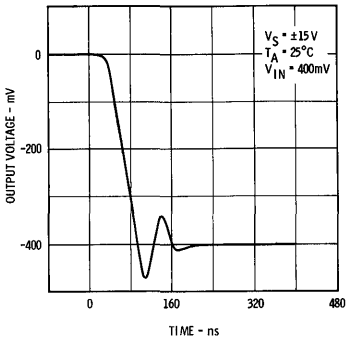
LARGE SIGNAL PULSE RESPONSE



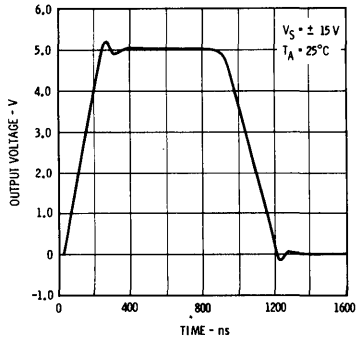
HIGH SLEW RATE CIRCUIT



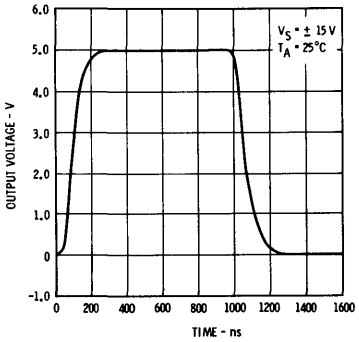
SMALL SIGNAL PULSE RESPONSE INVERTING UNITY GAIN



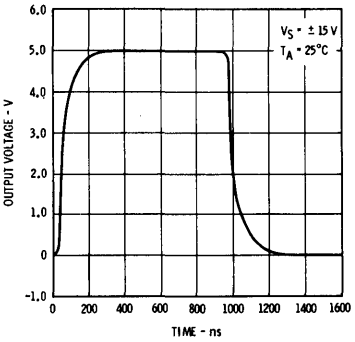
UNITY GAIN LARGE SIGNAL PULSE RESPONSE



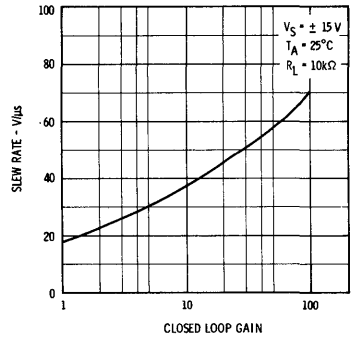
LARGE SIGNAL PULSE RESPONSE FOR GAIN 10



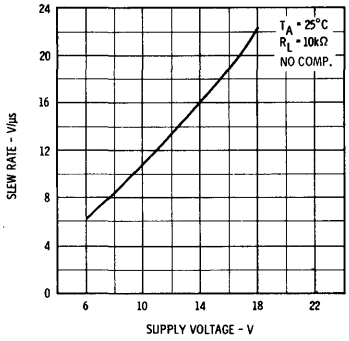
LARGE SIGNAL PULSE RESPONSE FOR GAIN 100



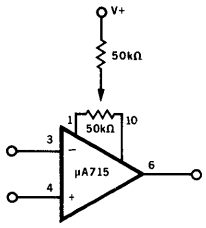
SLEW RATE AS A FUNCTION OF THE CLOSED LOOP GAIN



SLEW RATE AS A FUNCTION OF SUPPLY VOLTAGE

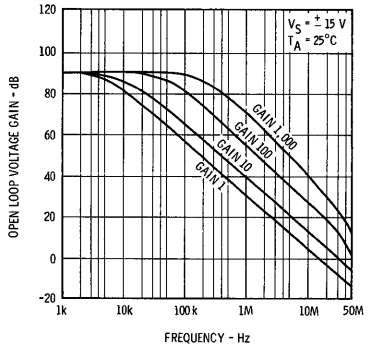


VOLTAGE OFFSET NULL CIRCUIT

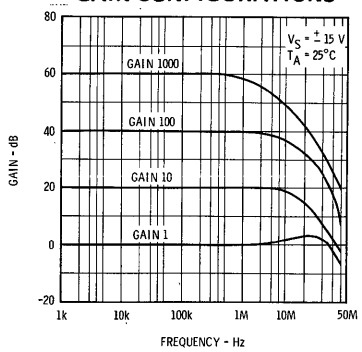


TYPICAL PERFORMANCE CURVES FOR 715 AND 715C

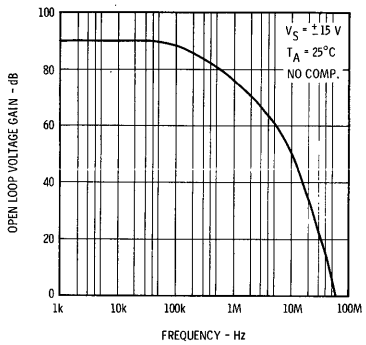
OPEN LOOP RESPONSE WITH COMPENSATION NECESSARY FOR VARIOUS CLOSED LOOP GAIN CONFIGURATIONS



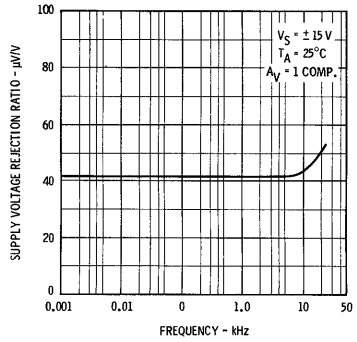
CLOSED LOOP FREQUENCY RESPONSE FOR VARIOUS GAIN CONFIGURATIONS



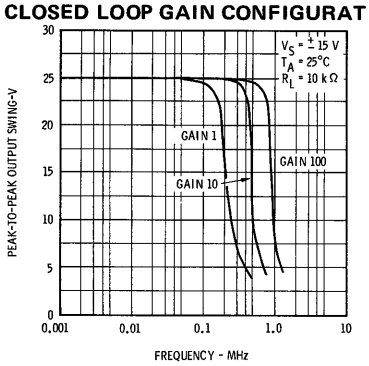
OPEN LOOP GAIN AS A FUNCTION OF FREQUENCY



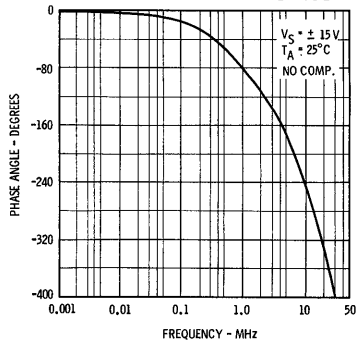
SUPPLY VOLTAGE REJECTION RATIO AS A FUNCTION OF FREQUENCY



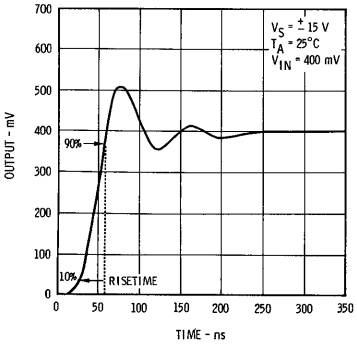
OUTPUT SWING AS A FUNCTION OF FREQUENCY FOR VARIOUS CLOSED LOOP GAIN CONFIGURATIONS



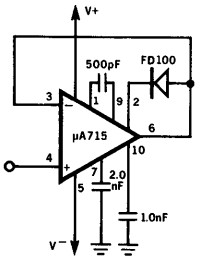
OPEN LOOP PHASE AS A FUNCTION OF FREQUENCY



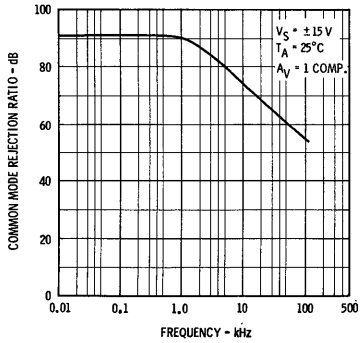
VOLTAGE FOLLOWER TRANSIENT RESPONSE



VOLTAGE FOLLOWER



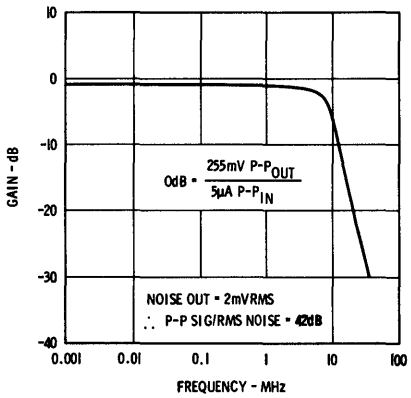
COMMON MODE REJECTION RATIO AS A FUNCTION OF FREQUENCY

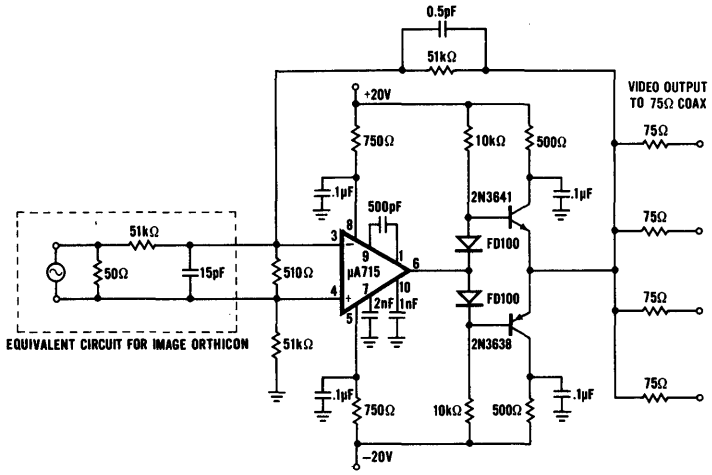


NOTES
1. Rating applies to ambient temperature up to 70°C. Above 70°C ambient derate linearly at 6.3 mW/°C for Metal Can and 8.3 mW/°C for the DIP.
2. For supply voltages less than ±15 V, the absolute maximum input voltage is equal to the supply voltage.

TYPICAL APPLICATIONS

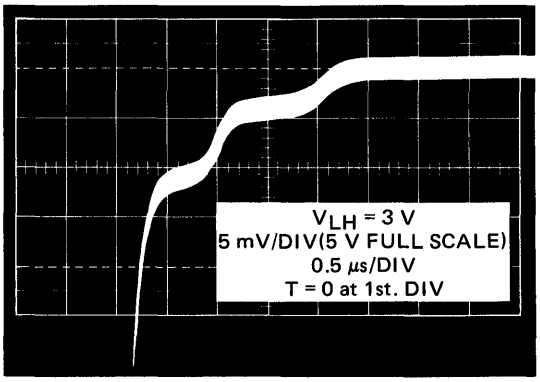
WIDE BAND VIDEO AMPLIFIER WITH 75 Ω COAX CABLE DRIVE CAPABILITY



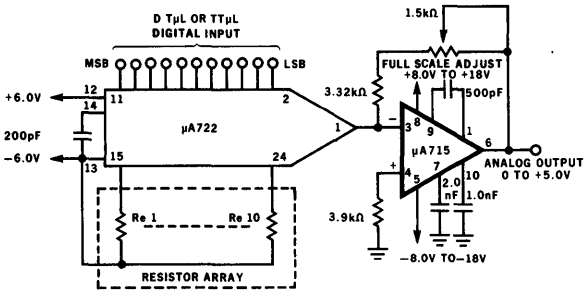


HIGH SPEED 10-BIT DIGITAL TO ANALOG CONVERTER

ANALOG OUTPUT 0 TO +5.0 V



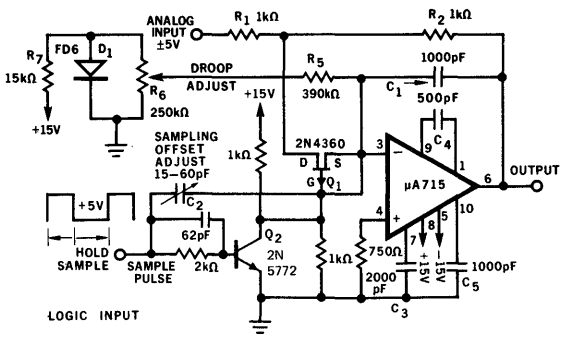
μA722/μA715 op amp switching ON, as it should with typical logic voltage on least significant bits. Note complete absence of ringing.



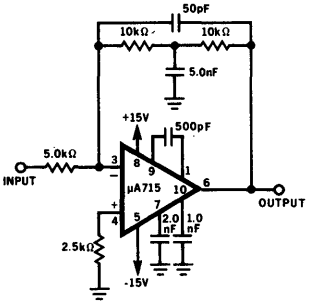
Conversion Rate
6 bits - 300 ns
8 bits - 600 ns
10 bits - 1000 ns

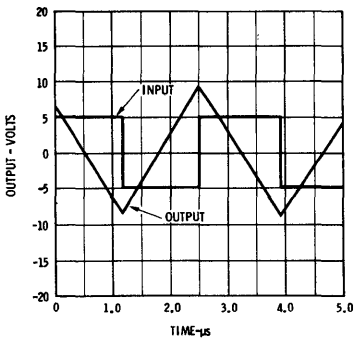
NOTE:
Contact Fairchild for additional information including how to increase conversion speed by clamping LSB's and how to obtain bipolar outputs.

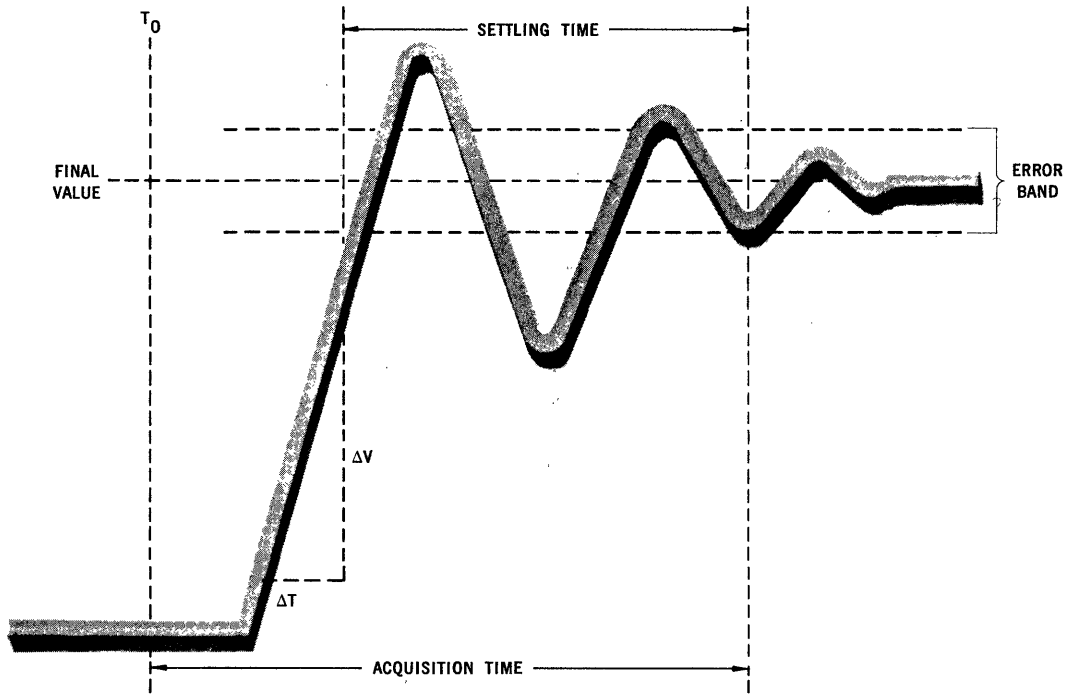
HIGH SPEED SAMPLE AND HOLD



HIGH SPEED INTEGRATOR







HELPFUL HINTS

LAYOUT – The layout should be such that stray capacitance is minimal.

SUPPLIES – The supplies should be adequately bypassed. Use of 0.1 μF high quality ceramic capacitors is recommended.

RINGING – Excessive ringing (long acquisition time) may occur with large capacitive loads. This may be reduced by isolating the capacitive load with a resistance of 100 Ω. Large source resistances may also give rise to the same problem and this may be decreased by the addition of a capacitance across the feedback resistance. A value of around 50 pF for unity gain configuration and around 3.0 pF for gain 10 should be adequate.

LATCH UP – This may occur when the amplifier is used as a voltage follower. The inclusion of a diode between pins 6 and 2 with the cathode towards pin 2 is the recommended preventive.

μA725

INSTRUMENTATION OPERATIONAL AMPLIFIER

FAIRCHILD LINEAR INTEGRATED CIRCUITS

GENERAL DESCRIPTION — The μA715 is a monolithic Instrumentation Operational Amplifier constructed using the Fairchild Planar* epitaxial process. It is intended for precise, low level signal amplification applications where low noise, low drift and accurate closed loop gain are required. The offset null capability, low power consumption, very high voltage gain as well as wide power supply voltage range provide superior performance for a wide range of instrumentation applications. The μA715 is pin compatible with the popular μA741 operational amplifier.

- **LOW INPUT NOISE CURRENT . . . . . 0.15 pA $\sqrt{Hz}$**
- **HIGH OPEN LOOP GAIN 3,000,000**
- **LOW INPUT OFFSET CURRENT. . . . . 2 nA**
- **LOW INPUT VOLTAGE DRIFT . . . . . 0.6 μV/°C**
- **HIGH COMMON MODE REJECTION . . . . . 120 dB**
- **HIGH INPUT VOLTAGE RANGE . . . . . ±14 V**
- **WIDE POWER SUPPLY RANGE . . . . . ±3 V TO ±22 V**
- **OFFSET NULL CAPABILITY**

ABSOLUTE MAXIMUM RATINGS

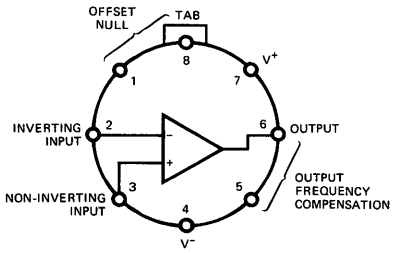
Supply Voltage	±22
Internal Power Dissipation (Note 1)	
Metal Can	500 mW
Differential Input Voltage	±5 V
Input Voltage (Note 2)	±22 V
Voltage Between Offset Null and V^+	±0.5 V
Storage Temperature Range	
Metal Can	−65°C to +150°C
Operating Temperature Range	
Military (725A, 725)	−55°C to +125°C
Commercial (725E, 725C)	0°C to +70°C
Lead Temperature	
Metal Can (Soldering, 60 Seconds)	300°C

CONNECTION DIAGRAM

8-LEAD METAL CAN

(TOP VIEW)

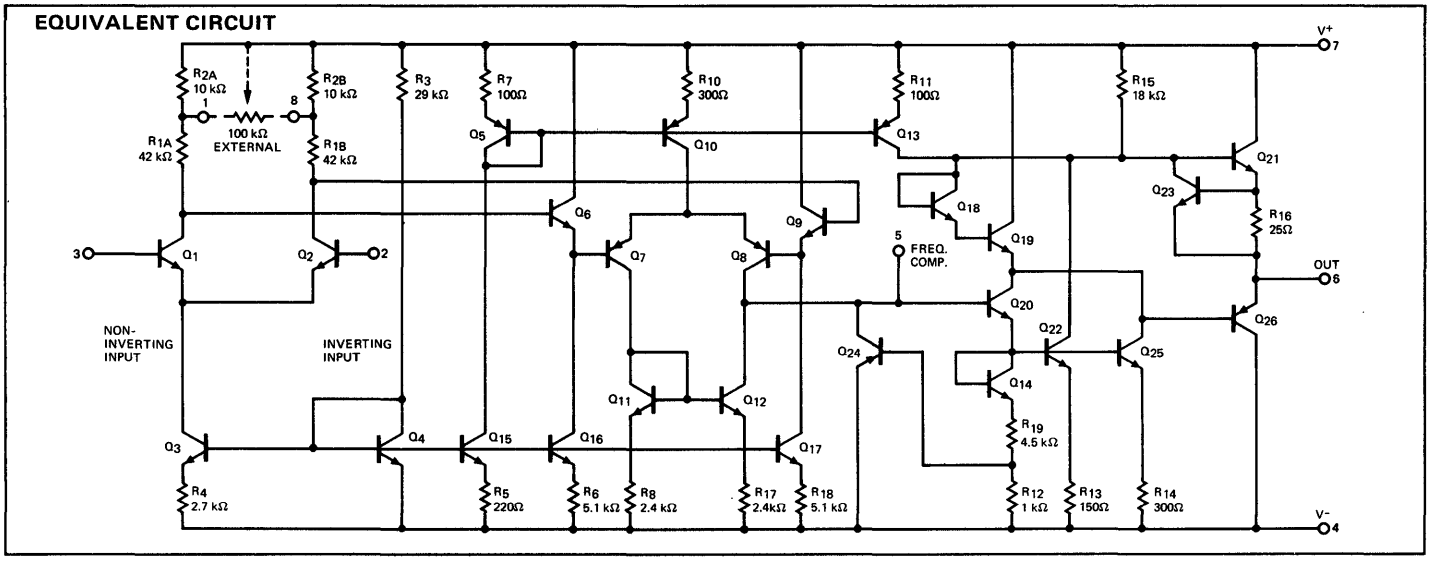
PACKAGE OUTLINE 5B



ORDER INFORMATION

TYPE	PART NO.
725A	725AHM
725	725HM
725C	725HC
725E	725EHC

EQUIVALENT CIRCUIT



Notes on following pages

*Planar is a patented Fairchild process.

725A

ELECTRICAL CHARACTERISTICS (V_S = ±15 V, T_A = 25°C unless otherwise specified)

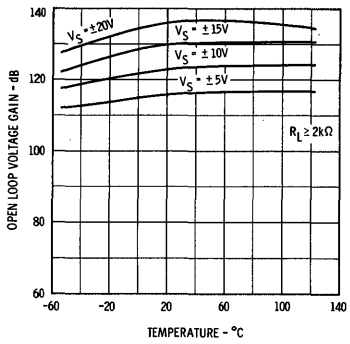
PARAMETER	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Input Offset Voltage (Without external trim)	$R_S \leq 10$ kΩ			0.5	mV
Input Offset Current				5.0	nA
Input Bias Current				75	nA
Input Noise Voltage	f_o = 10 Hz			15	nV/√Hz
	f_o = 100 Hz			9.0	nV/√Hz
	f_o = 1 kHz			7.5	nV/√Hz
Input Noise Current	f_o = 10 Hz			1.2	pA/√Hz
	f_o = 100 Hz			0.6	pA/√Hz
	f_o = 1 kHz			0.25	pA/√Hz
Input Resistance			1.5		MΩ
Input Voltage Range		±13.5	±14		V
Large Signal Voltage Gain	$R_L \geq 2$ kΩ, V_{OUT} = ±10 V	1,000,000	3,000,000		V/V
	$R_L \geq 500$ Ω, V_{OUT} = ±0.5 V, V_S = ±3 V	100,000			V/V
Common Mode Rejection Ratio	$R_S \leq 10$ kΩ	120	130		dB
Power Supply Rejection Ratio	$R_S \leq 10$ kΩ		2.0	5.0	μV/V
Output Voltage Swing	$R_L \geq 10$ kΩ	±12.5			V
	$R_L \geq 2$ kΩ	±10			V
Output Resistance			150		Ω
Power Consumption			80	120	mW
	V_S = ±3 V			6.0	mW

The following specifications apply for −55°C ≤ T_A ≤ +125°C unless otherwise specified:

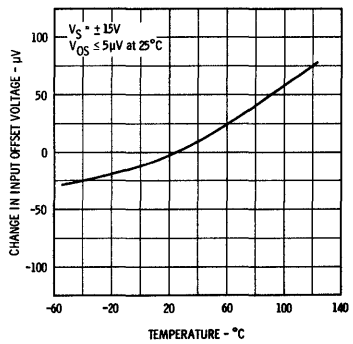
Input Offset Voltage (Without External trim)	$R_S \leq 10$ kΩ			0.75	mV
Average Input Offset Voltage Drift (Without external trim)	R_S = 50 Ω			2.0	μV/°C
Average Input Offset Voltage Drift (With external trim)	R_S = 50 Ω		0.6	1.0	μV/°C
Input Offset Current	T_A = +125°C			4.0	nA
	T_A = −55°C		5.0	18	nA
Average Input Offset Current Drift				90	pA/°C
Input Bias Current	T_A = +125°C			70	nA
	T_A = −55°C			180	nA
Large Signal Voltage Gain	$R_L \geq 2$ kΩ, T_A = +125°C	1,000,000			V/V
	$R_L \geq 2$ kΩ, T_A = −55°C	500,000			V/V
Common Mode Rejection Ratio	$R_S \leq 10$ kΩ	110			dB
Power Supply Rejection Ratio	$R_S \leq 10$ kΩ			8.0	μV/V
Output Voltage Swing	$R_L \geq 2$ kΩ	±10			V

TYPICAL PERFORMANCE CURVES FOR 725A AND 725

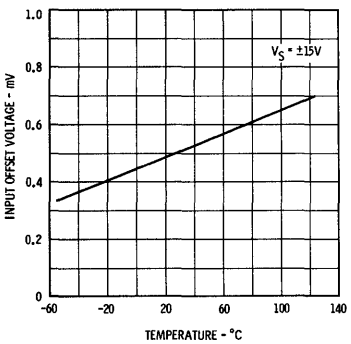
OPEN LOOP VOLTAGE GAIN AS A FUNCTION OF TEMPERATURE FOR VARIOUS SUPPLY VOLTAGES



NULLED INPUT OFFSET VOLTAGE AS A FUNCTION OF TEMPERATURE



UNNULLED INPUT OFFSET VOLTAGE AS A FUNCTION OF TEMPERATURE



725

ELECTRICAL CHARACTERISTICS (V_S = ±15 V, T_A = 25°C unless otherwise specified)

PARAMETER	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Input Offset Voltage (Without external trim)	$R_S \leq 10$ kΩ		0.5	1.0	mV
Input Offset Current			2.0	20	nA
Input Bias Current			42	100	nA
Input Noise Voltage	f_o = 10 Hz		15		nV/√Hz
	f_o = 100 Hz		9.0		nV/√Hz
	f_o = 1 kHz		8.0		nV/√Hz
Input Noise Current	f_o = 10 Hz		1.0		pA/√Hz
	f_o = 100 Hz		0.3		pA/√Hz
	f_o = 1 kHz		0.15		pA/√Hz
Input Resistance			1.5		MΩ
Input Voltage Range		±13.5	±14		V
Large Signal Voltage Gain	$R_L \geq$ 2 kΩ, V_{OUT} = ±10 V	1,000,000	3,000,000		V/V
Common Mode Rejection Ratio	$R_S \leq 10$ kΩ	110	120		dB
Power Supply Rejection Ratio	$R_S \leq 10$ kΩ		2.0	10	μV/V
Output Voltage Swing	$R_L \geq 10$ kΩ	±12	±13.5		V
	$R_L \geq$ 2 kΩ	±10	±13.5		V
Output Resistance			150		Ω
Power Consumption			80	105	mW
The following specifications apply for −55°C ≤ T_A ≤ +125°C unless otherwise specified:					
Input Offset Voltage (Without external trim)	$R_S \leq 10$ kΩ			1.5	mV
Average Input Offset Voltage Drift (Without external trim)	R_S = 50Ω		2.0	5.0	μV/°C
Average Input Offset Voltage Drift (With external trim)	R_S = 50Ω		0.6		μV/°C
Input Offset Current	T_A = +125°C		1.2	20	nA
	T_A = −55°C		7.5	40	nA
Average Input Offset Current Drift			35	150	pA/°C
Input Bias Current	T_A = +125°C		20	100	nA
	T_A = −55°C		80	200	nA
Large Signal Voltage Gain	$R_L \geq$ 2 kΩ, T_A = +125°C	1,000,000			V/V
	$R_L \geq$ 2 kΩ, T_A = −55°C	250,000			V/V
Common Mode Rejection Ratio	$R_S \leq 10$ kΩ	100			dB
Power Supply Rejection Ratio	$R_S \leq 10$ kΩ			20	μV/V
Output Voltage Swing	$R_L \geq$ 2 kΩ	±10			V

NOTES:
1. Rating applies to ambient temperatures up to 70°C. Above 70°C ambient derate linearly at 6.3 mW/°C.
2. For supply voltages less than ±22 V, the absolute maximum input voltage is equal to the supply voltage.

725E

ELECTRICAL CHARACTERISTICS (V_S = ±15 V, T_A = 25°C unless otherwise specified)

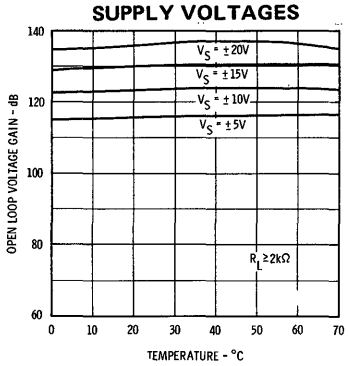
PARAMETER	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Input Offset Voltage (Without external trim)	$R_S \leq 10$ kΩ			0.5	mV
Input Offset Current				5.0	nA
Input Bias Current				75	nA
Input Noise Voltage	f_o = 10 Hz			15	nV/√Hz
	f_o = 100 Hz			9.0	nV/√Hz
	f_o = 1 kHz			7.5	nV/√Hz
Input Noise Current	f_o = 10 Hz			1.2	pA/√Hz
	f_o = 100 Hz			0.6	pA/√Hz
	f_o = 1 kHz			0.25	pA/√Hz
Input Resistance			1.5		MΩ
Input Voltage Range		±13.5	±14		V
Large Signal Voltage Gain	$R_L \geq 2$ kΩ, V_{OUT} = ±10 V	1,000,000	3,000,000		V/V
	$R_L \geq 500$ Ω, V_{OUT} = ±0.5 V, V_S = ±3 V	100,000			V/V
Common Mode Rejection Ratio	$R_S \leq 10$ kΩ	120			dB
Power Supply Rejection Ratio	$R_S \leq 10$ kΩ		2.0	5.0	μV/V
Output Voltage Swing	$R_L \geq 10$ kΩ	±12.5			V
	$R_L \geq 2$ kΩ	±10			V
Output Resistance			150		Ω
Power Consumption			80	150	mW
	V_S = ±3 V			6.0	mW

The following specifications apply for 0°C ≤ T_A ≤ +70°C unless otherwise specified:

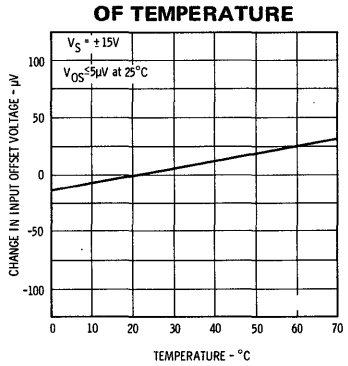
Input Offset Voltage (Without external trim)	$R_S \leq 10$ kΩ			0.75	mV
Average Input Offset Voltage Drift (Without external trim)	R_S = 50 Ω			2.0	μV/°C
Average Input Offset Voltage Drift (With external trim)	R_S = 50 Ω			1.0	μV/°C
Input Offset Current	T_A = +70°C		1.2	4.0	nA
	T_A = 0°C		4.0	18	nA
Average Input Offset Current Drift			10	90	pA/°C
Input Bias Current	T_A = +70°C			70	nA
	T_A = 0°C			180	nA
Large Signal Voltage	$R_L \geq 2$ kΩ, T_A = +70°C	1,000,000			V/V
	$R_L \geq 2$ kΩ, T_A = 0°C	500,000			V/V
Common Mode Rejection Ratio	$R_S \leq 10$ kΩ	110			dB
Power Supply Rejection Ratio	$R_S \leq 10$ kΩ			8.0	μV/V
Output Voltage Swing	$R_L \geq 2$ kΩ	±10			V

TYPICAL PERFORMANCE CURVES FOR 725E AND 725C

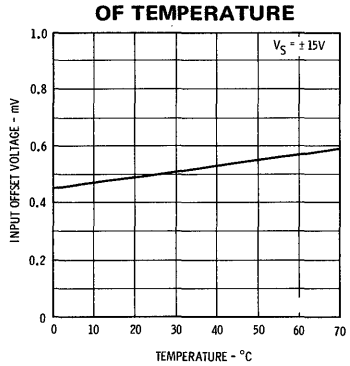
OPEN LOOP VOLTAGE GAIN AS A FUNCTION OF TEMPERATURE FOR VARIOUS SUPPLY VOLTAGES



NULLED INPUT OFFSET VOLTAGE AS A FUNCTION OF TEMPERATURE



UNNULLED INPUT OFFSET VOLTAGE AS A FUNCTION OF TEMPERATURE



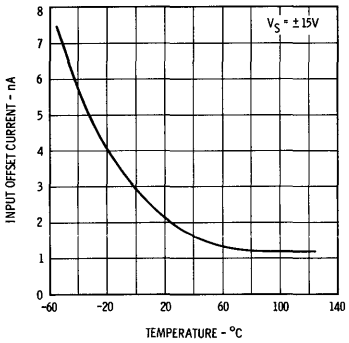
725C

ELECTRICAL CHARACTERISTICS (V_S = ±15 V, T_A = 25°C unless otherwise specified)

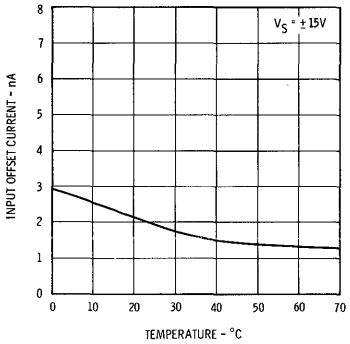
PARAMETER	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Input Offset Voltage (Without external trim)	$R_S \leq 10$ kΩ		0.5	2.5	mV
Input Offset Current			2.0	35	nA
Input Bias Current			42	125	nA
Input Noise Voltage	f_o = 10 Hz		15		nV/√Hz
	f_o = 100 Hz		9.0		nV/√Hz
	f_o = 1 kHz		8.0		nV/√Hz
Input Noise Current	f_o = 10 Hz		1.0		pA/√Hz
	f_o = 100 Hz		0.3		pA/√Hz
	f_o = 1 kHz		0.15		pA/√Hz
Input Resistance			1.5		MΩ
Input Voltage Range		±13.5	±14		V
Large Signal Voltage Gain	$R_L \geq 2$ kΩ, V_{OUT} = ±10 V	250,000	3,000,000		V/V
Common Mode Rejection Ratio	$R_S \leq 10$ kΩ	94	120		dB
Power Supply Rejection Ratio	$R_S \leq 10$ kΩ		2.0	35	μV/V
Output Voltage Swing	$R_L \geq 10$ kΩ	±12	±13.5		V
	$R_L \geq 2$ kΩ	±10	±13.5		V
Output Resistance			150		Ω
Power Consumption			80	150	mW
The following specifications apply for 0°C ≤ T_A ≤ +70°C unless otherwise specified:					
Input Offset Voltage (Without external trim)	$R_S \leq 10$ kΩ			3.5	mV
Average Input Offset Voltage Drift (Without external trim)	R_S = 50Ω		2.0		μV/°C
Average Input Offset Voltage Drift (With external trim)	R_S = 50Ω		0.6		μV/°C
Input Offset Current	T_A = +70°C		1.2	35	nA
	T_A = 0°C		4.0	50	nA
Average Input Offset Current Drift			10		pA/°C
Input Bias Current	T_A = +70°C			125	nA
	T_A = 0°C			250	nA
Large Signal Voltage	$R_L \geq 2$ kΩ, T_A = +70°	125,000			V/V
	$R_L \geq 2$ kΩ, T_A = 0°C	125,000			V/V
Common Mode Rejection Ratio	$R_S \leq 10$ kΩ		115		dB
Power Supply Rejection Ratio	$R_S \leq 10$ kΩ		20		μV/V
Output Voltage Swing	$R_L \geq 2$ kΩ	±10			V

TYPICAL PERFORMANCE CURVES FOR ALL TYPES (Unless Otherwise Specified)

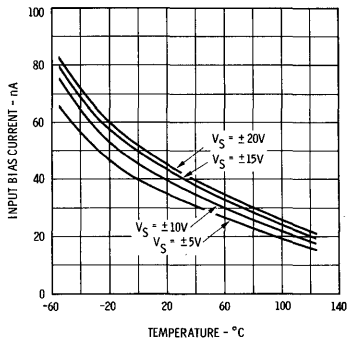
INPUT OFFSET CURRENT AS A FUNCTION OF TEMPERATURE 725A AND 725



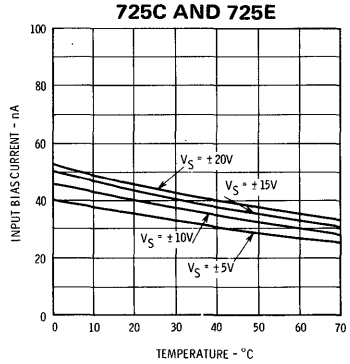
INPUT OFFSET CURRENT AS A FUNCTION OF TEMPERATURE 725C AND 725E



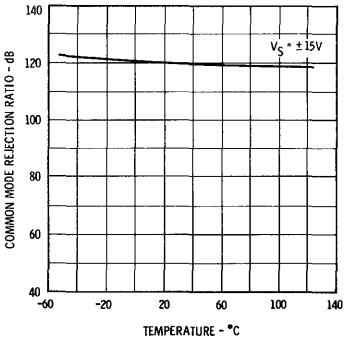
INPUT BIAS CURRENT AS A FUNCTION OF TEMPERATURE 725A AND 725



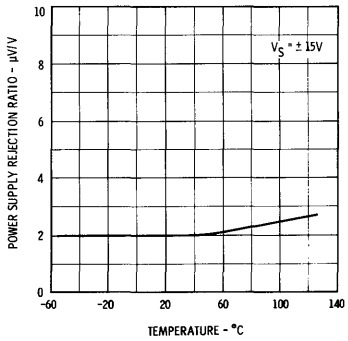
INPUT BIAS CURRENT AS A FUNCTION OF TEMPERATURE 725C AND 725E



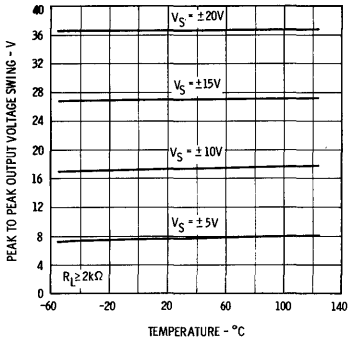
COMMON MODE REJECTION RATIO AS A FUNCTION OF TEMPERATURE



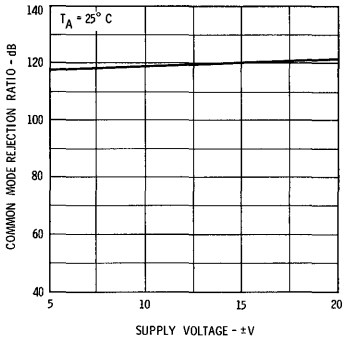
SUPPLY VOLTAGE REJECTION RATIO AS A FUNCTION OF TEMPERATURE



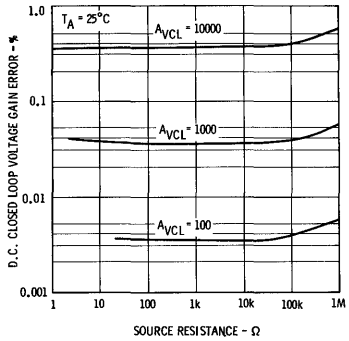
OUTPUT VOLTAGE SWING AS A FUNCTION OF TEMPERATURE



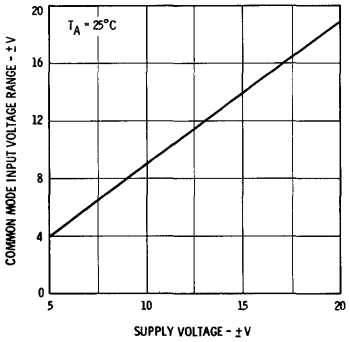
COMMON MODE REJECTION RATIO AS A FUNCTION OF SUPPLY VOLTAGE



D.C. CLOSED LOOP VOLTAGE GAIN ERROR AS A FUNCTION OF SOURCE RESISTANCE

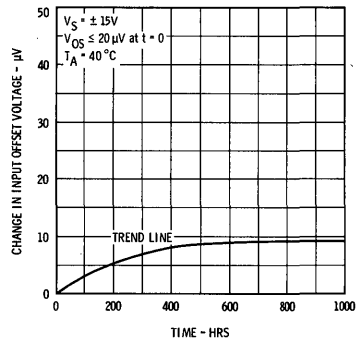


COMMON MODE INPUT VOLTAGE RANGE AS A FUNCTION OF SUPPLY VOLTAGE

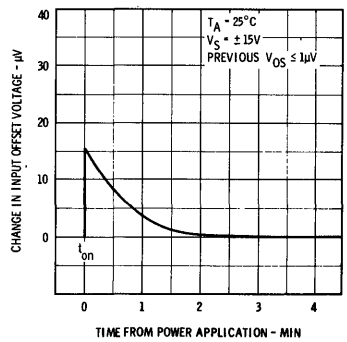


TYPICAL PERFORMANCE CURVES FOR ALL TYPES (Unless Otherwise Specified)

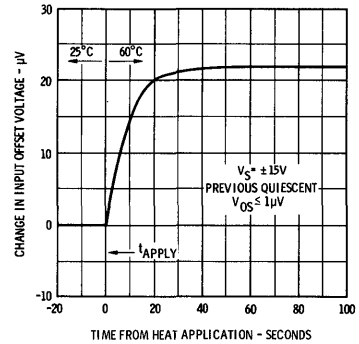
INPUT OFFSET VOLTAGE DRIFT AS A FUNCTION OF TIME



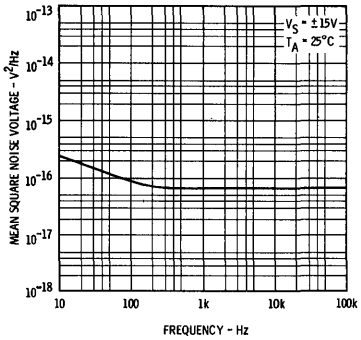
STABILIZATION TIME OF INPUT OFFSET VOLTAGE FROM POWER TURN-ON



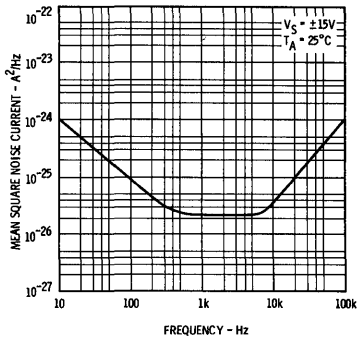
CHANGE IN INPUT OFFSET VOLTAGE DUE TO THERMAL SHOCK AS A FUNCTION OF TIME



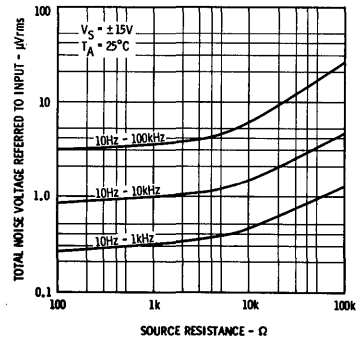
INPUT NOISE VOLTAGE AS A FUNCTION OF FREQUENCY



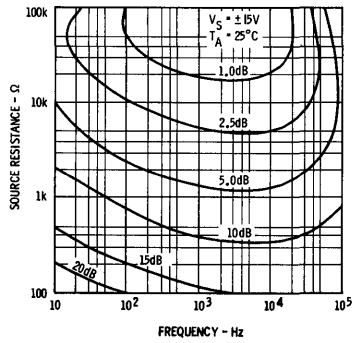
INPUT NOISE CURRENT AS A FUNCTION OF FREQUENCY



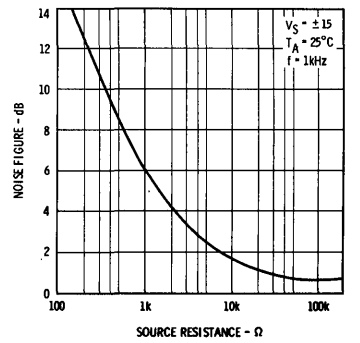
BROADBAND NOISE FOR VARIOUS BANDWIDTHS



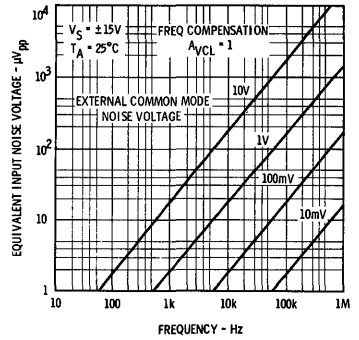
NARROW BAND SPOT NOISE FIGURE CONTOURS



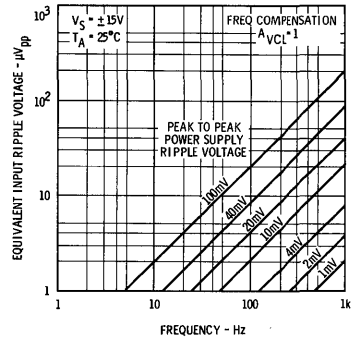
NOISE FIGURE AS A FUNCTION OF SOURCE RESISTANCE



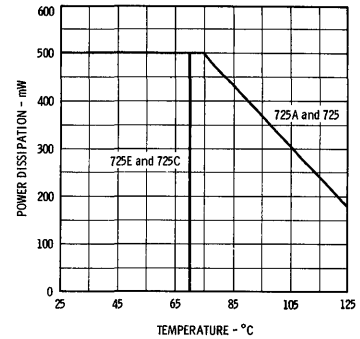
EQUIVALENT INPUT NOISE VOLTAGE DUE TO EXTERNAL COMMON MODE NOISE AS A FUNCTION OF FREQUENCY



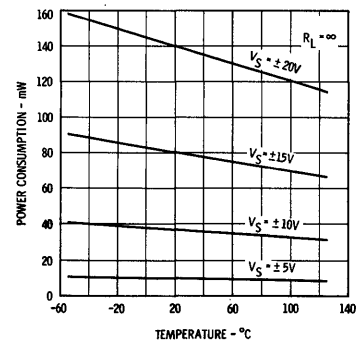
EQUIVALENT INPUT RIPPLE VOLTAGE DUE TO POWER SUPPLY RIPPLE AS A FUNCTION OF FREQUENCY



ABSOLUTE MAXIMUM POWER DISSIPATION AS A FUNCTION OF AMBIENT TEMPERATURE

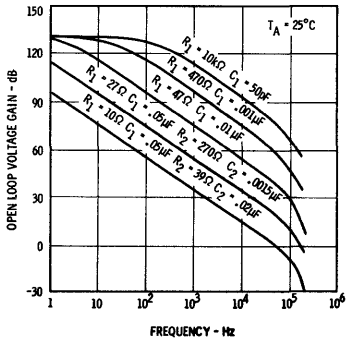


POWER CONSUMPTION AS A FUNCTION OF TEMPERATURE

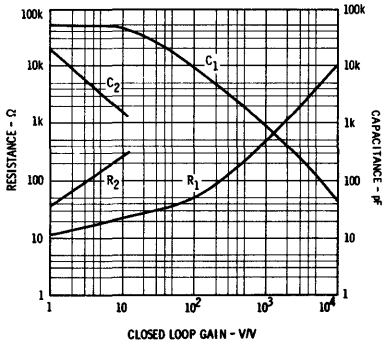


TYPICAL PERFORMANCE CURVES FOR ALL TYPES

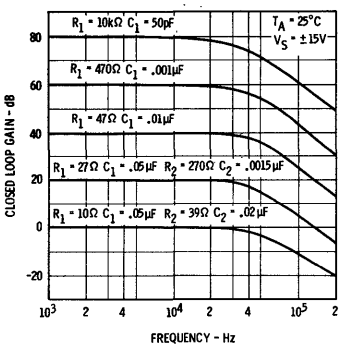
OPEN LOOP VOLTAGE GAIN AS A FUNCTION OF FREQUENCY USING RECOMMENDED COMPENSATION NETWORKS



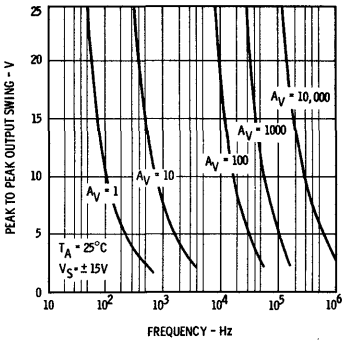
VALUES FOR SUGGESTED COMPENSATION NETWORKS FOR VARIOUS CLOSED LOOP VOLTAGE GAINS



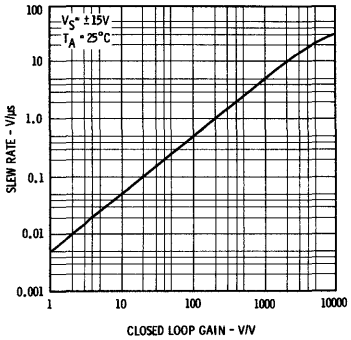
FREQUENCY RESPONSE FOR VARIOUS CLOSED-LOOP GAINS USING RECOMMENDED COMPENSATION NETWORKS



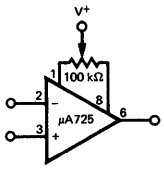
OUTPUT VOLTAGE SWING AS A FUNCTION OF FREQUENCY FOR RECOMMENDED COMPENSATION NETWORKS



SLEW RATE AS A FUNCTION OF CLOSED-LOOP GAIN USING RECOMMENDED COMPENSATION NETWORKS



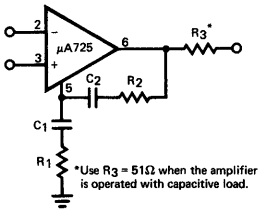
VOLTAGE OFFSET NULL CIRCUIT



COMPENSATION COMPONENT VALUES

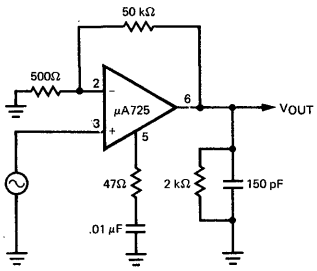
A_V	R_1 (Ω)	C_1 (μF)	R_2 (Ω)	C_2 (μF)
10,000	10 k	50 pF	—	—
1,000	470	.001	—	—
100	47	.01	—	—
10	27	.05	270	.0015
1	10	.05	39	.02

FREQUENCY COMPENSATION CIRCUIT



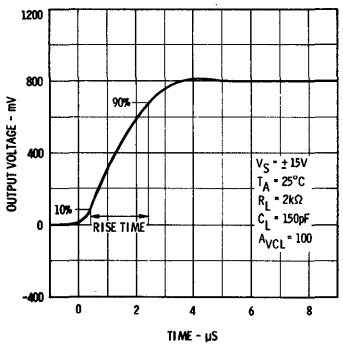
*Use R_3 = 51Ω when the amplifier is operated with capacitive load.

TRANSIENT RESPONSE TEST CIRCUIT



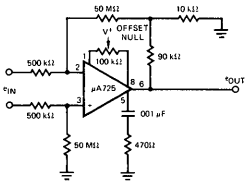
Pin numbers are shown for Metal Can only.

TRANSIENT RESPONSE



TYPICAL APPLICATIONS

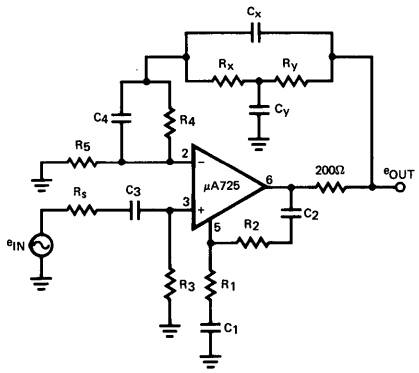
PRECISION AMPLIFIER – A_{VCL} = 1000



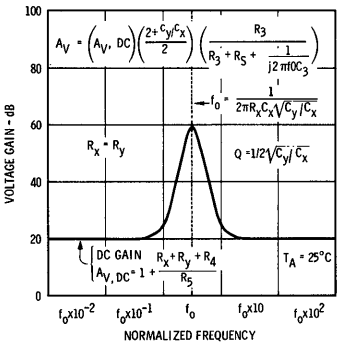
CHARACTERISTICS:

- A_V = 1000 = 60 dB
- DC Gain Error = 0.05%
- Bandwidth = 1 kHz for −0.05% error
- Diff. Input Res. = 1 MΩ
- Typical amplifying capability
  - e_{IN} = 10 μV on V_{CMI} = 1.0 V
- Caution: Minimize Stray Capacitance

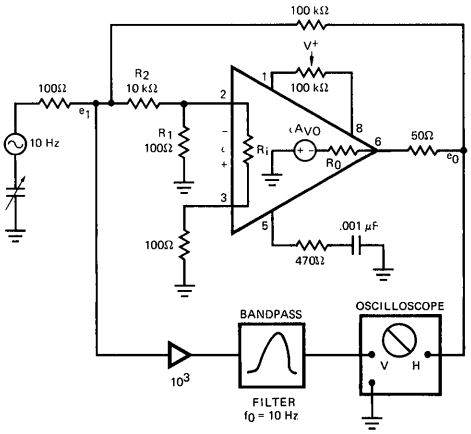
ACTIVE FILTER – BANDPASS WITH 60 dB GAIN



ACTIVE FILTER FREQUENCY RESPONSE

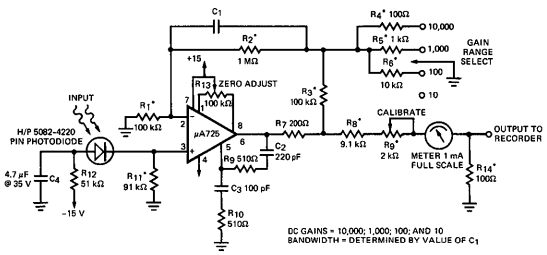


OPEN LOOP VOLTAGE GAIN TEST CIRCUIT



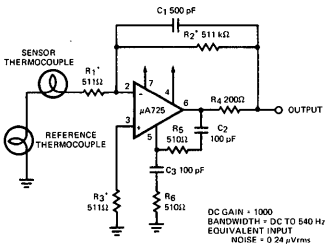
$$A_{VO} \simeq \frac{e_0}{e_1}\left(\frac{R_2 R_i + R_1 R_i + R_1 R_2}{R_1 R_i}\right) = \frac{e_0}{e_1}\ 101$$

PIN PHOTODIODE AMPLIFIER



NOTE: * Indicates ±1% Metal film resistors recommended for temperature stability.

THERMOCOUPLE AMPLIFIER



NOTE: * Indicates ±1% metal film resistors recommended for temperature stability.

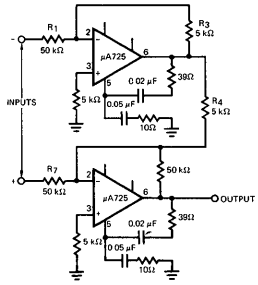
±100 V COMMON MODE RANGE INSTRUMENTATION AMPLIFIER

$$\frac{R_1}{R_7} = \frac{R_3}{R_4} \text{ for best CMRR}$$

$R_3 = R_4$

$R_1 = R_6 = 10R_3$

$$\text{Gain} = \frac{R_7}{R_6}$$



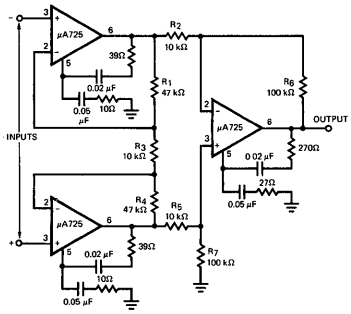
INSTRUMENTATION AMPLIFIER WITH HIGH COMMON MODE REJECTION

$$\frac{R_2}{R_5} = \frac{R_6}{R_7} \text{ for best CMR}$$

$R_1 = R_4$

$R_2 = R_5$

$$\text{Gain} = \frac{R_6}{R_2}\left(1 + \frac{2R_1}{R_3}\right)$$



μA727

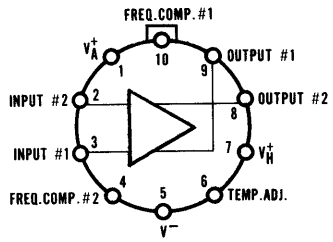
TEMPERATURE-CONTROLLED DIFFERENTIAL PREAMPLIFIER

FAIRCHILD LINEAR INTEGRATED CIRCUITS

GENERAL DESCRIPTION — The μA727 is a monolithic, fixed gain, Differential-Input Differential-Output Amplifier, constructed with the Fairchild Planar* epitaxial process, mounted in a high thermal-resistance package, and held at constant temperature by active regulator circuitry. The high gain and low standby dissipation of the regulator circuit give tight temperature control over a wide ambient temperature range. The device is intended for use as a self-contained input stage in very low-drift dc amplifiers, replacing complex chopper-stabilized amplifiers in such applications as thermo-couple bridges, strain gauge transducers, and A to D conververs.

- **VERY LOW OFFSET DRIFTS**
- **HIGH INPUT IMPEDANCE . . . 300 MΩ**
- **WIDE COMMON MODE RANGE . . . C_{MRR} = 100 dB**

CONNECTION DIAGRAM
10-LEAD METAL CAN
(TOP VIEW)
PACKAGE OUTLINE 5U



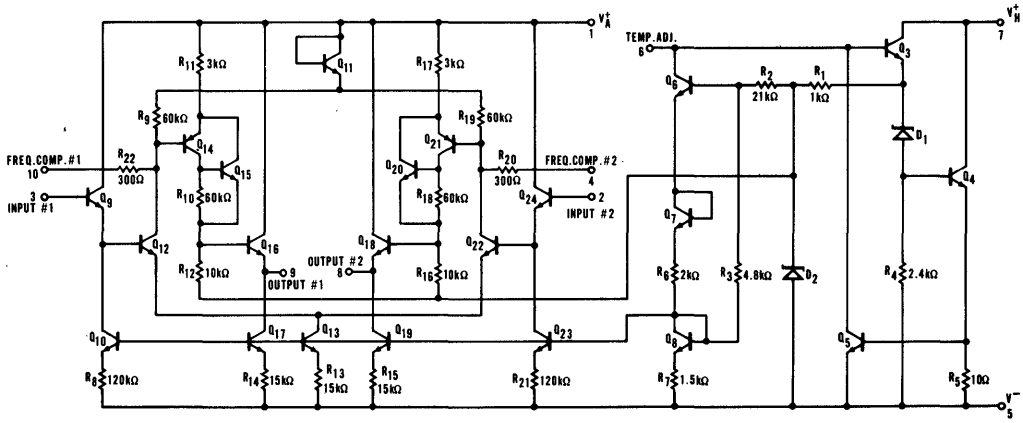
ORDER INFORMATION

TYPE	PART NO.
727	727HM
727C	727HC

ABSOLUTE MAXIMUM RATINGS

Operating Temperature Range	
Military (727)	−55°C to +125°C
Commercial (727C)	−20°C to +85°C
Storage Temperature Range	−65°C to +150°C
Lead Temperature (Soldering, 60 second time limit)	300°C
Internal Power Dissipation	500 mW
Supply Voltage (Amplifier and Heater)	±18 V
Differential Input Voltage	±10 V
Common Mode Input Voltage	±15 V

EQUIVALENT CIRCUIT



* Planar is a patented Fairchild process.

727

ELECTRICAL CHARACTERISTICS ($-55°C \leq T_A \leq +125°C$, $V_{H+} = V_{A+} = +15$ V, $V_- = -15$ V, $R_{ADJ} = 330$ kΩ, unless otherwise specified)

PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNITS
Input Offset Voltage	$R_S \leq 50\Omega$		2.0	10	mV
Input Offset Current			2.5	15	nA
Input Bias Current			12	40	nA
Input Offset Voltage Drift	$R_S \leq 50\Omega$, $+25°C \leq T_A \leq +125°C$		0.6	1.5	μV/°C
	$R_S \leq 50\Omega$, $-55°C \leq T_A \leq +25°C$		0.6	1.5	μV/°C
Input Offset Current Drift	$+25°C \leq T_A \leq +125°C$		2.0		pA/°C
	$-55°C \leq T_A \leq +25°C$		2.0		pA/°C
Input Bias Current Drift	$-55°C \leq T_A \leq +125°C$		15		pA/°C
Differential Input Resistance			300		MΩ
Common Mode Input Resistance			1000		MΩ
Input Voltage Range		±12	±13		V
Supply Voltage Rejection Ratio	$R_S \leq 100$ kΩ		80		μV/V
Common Mode Rejection Ratio	$R_S \leq 100$ kΩ	80	100		dB
Output Resistance			1.0	4.0	kΩ
Output Common Mode Voltage		−6.0	−5.0	−4.0	V
Differential Output Voltage Swing		±5.0	±7.0	±10	V
Output Sink Current		10	30	80	μA
Differential Load Rejection			5.0	10	μV/μA
Differential Voltage Gain		60	100	250	
Low Frequency Noise	BW = 10 Hz to 500 Hz, $R_S \leq 50\Omega$		3.0		μV_{rms}
Long Term Drift	$R_S \leq 50\Omega$		5.0		μV/week
Amplifier Supply Current	$T_A = +25°C$		1.0	2.0	mA
Heater Supply Current	$T_A = +25°C$		10	15	mA

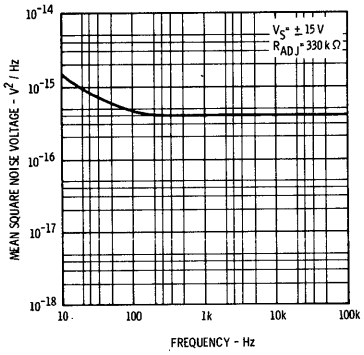
727C

ELECTRICAL CHARACTERISTICS ($-20°C \leq T_A \leq +85°C$, $V_{H+} = V_{A+} = +15$ V, $V_- = -15$ V, $R_{ADJ} = 1$MΩ, unless otherwise specified)

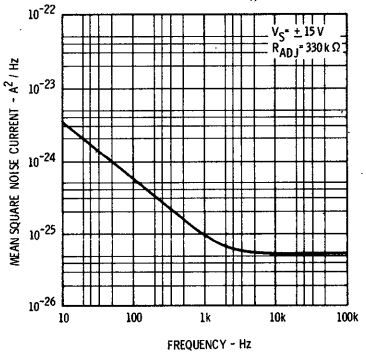
PARAMETER	CONDITONS	MIN.	TYP.	MAX.	UNITS
Input Offset Voltage	$R_S \leq 50\Omega$		2.0	10	mV
Input Offset Current			2.5	25	nA
Input Bias Current			12	75	nA
Input Offset Voltage Drift	$R_S \leq 50\Omega$		0.6	3.0	μV/°C
Input Offset Current Drift			2.0		pA/°C
Input Bias Current Drift			15		pA/°C
Differential Input Resistance			300		MΩ
Common Mode Input Resistance			1000		MΩ
Input Voltage Range		±12	±13		V
Supply Voltage Rejection Ratio	$R_S \leq 100$ kΩ		80		μV/V
Common Mode Rejection Ratio	$R_S \leq 100$ kΩ	70	100		dB
Output Resistance			1.0	4.0	kΩ
Output Common Mode Voltage		−7.0	−5.0	−4.0	V
Differential Output Voltage Swing		±3.0	±7.0	±10	V
Output Sink Current		10	30	80	μA
Differential Load Rejection			5.0	15	μV/μA
Differential Voltage Gain		50	100	250	
Low Frequency Noise	BW = 10 Hz to 500 Hz, $R_S \leq 50\Omega$		3.0		μV_{rms}
Long Term Drift	$R_S \leq 50\Omega$		5.0		μV/week
Amplifier Supply Current	$T_A = +25°C$		1.0	2.0	mA
Heater Supply Current	$T_A = +25°C$		10	15	mA

TYPICAL PERFORMANCE CURVES FOR 727 AND 727C

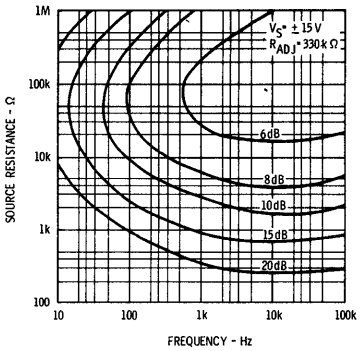
NOISE VOLTAGE AS A FUNCTION OF FREQUENCY



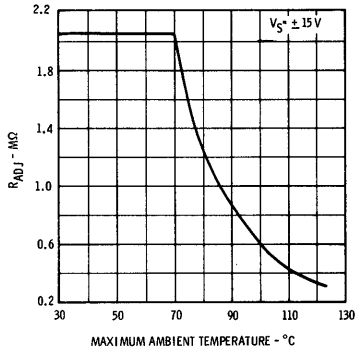
NOISE CURRENT AS A FUNCTION OF FREQUENCY



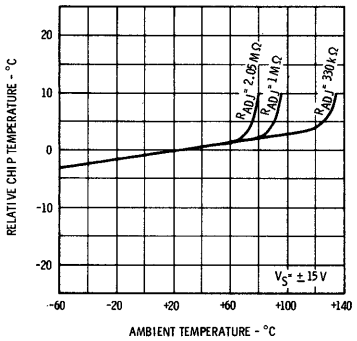
SPOT NOISE CONTOURS



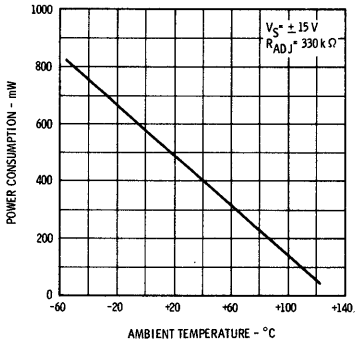
RECOMMENDED R_{ADJ} AS A FUNCTION OF MAXIMUM AMBIENT TEMPERATURE



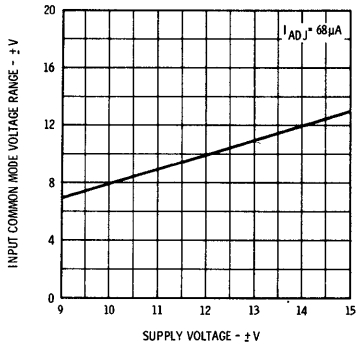
RELATIVE CHIP TEMPERATURE AS A FUNCTION OF AMBIENT TEMPERATURE



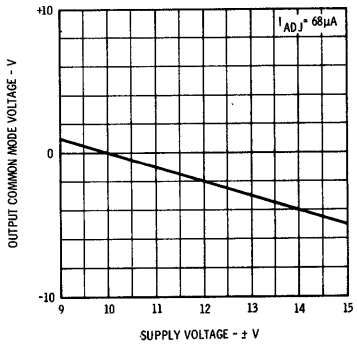
POWER CONSUMPTION AS A FUNCTION OF AMBIENT TEMPERATURE



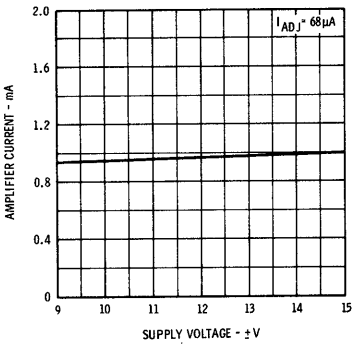
INPUT COMMON MODE VOLTAGE RANGE AS A FUNCTION OF SUPPLY VOLTAGE



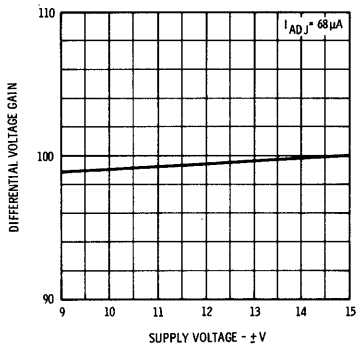
OUTPUT COMMON MODE VOLTAGE AS A FUNCTION OF SUPPLY VOLTAGE



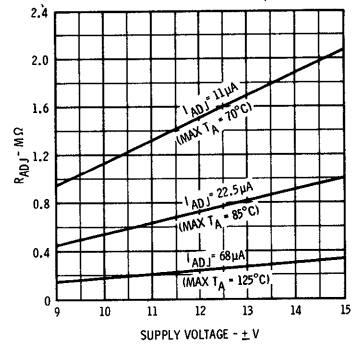
AMPLIFIER CURRENT AS A FUNCTION OF SUPPLY VOLTAGE



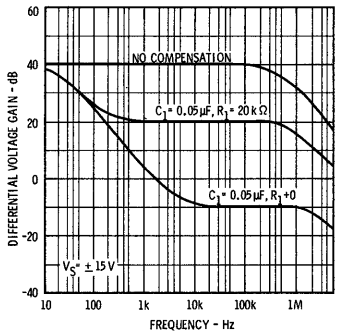
DIFFERENTIAL VOLTAGE GAIN AS A FUNCTION OF SUPPLY VOLTAGE



REQUIRED R_{ADJ} FOR CONSTANT I_{ADJ} AS A FUNCTION OF SUPPLY VOLTAGE

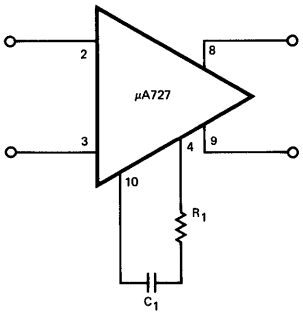


OPEN-LOOP FREQUENCY RESPONSE FOR VARIOUS VALUES OF COMPENSATION

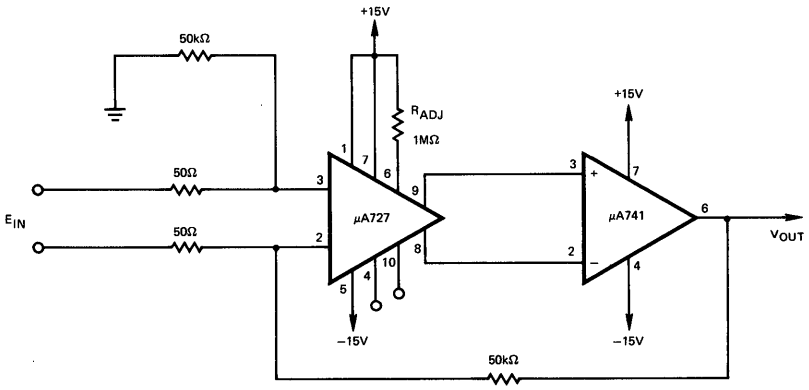


3

FREQUENCY COMPENSATION CIRCUIT



TYPICAL X1000 CIRCUIT



μA730

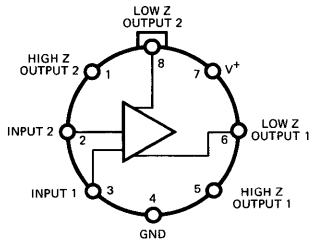
DIFFERENTIAL AMPLIFIER

FAIRCHILD LINEAR INTEGRATED CIRCUITS

GENERAL DESCRIPTION — The μA730 is a Differential Amplifier constructed on a single silicon chip using the Fairchild Planar* epitaxial process. This device has a wide range of applications since it has both a differential input and output; any combination of single-ended or differential configurations can be employed at its input and output. The emitter follower output stage gives this device a low output impedance making it useful as a preamplifier.

CONNECTION DIAGRAM
8-Lead Metal Can

(TOP VIEW)
PACKAGE OUTLINE 5B



NOTE: Pin 4 connected to case.

ORDER INFORMATION

TYPE	PART NO.
730	730HM
730C	730HC

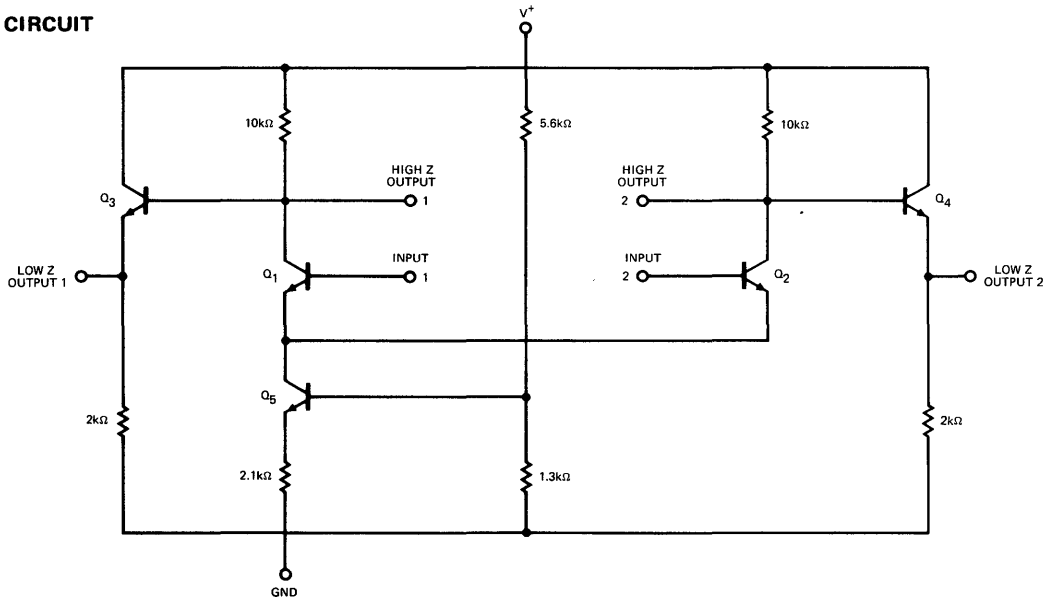
ABSOLUTE MAXIMUM RATINGS

Supply Voltage	15 V
Differential Input Voltage	±5 V
Common Mode Input Voltage	2.5 to 5.5 V
Internal Power Dissipation (Note 1)	500 mW
Operating Temperature Range	
Military (730)	−55°C to +125°C
Commercial (730C)	0°C to +70°C
Storage Temperature Range	−65°C to +150°C
Lead Temperature (Soldering, 60 seconds)	+300°C

NOTE:
1. Rating applies for ambient temperature to +70°C; derate linearly at 6.3 mW/°C for ambient temperatures above +70°C.

*Planar is a patented Fairchild process.

EQUIVALENT CIRCUIT



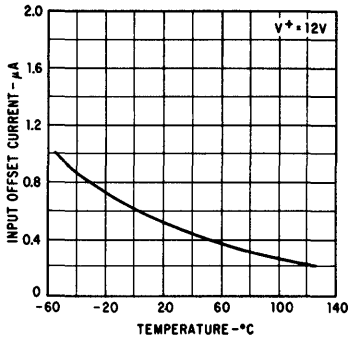
730

ELECTRICAL CHARACTERISTICS (T_A = 25°C, V+ = 12.0 V, and V_{CM} = 3.5 V unless otherwise specified)

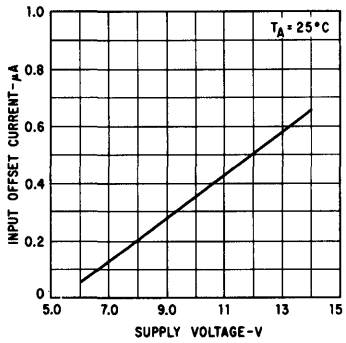
PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNITS
Input Offset Voltage	$R_S \leq 50\Omega$		1.0	2.5	mV
Input Offset Current			0.5	1.5	μA
Input Bias Current			3.5	7.5	μA
Input Resistance		5.0	20		kΩ
Differential Voltage Gain	$R_L \geq 100$ kΩ	100	145	160	
Differential Distortion	$R_L \geq 100$ kΩ		80	300	mVp-p
Bandwidth		1.0	1.5		MHz
Single-Ended Output Resistance			70	500	Ω
Output Voltage Swing	$R_L \geq 100$ kΩ	5.0	8.0		Vp-p
Supply Current	$R_L \geq 100$ kΩ		9.5	13	mA
Power Consumption	$R_L \geq 100$ kΩ		114	156	mW
The following specifications apply for −55°C ≤ T_A ≤ 125°C:					
Input Offset Voltage	$R_S \leq 50\Omega$			3.5	mV
Input Offset Current	T_A = +125°C		0.2	1.5	μA
	T_A = −55°C		1.0	3.0	μA
Input Bias Current	T_A = −55°C		6.5	15	μA
Input Resistance		0.9			kΩ
Input Voltage Range		3.5		5.2	V
Common Mode Rejection Ratio	$R_S \leq 50\Omega$, f ≤ 1.0 kHz, +3.5V ≤ V_{CM} ≤ +5.2V	70	85		dB
Differential Voltage Gain	$R_L \geq 100$ kΩ	90		175	
Common Mode Output Voltage		5.5	7.0	7.75	V
Output Resistance				600	Ω
Output Voltage Swing		4.5	6.8		Vp-p
Supply Current	T_A = −55°C		10	15	mA
	T_A = 125°C		8.0	11	mA
Power Consumption	T_A = −55°C		120	180	mW
	T_A = 125°C		96	121	mW

TYPICAL PERFORMANCE CURVES FOR 730

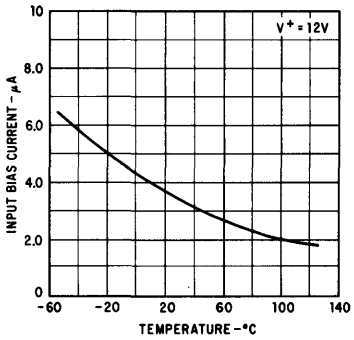
INPUT OFFSET CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



INPUT OFFSET CURRENT AS A FUNCTION OF SUPPLY VOLTAGE



INPUT BIAS CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



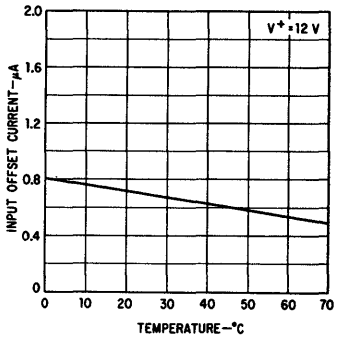
730C

ELECTRICAL CHARACTERISTICS (T_A = 25°C, V+ = 12.0 V, and V_{CM} = 3.5 V unless otherwise specified)

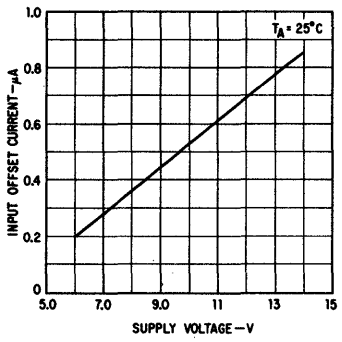
PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNITS
Input Offset Voltage	$R_S \leq 50\Omega$		2.0	5.0	mV
Input Offset Current			0.7	3.0	μA
Input Bias Current			4.5	16.0	μA
Input Resistance		2.5	15		kΩ
Differential Voltage Gain	$R_L \geq 100$ kΩ	100	135	160	
Differential Distortion	$R_L \geq 100$ kΩ		85	300	mVp-p
Bandwidth		1.0	1.5		MHz
Single-Ended Output Resistance			70	500	Ω
Output Voltage Swing	$R_L \geq 100$ kΩ	5.0	8.0		Vp-p
Supply Current	$R_L \geq 100$ kΩ		9.5	13	mA
Power Consumption	$R_L \geq 100$ kΩ		114	156	mW
The following specifications apply for 0°C ≤ T_A ≤ +70°C					
Input Offset Voltage	$R_S \leq 50\Omega$			7.5	mV
Input Offset Current	T_A = +70°C		0.5	3.0	μA
	T_A = 0°C		0.8	5.0	μA
Input Bias Current	T_A = 0°C		5.0	20	μA
Input Resistance		1.8			kΩ
Input Voltage Range		+3.5		+5.2	
Common Mode Rejection Ratio	$R_S \leq 50\Omega$, f ≤ 1.0 kHz, +3.5V ≤ V_{CM} ≤ +5.2V	60	80		dB
Differential Voltage Gain	$R_L \geq 100$ kΩ	80		190	
Common Mode Output Voltage		5.0	7.0	8.0	V
Output Resistance				600	Ω
Output Voltage Swing		4.5	7.5		Vp-p
Supply Current	T_A = 0°C		10	15	mA
	T_A = +70°C		8.8	13	mA
Power Consumption	T_A = 0°C		120	180	mW
	T_A = +70°C		106	156	mW

TYPICAL PERFORMANCE CURVES FOR 730C

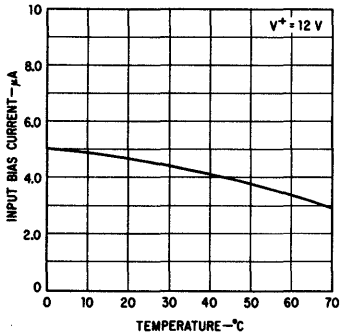
INPUT OFFSET CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



INPUT OFFSET CURRENT AS A FUNCTION OF SUPPLY VOLTAGE

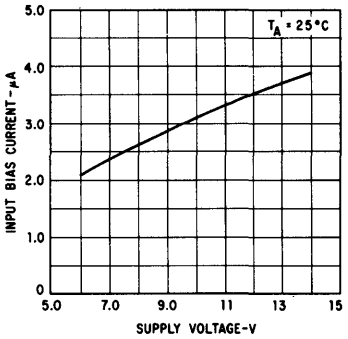


INPUT BIAS CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE

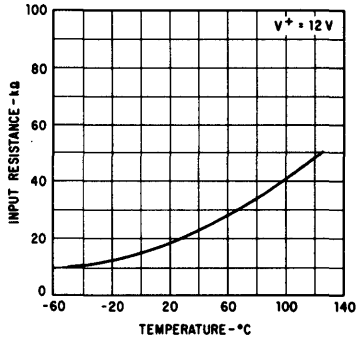


TYPICAL PERFORMANCE CURVES FOR 730

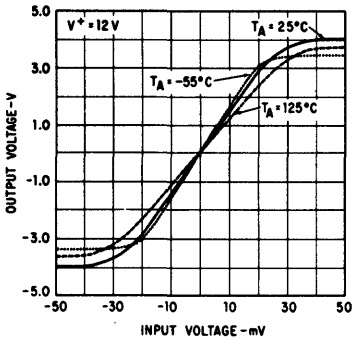
INPUT BIAS CURRENT AS A FUNCTION OF SUPPLY VOLTAGE



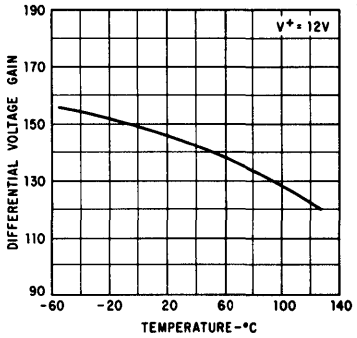
INPUT RESISTANCE AS A FUNCTION OF AMBIENT TEMPERATURE



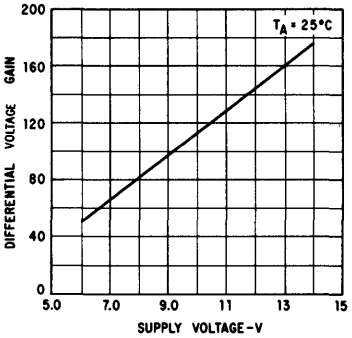
VOLTAGE TRANSFER CHARACTERISTICS



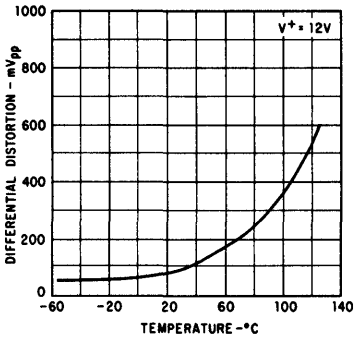
DIFFERENTIAL VOLTAGE GAIN AS A FUNCTION OF AMBIENT TEMPERATURE



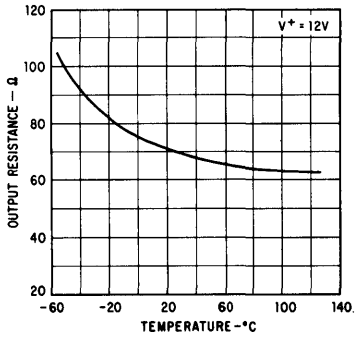
DIFFERENTIAL VOLTAGE GAIN AS A FUNCTION OF SUPPLY VOLTAGE



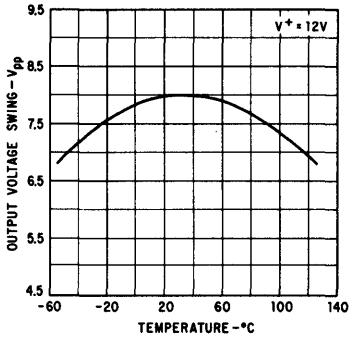
DIFFERENTIAL DISTORTION AS A FUNCTION OF AMBIENT TEMPERATURE



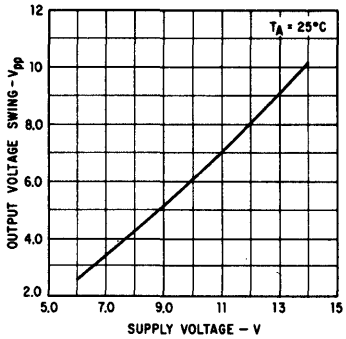
OUTPUT RESISTANCE AS A FUNCTION OF AMBIENT TEMPERATURE



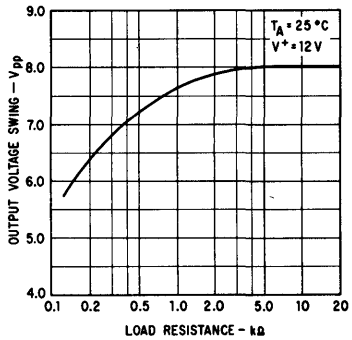
OUTPUT VOLTAGE SWING AS A FUNCTION OF AMBIENT TEMPERATURE



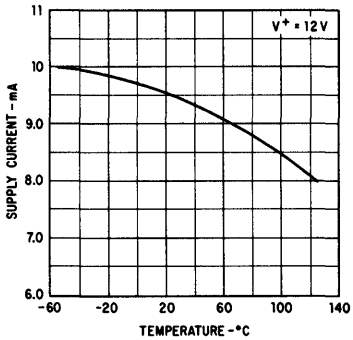
OUTPUT VOLTAGE SWING AS A FUNCTION OF SUPPLY VOLTAGE



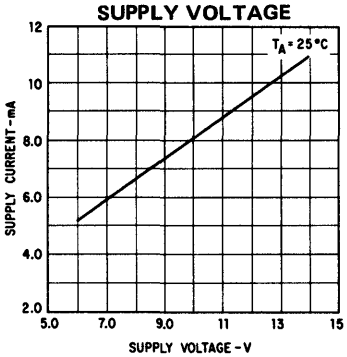
OUTPUT VOLTAGE SWING AS A FUNCTION OF LOAD RESISTANCE



SUPPLY CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE

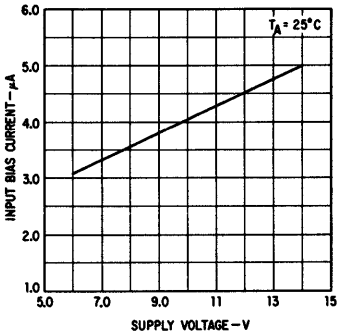


SUPPLY CURRENT AS A FUNCTION OF SUPPLY VOLTAGE

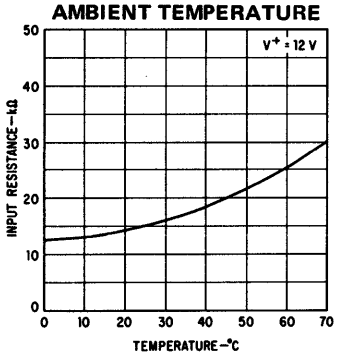


TYPICAL PERFORMANCE CURVES FOR 730C

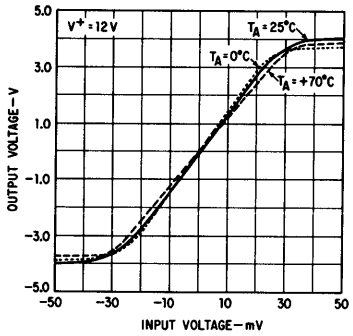
INPUT BIAS CURRENT AS A FUNCTION OF SUPPLY VOLTAGE



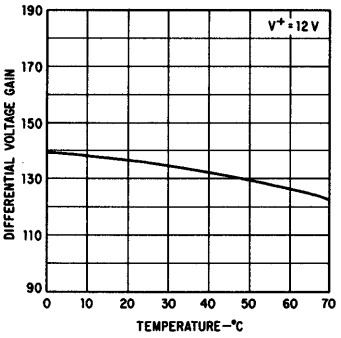
INPUT RESISTANCE AS A FUNCTION OF AMBIENT TEMPERATURE



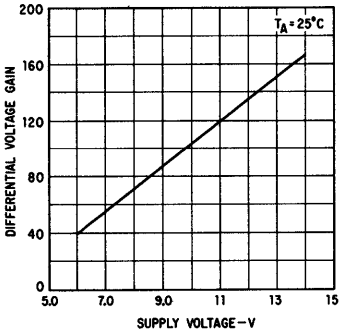
VOLTAGE TRANSFER CHARACTERISTICS



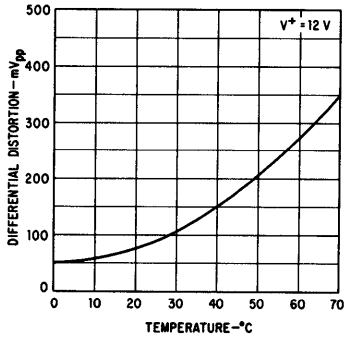
DIFFERENTIAL VOLTAGE GAIN AS A FUNCTION OF AMBIENT TEMPERATURE



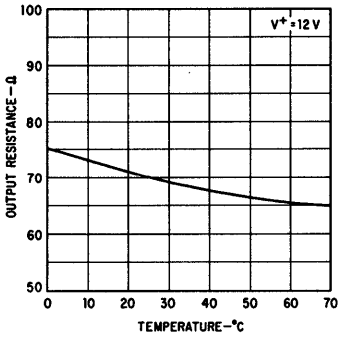
DIFFERENTIAL VOLTAGE GAIN AS A FUNCTION OF SUPPLY VOLTAGE



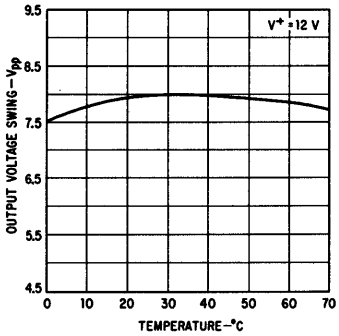
DIFFERENTIAL DISTORTION AS A FUNCTION OF AMBIENT TEMPERATURE



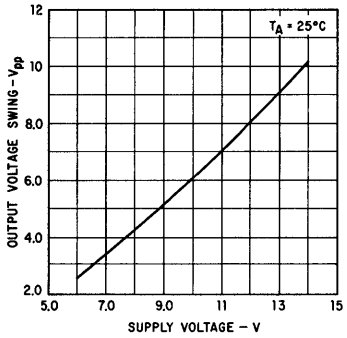
OUTPUT RESISTANCE AS A FUNCTION OF AMBIENT TEMPERATURE



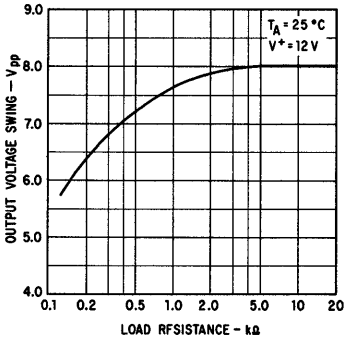
OUTPUT VOLTAGE SWING AS A FUNCTION OF AMBIENT TEMPERATURE



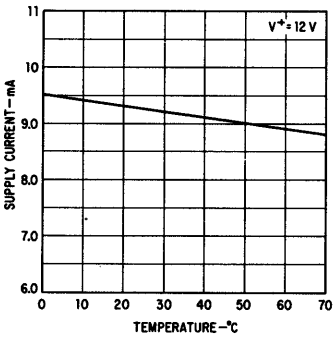
OUTPUT VOLTAGE SWING AS A FUNCTION OF SUPPLY VOLTAGE



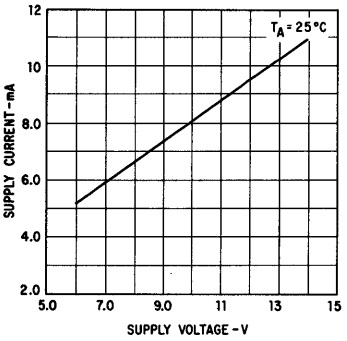
OUTPUT VOLTAGE SWING AS A FUNCTION OF LOAD RESISTANCE



SUPPLY CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE

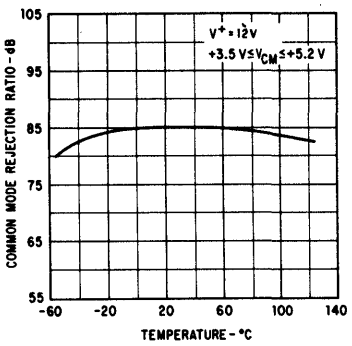


SUPPLY CURRENT AS A FUNCTION OF SUPPLY VOLTAGE

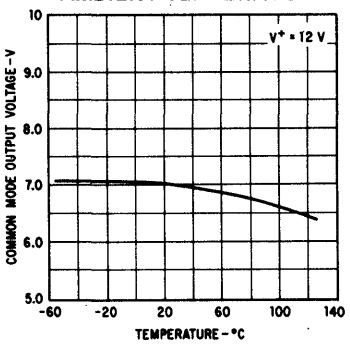


TYPICAL PERFORMANCE CURVES FOR 730 AND 730C

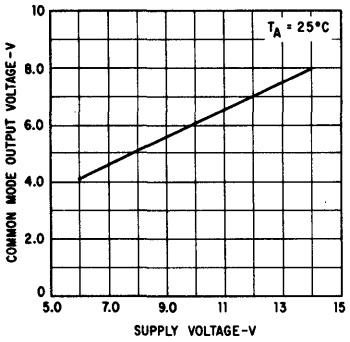
COMMON MODE REJECTION RATIO AS A FUNCTION OF AMBIENT TEMPERATURE



COMMON MODE OUTPUT VOLTAGE AS A FUNCTION OF AMBIENT TEMPERATURE



COMMON MODE OUTPUT VOLTAGE AS A FUNCTION OF SUPPLY VOLTAGE



μA740

FET INPUT OPERATIONAL AMPLIFIER

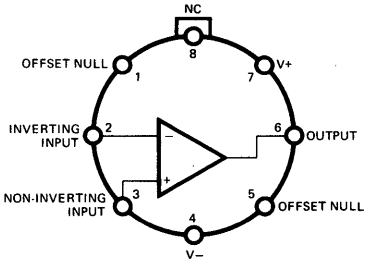
FAIRCHILD LINEAR INTEGRATED CIRCUITS

GENERAL DESCRIPTION — The μA740 is a high performance monolithic FET-Input Operational Amplifier constructed using the Fairchild Planar* epitaxial process. It is intended for a wide range of analog applications where very high input impedance is required and features very low input offset current and very low input bias current. High slew rate, high common mode voltage range and absence of "latch up" make the μA740 ideal for use as a voltage follower. The high gain and wide range of operating voltages provide superior performance in active filters, integrators, summing amplifiers, sample and holds, transducer amplifiers, and other general feedback applications. The μA740 is short circuit protected and has the same pin configuration as the popular μA741 operational amplifier. No external components for frequency compensation are required as the internal 6 dB/octave roll-off insures stability in closed loop applications.

- **HIGH INPUT IMPEDANCE . . . 1,000,000 MΩ**
- **NO FREQUENCY COMPENSATION REQUIRED**
- **SHORT-CIRCUIT PROTECTION**
- **OFFSET VOLTAGE NULL CAPABILITY**
- **LARGE COMMON-MODE AND DIFFERENTIAL VOLTAGE RANGES**
- **NO LATCH UP**

CONNECTION DIAGRAM

8-LEAD METAL CAN
(TOP VIEW)
PACKAGE OUTLINE 5B



NOTE: Pin 4 Connected to Case.

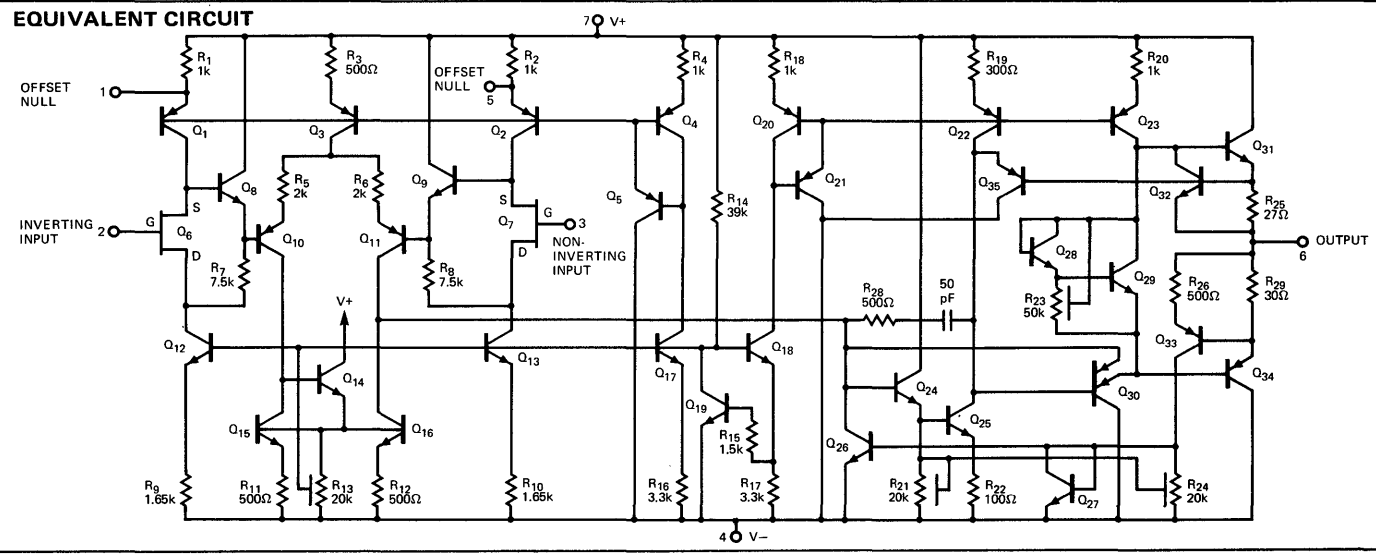
ORDER INFORMATION

TYPE	PART NO.
740	740 HM
740C	740 HC

ABSOLUTE MAXIMUM RATINGS

Supply Voltage	±22V
Internal Power Dissipation (Note 1)	500 mW
Differential Input Voltage	±30V
Input Voltage (Note 2)	±15V
Voltage between Offset Null and V+	±0.5V
Storage Temperature Range	−65°C to +150°C
Operating Temperature Range	
Military (740)	−55°C to +125°C
Commercial (740C)	0°C to +70°C
Lead Temperature (Soldering, 60 seconds)	300°C
Output Short-Circuit Duration (Note 3)	Indefinite

EQUIVALENT CIRCUIT



Notes on following pages.

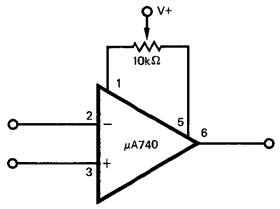
*Planar is a patented Fairchild process.

740

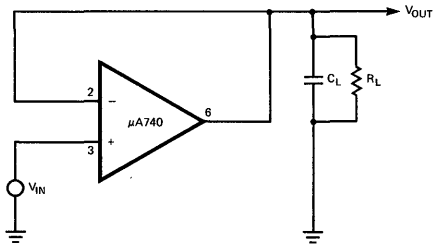
ELECTRICAL CHARACTERISTICS ($V_S = \pm 15V$, $T_C = 25°C$ unless otherwise specified)

PARAMETER		CONDITIONS	MIN.	TYP.	MAX.	UNITS
Input Offset Voltage		$R_S \leqslant 100\,k\Omega$		10	20	mV
Input Offset Current [Note 4]				40	150	pA
Input Current (either input) [Note 4]				100	200	pA
Input Resistance				1,000,000		MΩ
Large Signal Voltage Gain		$R_L \geqslant 2k\Omega$, $V_{OUT} = \pm 10V$	50,000	1,000,000		
Output Resistance				75		Ω
Output Short-Circuit Current				20		mA
Common Mode Rejection Ratio			64	80		dB
Supply Voltage Rejection Ratio				70	300	μV/V
Supply Current				4.2	5.2	mA
Power Consumption				126	156	mW
Slew Rate				6.0		V/μs
Unity Gain Bandwidth				3.0		MHz
Transient Response (Unity Gain)	Risetime	$C_L \leqslant 100pF$, $R_L = 2k\Omega$, $V_{IN} = 100mV$		110		ns
	Overshoot			10	20	%
The following specifications apply for $T_C = -55°C$ to $+85°C$:						
Input Voltage Range			±10		±12	V
Large Signal Voltage Gain			25,000			
Output Voltage Swing		$R_L \geqslant 10k\Omega$	±12	±14		V
		$R_L \geqslant 2k\Omega$	±10	±13		V
Input Offset Voltage		$R_S \leqslant 100k\Omega$		15	30	mV
Input Offset Current		$T_A = -55°C$		30		pA
		$T_A = +85°C$		185		pA
Input Current (either input)		$T_A = -55°C$			200	pA
		$T_A = +85°C$		2.5	4.0	nA

VOLTAGE OFFSET NULL CIRCUIT



TRANSIENT RESPONSE TEST CIRCUIT



740C

ELECTRICAL CHARACTERISTICS ($V_S = \pm 15V$, $T_C = 25^oC$ unless otherwise specified)

PARAMETER		CONDITIONS	MIN.	TYP.	MAX.	UNITS
Input Offset Voltage		$R_S \leqslant 100k\Omega$		30	110	mV
Input Offset Current (Note 4)				60	300	pA
Input Current (either input) [Note 4]				0.1	2.0	nA
Input Resistance				1,000,000		MΩ
Large Signal Voltage Gain		$R_L \geqslant 2k\Omega$, $V_{OUT} = \pm 10V$	20,000	1,000,000		
Output Resistance				75		Ω
Output Short-Circuit Current				20		mA
Supply Current				4.2	8.0	mA
Power Consumption				126	240	mW
Slew Rate				6.0		V/μs
Unity Gain Bandwidth				1.0		MHz
Transient Response (Unity Gain)	Risetime	$C_L \leqslant 100pF$, $R_L = 2k\Omega$, $V_{IN} = 100mV$		300		ns
	Overshoot			10		%
The following specifications apply for $0^oC \leqslant T_A \leqslant +70^oC$:						
Input Voltage Range			±10	±12		V
Common Mode Rejection Ratio			55	80		dB
Supply Voltage Rejection Ratio				70	500	μV/V
Large Signal Voltage Gain				500,000		
Output Voltage Swing		$R_L \geqslant 10k\Omega$	±12	±14		V
		$R_L \geqslant 2k\Omega$	±10	±13		V
Input Offset Voltage				30		mV
Input Offset Current				60		pA
Input Current (either input)				1.1	10	nA

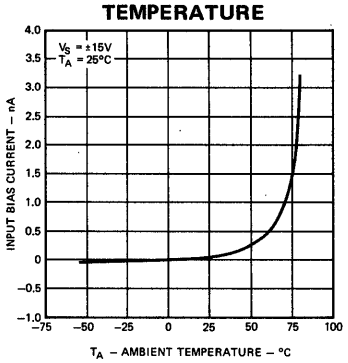
NOTES:

1. Rating applies for ambient temperature to +70°C; derate linearly at 6.3mW/°C for ambient temperatures above +70°C.
2. For supply voltages less than ±15V, the absolute maximum input voltage is equal to the supply voltage.
3. Short circuit may be to ground or either supply. Rating applies to +125°C case temperature or +75°C ambient temperature.
4. Typically doubles for every 10°C increase in ambient temperature.

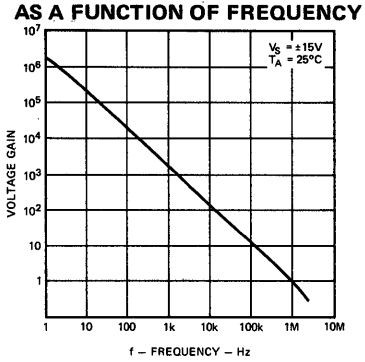
3

TYPICAL PERFORMANCE CURVES FOR 740 AND 740C

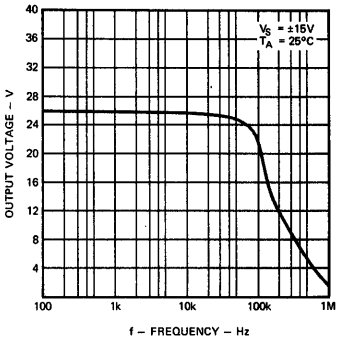
INPUT BIAS CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



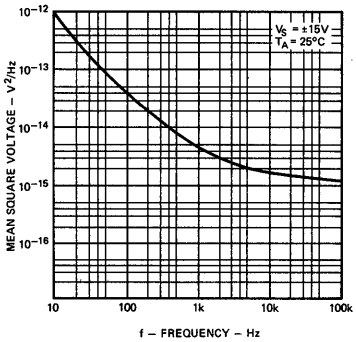
OPEN LOOP VOLTAGE GAIN AS A FUNCTION OF FREQUENCY



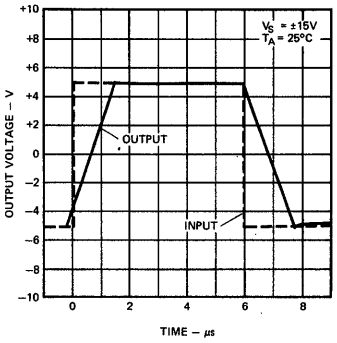
OUTPUT VOLTAGE SWING AS A FUNCTION OF FREQUENCY



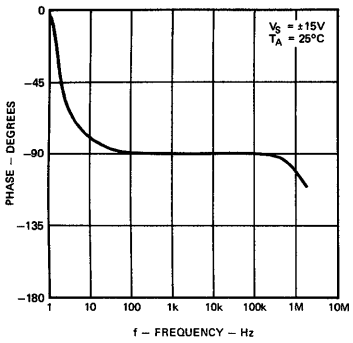
INPUT NOISE VOLTAGE AS A FUNCTION OF FREQUENCY



VOLTAGE FOLLOWER LARGE SIGNAL PULSE RESPONSE



OPEN LOOP PHASE RESPONSE AS A FUNCTION OF FREQUENCY



μA741

FREQUENCY-COMPENSATED OPERATIONAL AMPLIFIER

FAIRCHILD LINEAR INTEGRATED CIRCUITS

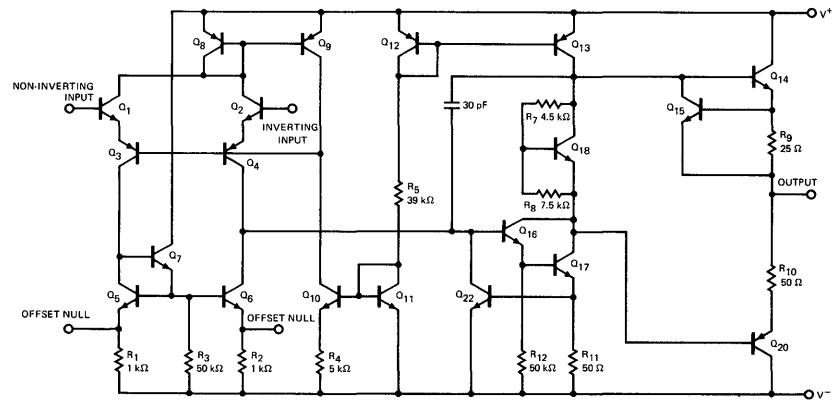
GENERAL DESCRIPTION — The μA741 is a high performance monolithic Operational Amplifier constructed using the Fairchild Planar* epitaxial process. It is intended for a wide range of analog applications. High common mode voltage range and absence of "latch-up" tendencies make the μA741 ideal for use as a voltage follower. The high gain and wide range of operating voltage provides superior performance in integrator, summing amplifier, and general feedback applications.

- **NO FREQUENCY COMPENSATION REQUIRED**
- **SHORT CIRCUIT PROTECTION**
- **OFFSET VOLTAGE NULL CAPABILITY**
- **LARGE COMMON-MODE AND DIFFERENTIAL VOLTAGE RANGES**
- **LOW POWER CONSUMPTION**
- **NO LATCH UP**

ABSOLUTE MAXIMUM RATINGS

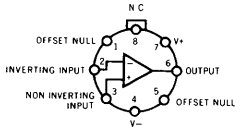
Supply Voltage	
Military (741)	±22 V
Commercial (741C)	±18 V
Internal Power Dissipation (Note 1)	
Metal Can	500 mW
DIP	670 mW
Mini DIP	310 mW
Flatpak	570 mW
Differential Input Voltage	±30 V
Input Voltage (Note 2)	±15 V
Storage Temperature Range	
Metal Can, DIP, and Flatpak	−65°C to +150°C
Mini DIP	−55°C to +125°C
Operating Temperature Range	
Military (741)	−55°C to +125°C
Commercial (741C)	0°C to +70°C
Lead Temperature (Soldering)	
Metal Can, DIP, and Flatpak (60 seconds)	300°C
Mini DIP (10 seconds)	260°C
Output Short Circuit Duration (Note 3)	Indefinite

EQUIVALENT CIRCUIT



CONNECTION DIAGRAMS

8-LEAD METAL CAN
(TOP VIEW)
PACKAGE OUTLINE 5B

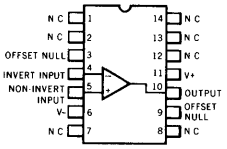


Note: Pin 4 connected to case

ORDER INFORMATION

TYPE	PART NO.
741	741HM
741C	741HC

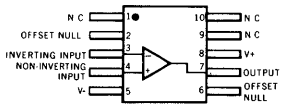
14-LEAD DIP
(TOP VIEW)
PACKAGE OUTLINE 6A



ORDER INFORMATION

TYPE	PART NO.
741	741DM
741C	741DC

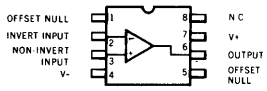
10-LEAD FLATPAK
(TOP VIEW)
PACKAGE OUTLINE 3F



ORDER INFORMATION

TYPE	PART NO.
741	741FM

8-LEAD MINIDIP
(TOP VIEW)
PACKAGE OUTLINE 9T



ORDER INFORMATION

TYPE	PART NO.
741C	741TC

Notes on following pages.

*Planar is a patented Fairchild process.

741

ELECTRICAL CHARACTERISTICS (V_S = ±15 V, T_A = 25°C unless otherwise specified)

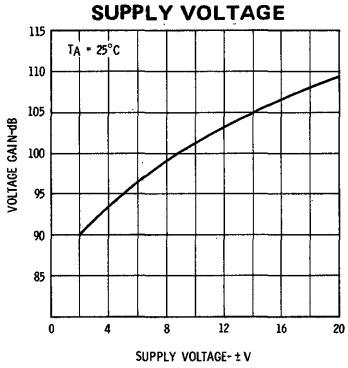
PARAMETERS (see definitions)		CONDITIONS	MIN.	TYP.	MAX.	UNITS
Input Offset Voltage		$R_S \leq 10\ k\Omega$		1.0	5.0	mV
Input Offset Current				20	200	nA
Input Bias Current				80	500	nA
Input Resistance			0.3	2.0		MΩ
Input Capacitance				1.4		pF
Offset Voltage Adjustment Range				±15		mV
Large Signal Voltage Gain		$R_L \geq 2\ k\Omega$, V_{OUT} = ±10 V	50,000	200,000		
Output Resistance				75		Ω
Output Short Circuit Current				25		mA
Supply Current				1.7	2.8	mA
Power Consumption				50	85	mW
Transient Response (Unity Gain)	Risetime	V_{IN} = 20 mV, R_L = 2 kΩ, $C_L \leq 100$ pF		0.3		μs
	Overshoot			5.0		%
Slew Rate		$R_L \geq 2\ k\Omega$		0.5		V/μs

The following specifications apply for $-55°C \leq T_A \leq +125°C$:

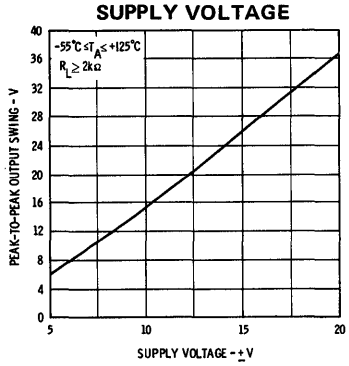
Input Offset Voltage	$R_S \leq 10\ k\Omega$		1.0	6.0	mV
Input Offset Current	T_A = +125°C		7.0	200	nA
	T_A = −55°C		85	500	nA
Input Bias Current	T_A = +125°C		0.03	0.5	μA
	T_A = −55°C		0.3	1.5	μA
Input Voltage Range		±12	±13		V
Common Mode Rejection Ratio	$R_S \leq 10\ k\Omega$	70	90		dB
Supply Voltage Rejection Ratio	$R_S \leq 10\ k\Omega$		30	150	μV/V
Large Signal Voltage Gain	$R_L \geq 2\ k\Omega$, V_{OUT} = ±10 V	25,000			
Output Voltage Swing	$R_L \geq 10\ k\Omega$	±12	±14		V
	$R_L \geq 2\ k\Omega$	±10	±13		V
Supply Current	T_A = +125°C		1.5	2.5	mA
	T_A = −55°C		2.0	3.3	mA
Power Consumption	T_A = +125°C		45	75	mW
	T_A = −55°C		60	100	mW

TYPICAL PERFORMANCE CURVES FOR 741

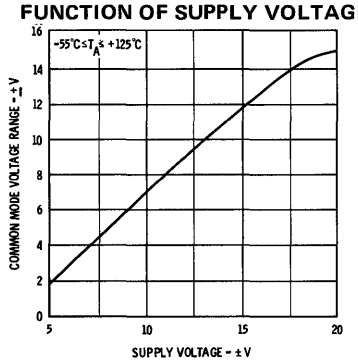
OPEN LOOP VOLTAGE GAIN AS A FUNCTION OF SUPPLY VOLTAGE



OUTPUT VOLTAGE SWING AS A FUNCTION OF SUPPLY VOLTAGE



INPUT COMMON MODE VOLTAGE RANGE AS A FUNCTION OF SUPPLY VOLTAGE



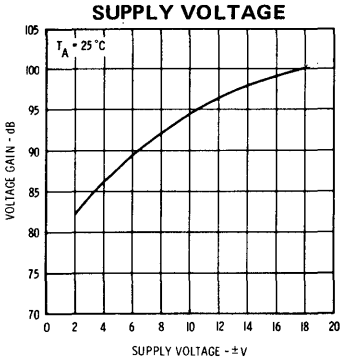
741C

ELECTRICAL CHARACTERISTICS (V_S = ±15 V, T_A = 25°C unless otherwise specified)

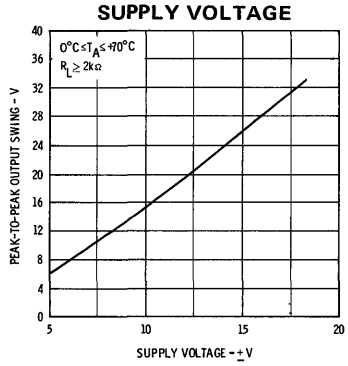
PARAMETERS (see definitions)		CONDITIONS	MIN.	TYP.	MAX.	UNITS
Input Offset Voltage		$R_S \leq 10$ kΩ		2.0	6.0	mV
Input Offset Current				20	200	nA
Input Bias Current				80	500	nA
Input Resistance			0.3	2.0		MΩ
Input Capacitance				1.4		pF
Offset Voltage Adjustment Range				±15		mV
Input Voltage Range			±12	±13		V
Common Mode Rejection Ratio		$R_S \leq 10$ kΩ	70	90		dB
Supply Voltage Rejection Ratio		$R_S \leq 10$ kΩ		30	150	μV/V
Large Signal Voltage Gain		$R_L \geq 2$ kΩ, V_{OUT} = ±10 V	20,000	200,000		
Output Voltage Swing		$R_L \geq 10$ kΩ	±12	±14		V
		$R_L \geq 2$ kΩ	±10	±13		V
Output Resistance				75		Ω
Output Short Circuit Current				25		mA
Supply Current				1.7	2.8	mA
Power Consumption				50	85	mW
Transient Response (Unity Gain)	Risetime	V_{IN} = 20 mV, R_L = 2 kΩ, $C_L \leq 100$ pF		0.3		μs
	Overshoot			5.0		%
Slew Rate		$R_L \geq 2$ kΩ		0.5		V/μs
The following specifications apply for 0°C ≤ T_A ≤ +70°C:						
Input Offset Voltage					7.5	mV
Input Offset Current					300	nA
Input Bias Current					800	nA
Large Signal Voltage Gain		$R_L \geq 2$ kΩ, V_{OUT} = ±10 V	15,000			
Output Voltage Swing		$R_L \geq 2$ kΩ	±10	±13		V

TYPICAL PERFORMANCE CURVES FOR 741C

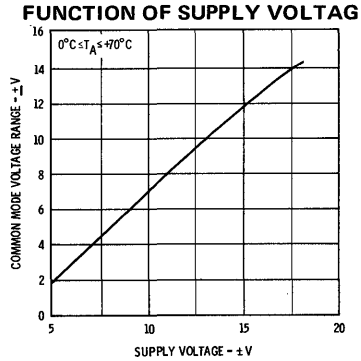
OPEN LOOP VOLTAGE GAIN AS A FUNCTION OF SUPPLY VOLTAGE



OUTPUT VOLTAGE SWING AS A FUNCTION OF SUPPLY VOLTAGE



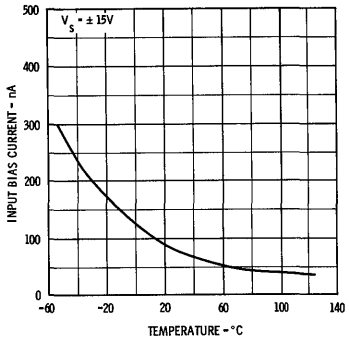
INPUT COMMON MODE VOLTAGE RANGE AS A FUNCTION OF SUPPLY VOLTAGE



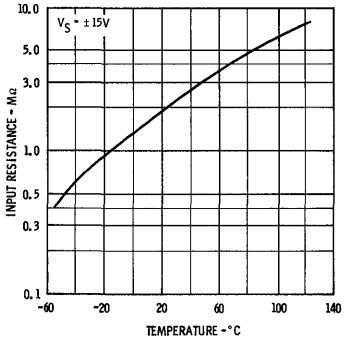
NOTES:
1. Rating applies to ambient temperatures up to 70°C. Above 70°C ambient derate linearly at 6.3 mW/°C for the Metal Can, 8.3 mW/°C for the DIP, 5.6 mW/°C for the Mini DIP and 7.1 mW/°C for the Flatpak.
2. For supply voltages less than ±15 V, the absolute maximum input voltage is equal to the supply voltage.
3. Short circuit may be to ground or either supply. Rating applies to +125°C case temperature or 75°C ambient temperature.

TYPICAL PERFORMANCE CURVES FOR 741

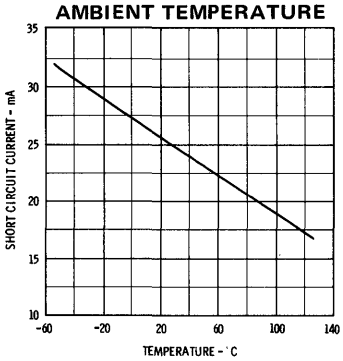
INPUT BIAS CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



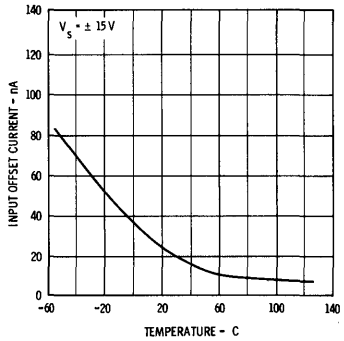
INPUT RESISTANCE AS A FUNCTION OF AMBIENT TEMPERATURE



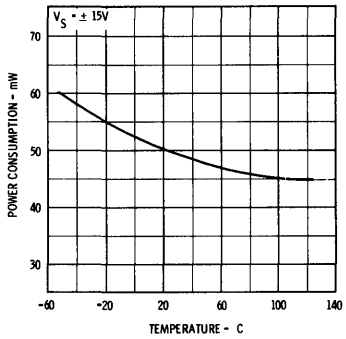
OUTPUT SHORT-CIRCUIT CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



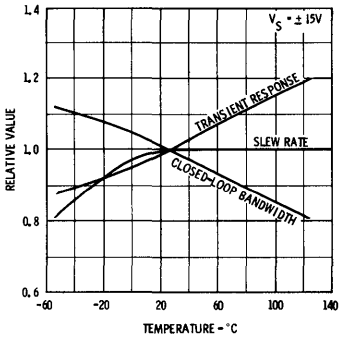
INPUT OFFSET CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



POWER CONSUMPTION AS A FUNCTION OF AMBIENT TEMPERATURE

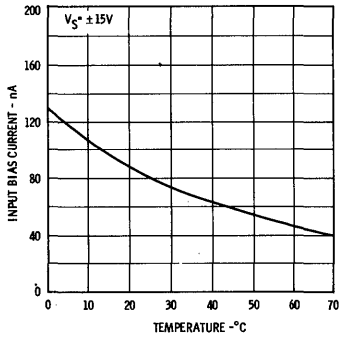


FREQUENCY CHARACTERISTICS AS A FUNCTION OF AMBIENT TEMPERATURE

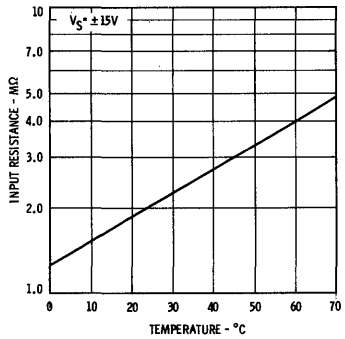


TYPICAL PERFORMANCE CURVES FOR 741C

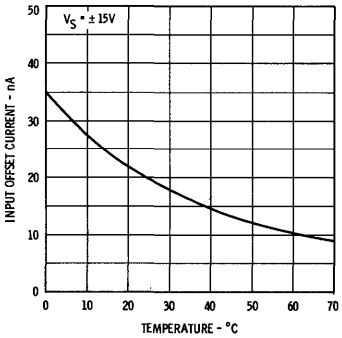
INPUT BIAS CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



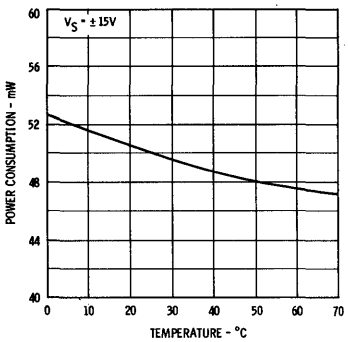
INPUT RESISTANCE AS A FUNCTION OF AMBIENT TEMPERATURE



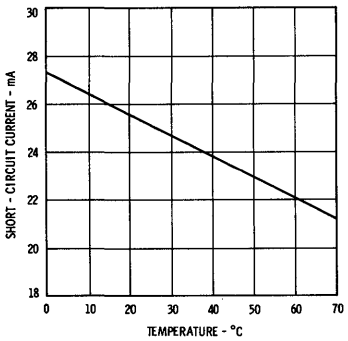
INPUT OFFSET CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



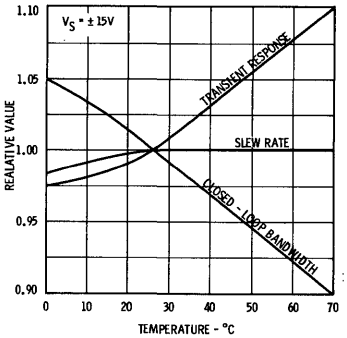
POWER CONSUMPTION AS A FUNCTION OF AMBIENT TEMPERATURE



OUTPUT SHORT-CIRCUIT CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE

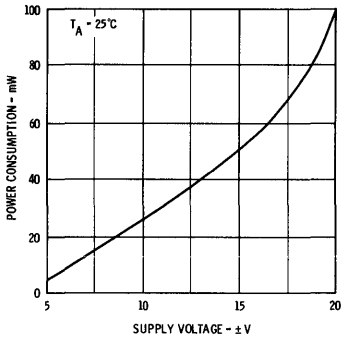


FREQUENCY CHARACTERISTICS AS A FUNCTION OF AMBIENT TEMPERATURE

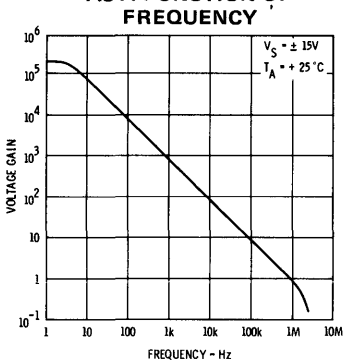


TYPICAL PERFORMANCE CURVES FOR 741 AND 741C (Cont'd)

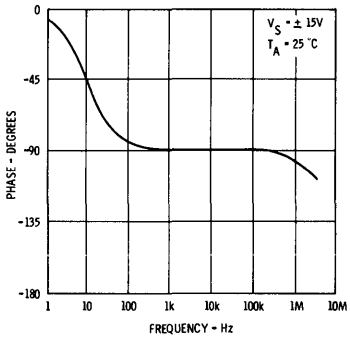
POWER CONSUMPTION AS A FUNCTION OF SUPPLY VOLTAGE



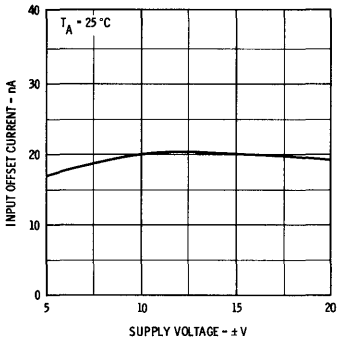
OPEN LOOP VOLTAGE GAIN AS A FUNCTION OF FREQUENCY



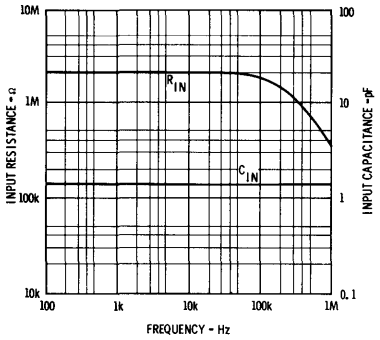
OPEN LOOP PHASE RESPONSE AS A FUNCTION OF FREQUENCY



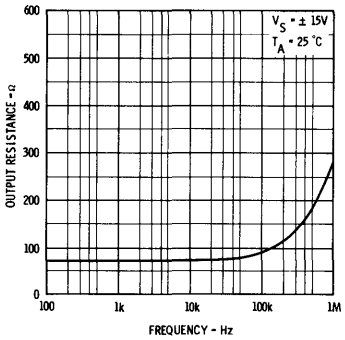
INPUT OFFSET CURRENT AS A FUNCTION OF SUPPLY VOLTAGE



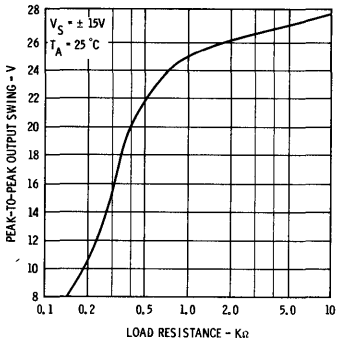
INPUT RESISTANCE AND INPUT CAPACITANCE AS A FUNCTION OF FREQUENCY



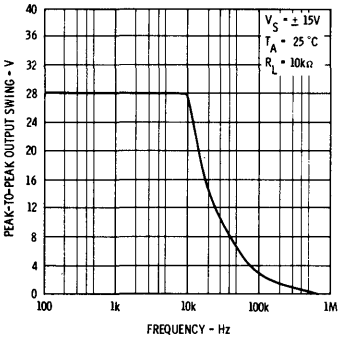
OUTPUT RESISTANCE AS A FUNCTION OF FREQUENCY



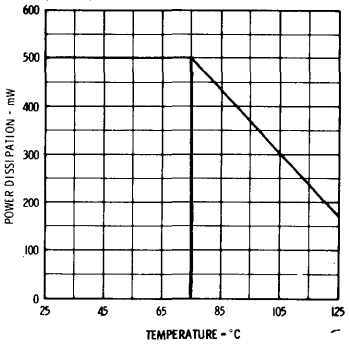
OUTPUT VOLTAGE SWING AS A FUNCTION OF LOAD RESISTANCE



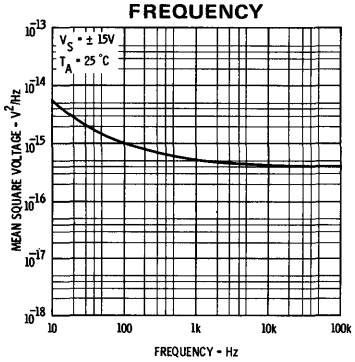
OUTPUT VOLTAGE SWING AS A FUNCTION OF FREQUENCY



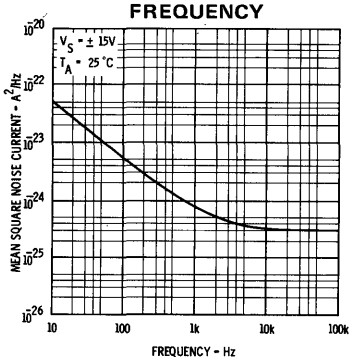
ABSOLUTE MAXIMUM POWER DISSIPATION AS A FUNCTION OF AMBIENT TEMPERATURE



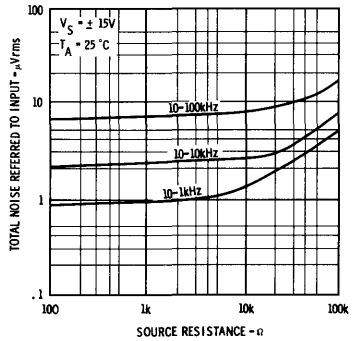
INPUT NOISE VOLTAGE AS A FUNCTION OF FREQUENCY



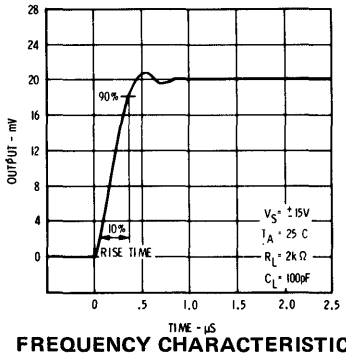
INPUT NOISE CURRENT AS A FUNCTION OF FREQUENCY



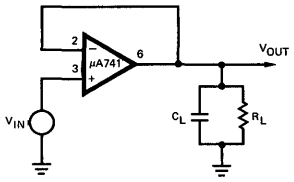
BROADBAND NOISE FOR VARIOUS BANDWIDTHS



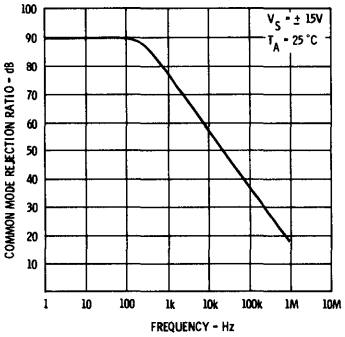
TRANSIENT RESPONSE



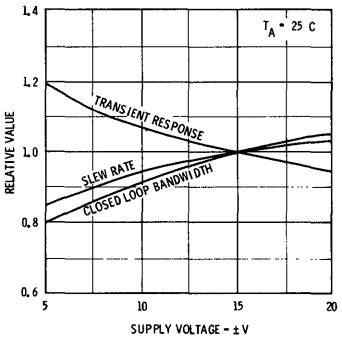
TRANSIENT RESPONSE TEST CIRCUIT



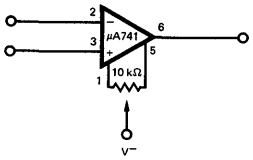
COMMON MODE REJECTION RATIO AS A FUNCTION OF FREQUENCY



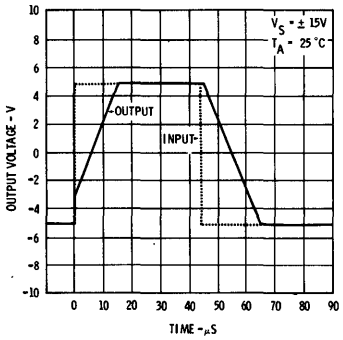
FREQUENCY CHARACTERISTICS AS A FUNCTION OF SUPPLY VOLTAGE



VOLTAGE OFFSET NULL CIRCUIT

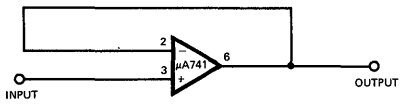


VOLTAGE FOLLOWER LARGE-SIGNAL PULSE RESPONSE



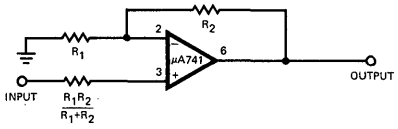
TYPICAL APPLICATIONS

UNITY-GAIN VOLTAGE FOLLOWER



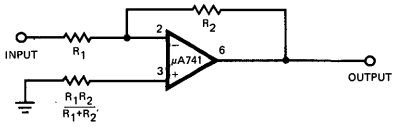
R_{IN} = 400 MΩ
C_{IN} = 1 pF
$R_{OUT} << 1\ \Omega$
B.W. = 1 MHz

NON-INVERTING AMPLIFIER



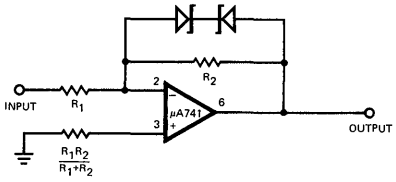
GAIN	R_1	R_2	B.W.	R_{IN}
10	1 kΩ	9 kΩ	100 kHz	400 MΩ
100	100 Ω	9.9 kΩ	10 kHz	280 MΩ
1000	100 Ω	99.9 kΩ	1 kHz	80 MΩ

INVERTING AMPLIFIER



GAIN	R_1	R_2	B.W.	R_{IN}
1	10 kΩ	10 kΩ	1 MHz	10 kΩ
10	1 kΩ	10 kΩ	100 kHz	1 kΩ
100	1 kΩ	100 kΩ	10 kHz	1 kΩ
1000	100 Ω	100 kΩ	1 kHz	100 Ω

CLIPPING AMPLIFIER

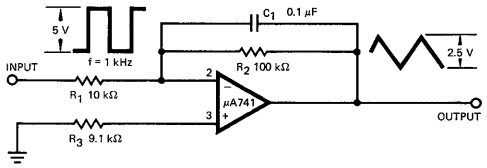


$$\frac{E_{OUT}}{E_{IN}} = \frac{R_2}{R_1} \text{ if } |E_{OUT}| \leq V_Z + 0.7\ V$$

where V_Z = Zener breakdown voltage

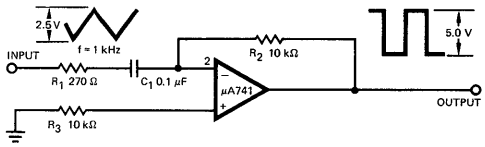
TYPICAL APPLICATIONS (Cont'd)

SIMPLE INTEGRATOR



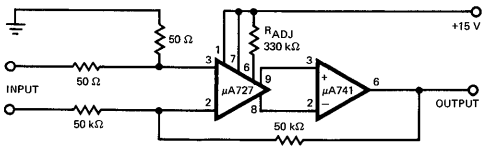
$$E_{OUT} = -\frac{1}{R_1C_1}\int E_{IN}dt$$

SIMPLE DIFFERENTIATOR



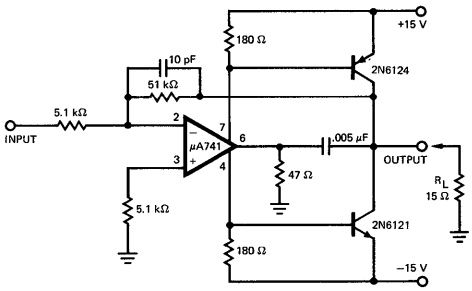
$$E_{OUT} = -R_2C_1\frac{dE_{IN}}{dt}$$

LOW DRIFT LOW NOISE AMPLIFIER

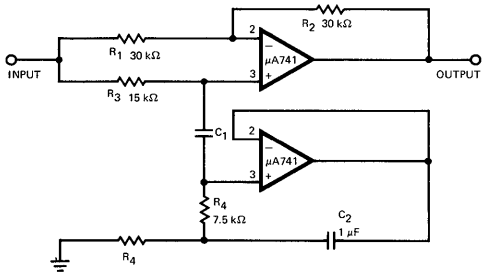


Voltage Gain = 10^3
Input Offset Voltage Drift = 0.6 μV/°C
Input Offset Current Drift = 2.0 pA/°C

HIGH SLEW RATE POWER AMPLIFIER



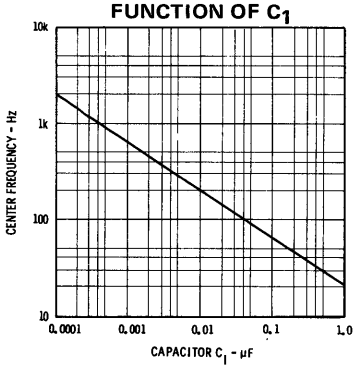
NOTCH FILTER USING THE μA741 AS A GYRATOR



Trim R_3 such that

$$\frac{R_1}{R_2} = \frac{R_3}{2\,R_4}$$

NOTCH FREQUENCY AS A FUNCTION OF C_1



μA741A • μA741E

FREQUENCY COMPENSATED OPERATIONAL AMPLIFIER

FAIRCHILD LINEAR INTEGRATED CIRCUITS

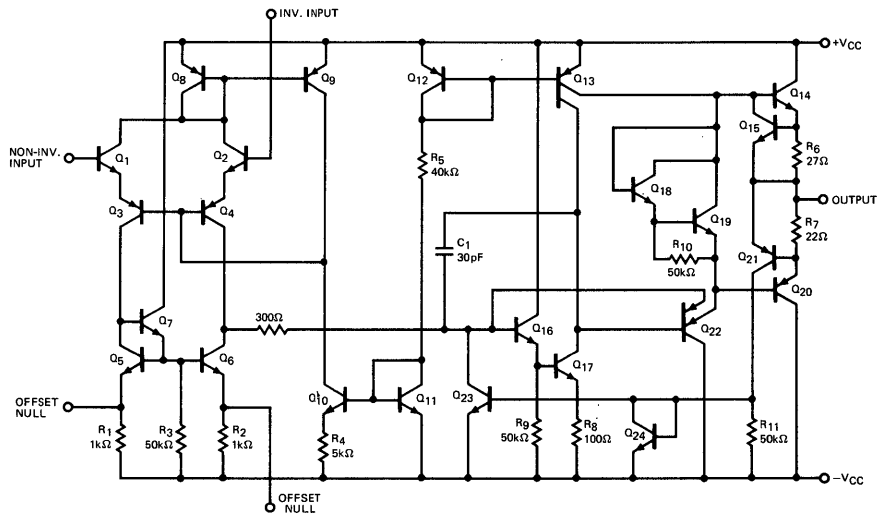
GENERAL DESCRIPTION — The μA741A and E are high performance monolithic Operational Amplifiers constructed using the Fairchild Planar* epitaxial process. They are intended for a wide range of analog applications. High common mode voltage range and absence of "latch-up" tendencies make the μA741A and E ideal for use as voltage followers. The high gain and wide range of operating voltage provides superior performance in integrator, summing amplifier, and general feedback applications. Electrical characteristics are identical to MIL-M-38510/10101.

- **NO FREQUENCY COMPENSATION REQUIRED**
- **SHORT-CIRCUIT PROTECTION**
- **OFFSET VOLTAGE NULL CAPABILITY**
- **LARGE COMMON-MODE AND DIFFERENTIAL VOLTAGE RANGES**
- **LOW POWER CONSUMPTION**
- **NO LATCH UP**

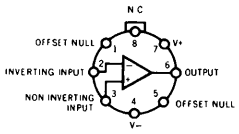
ABSOLUTE MAXIMUM RATINGS

Supply Voltage	±22V
Internal Power Dissipation (Note 1)	
Metal Can	500mW
DIP	670mW
Flatpak	570mW
Differential Input Voltage	±30V
Input Voltage (Note 2)	±15V
Storage Temperature Range	−65°C to +150°C
Operating Temperature Range	
Military (741A)	−55°C to +125°C
Commercial (741E)	0°C to +70°C
Lead Temperature (Soldering, 60 seconds)	300°C
Output Short Circuit Duration (Note 3)	Indefinite

EQUIVALENT CIRCUIT



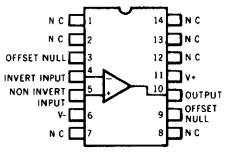
CONNECTION DIAGRAMS
8-LEAD METAL CAN
(TOP VIEW)
PACKAGE OUTLINE 5B



ORDER INFORMATION

TYPE	PART NO.
741A	741AHM
741EC	741EHC

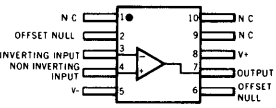
14-LEAD DIP
(TOP VIEW)
PACKAGE OUTLINE 6A



ORDER INFORMATION

TYPE	PART NO.
741A	741ADM
741EC	741EDC

10-LEAD FLATPAK
(TOP VIEW)
PACKAGE OUTLINE 3F



ORDER INFORMATION

TYPE	PART NO.
741A	741AFM

Notes on following pages.

*Planar is a patented Fairchild process.

741A

ELECTRICAL CHARACTERISTICS (V_S = ±15V, T_A = 25°C unless otherwise specified)

PARAMETERS (see definitions)		CONDITIONS		MIN.	TYP.	MAX.	UNITS
Input Offset Voltage		$R_S \leq 50\Omega$			0.8	3.0	mV
Average Input Offset Voltage Drift						15	μV/°C
Input Offset Current					3.0	30	nA
Average Input Offset Current Drift						0.5	nA/°C
Input Bias Current					30	80	nA
Power Supply Rejection Ratio		V_S = +10, −20; V_S = +20, −10V, R_S = 50Ω			15	50	μV/V
Output Short Circuit Current				10	25	35	mA
Power Dissipation		V_S = ±20V			80	150	mW
Input Impedance		V_S = ±20V		1.0	6.0		MΩ
Large Signal Voltage Gain		V_S = ±20V, R_L = 2kΩ, V_{OUT} = ±15V		50			V/mV
Transient Response	Rise Time				0.25	0.8	μs
(Unity Gain)	Overshoot				6.0	20	%
Bandwidth (Note 4)				.437	1.5		MHz
Slew Rate (Unity Gain)		V_{IN} = ±10V		0.3	0.7		V/μs
The following specifications apply for −55°C ≤ T_A ≤ +125°C							
Input Offset Voltage						4.0	mV
Input Offset Current						70	nA
Input Bias Current						210	nA
Common Mode Rejection Ratio		V_S = ±20V, V_{IN} = ±15V, R_S = 50Ω		80	95		dB
Adjustment For Input Offset Voltage		V_S = ±20V		10			mV
Output Short Circuit Current				10		40	mA
Power Dissipation		V_S = ±20V	−55°C			165	mW
			+125°C			135	mW
Input Impedance		V_S = ±20V		0.5			MΩ
Output Voltage Swing		V_S = ±20V,	R_L = 10kΩ	±16			V
			R_L = 2kΩ	±15			V
Large Signal Voltage Gain		V_S = ±20V, R_L = 2kΩ, V_{OUT} = ±15V		32			V/mV
		V_S = ±5V, R_L = 2kΩ, V_{OUT} = ±2 V		10			V/mV

NOTES
1. Rating applies to ambient temperatures up to 70°C. Above 70°C ambient derate linearly at 6.3mW/°C for the Metal Can, 8.3mW/°C for the DIP and 7.1mW/°C for the Flatpak.
2. For supply voltages less than ±15V, the absolute maximum input voltage is equal to the supply voltage.
3. Short circuit may be to ground or either supply. Rating applies to +125°C case temperature or 75°C ambient temperature.
4. Calculated value from: $BW(MHz) = \frac{0.35}{\text{Rise Time } (\mu s)}$

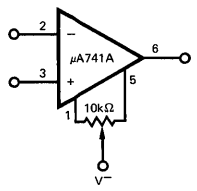
3

741E

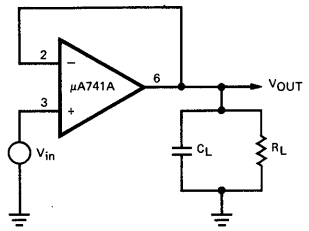
ELECTRICAL CHARACTERISTICS (V_S = ±15V, T_A = 25°C unless otherwise specified)

PARAMETERS (see definitions)		CONDITIONS	MIN.	TYP.	MAX.	UNITS
Input Offset Voltage		$R_S \leq 50\Omega$		0.8	3.0	mV
Average Input Offset Voltage Drift					15	μV/°C
Input Offset Current				3.0	30	nA
Average Input Offset Current Drift					0.5	nA/°C
Input Bias Current				30	80	nA
Power Supply Rejection Ratio		V_S = +10, −20; V_S = +20, −10V, R_S = 50Ω		15	50	μV/V
Output Short Circuit Current			10	25	35	mA
Power Dissipation		V_S = ±20V		80	150	mW
Input Impedance		V_S = ±20V	1.0	6.0		MΩ
Large Signal Voltage Gain		V_S = ±20V, R_L = 2kΩ, V_{OUT} = ±15V	50			V/mV
Transient Response	Rise Time			0.25	0.8	μs
(Unity Gain)	Overshoot			6.0	20	%
Bandwidth (Note 4)			.437	1.5		MHz
Slew Rate (Unity Gain)		V_{IN} = ±10V	0.3	0.7		V/μs
The following specifications apply for 0°C ≤ T_A ≤ 70°C						
Input Offset Voltage					4.0	mV
Input Offset Current					70	nA
Input Bias Current					210	nA
Common Mode Rejection Ratio		V_S = ±20V, V_{IN} = ±15V, R_S = 50Ω	80	95		dB
Adjustment For Input Offset Voltage		V_S = ±20V	10			mV
Output Short Circuit Current			10		40	mA
Power Dissipation		V_S = ±20V			150	mW
Input Impedance		V_S = ±20V	0.5			MΩ
Output Voltage Swing		V_S = ±20V, R_L = 10kΩ	±16			V
		V_S = ±20V, R_L = 2kΩ	±15			V
Large Signal Voltage Gain		V_S = ±20V, R_L = 2kΩ, V_{OUT} = ±15V	32			V/mV
		V_S = ±5V, R_L = 2kΩ, V_{OUT} = ±2 V	10			V/mV

VOLTAGE OFFSET NULL CIRCUIT

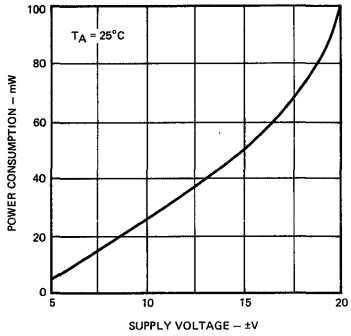


TRANSIENT RESPONSE TEST CIRCUIT

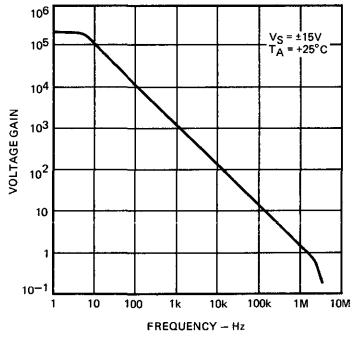


TYPICAL PERFORMANCE CURVES FOR 741A AND 741E

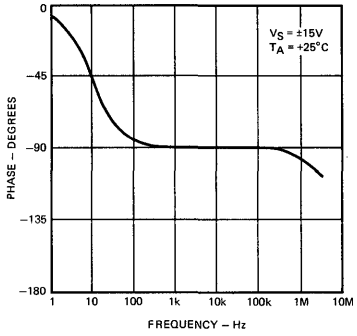
POWER CONSUMPTION AS A FUNCTION OF SUPPLY VOLTAGE



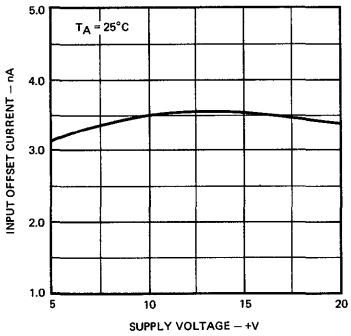
OPEN LOOP VOLTAGE GAIN AS A FUNCTION OF FREQUENCY



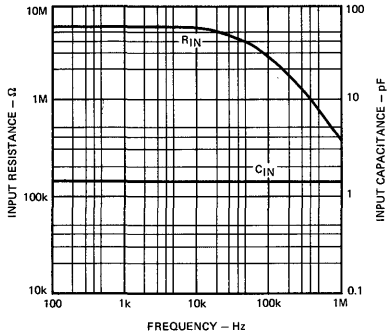
OPEN LOOP PHASE RESPONSE AS A FUNCTION OF FREQUENCY



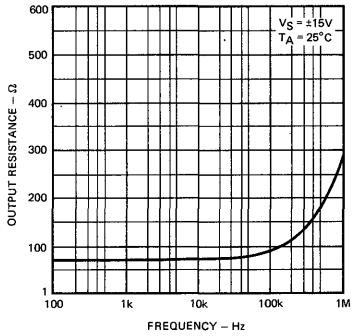
INPUT OFFSET CURRENT AS A FUNCTION OF SUPPLY VOLTAGE



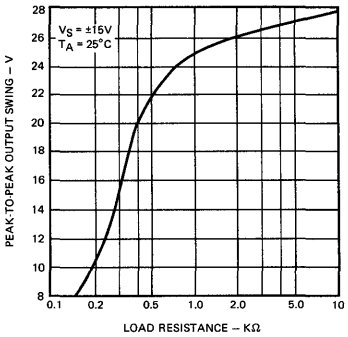
INPUT RESISTANCE AND INPUT CAPACITANCE AS A FUNCTION OF FREQUENCY



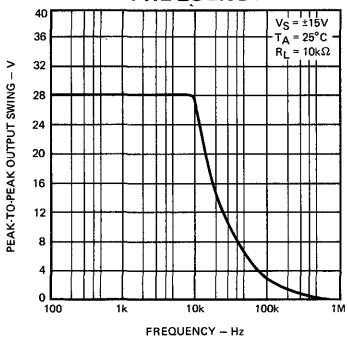
OUTPUT RESISTANCE AS A FUNCTION OF FREQUENCY



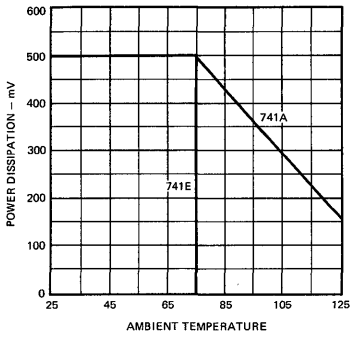
OUTPUT VOLTAGE SWING AS A FUNCTION OF LOAD RESISTANCE



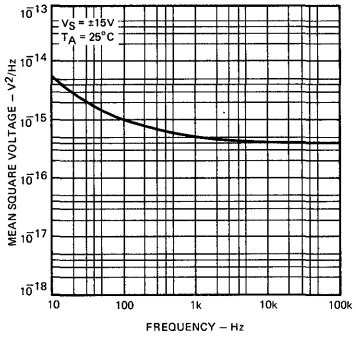
OUTPUT VOLTAGE SWING AS A FUNCTION OF FREQUENCY



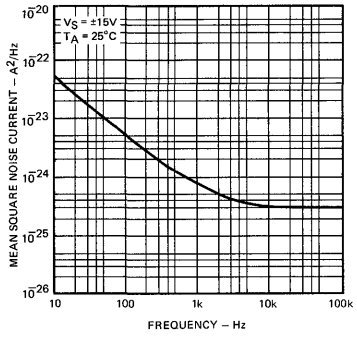
ABSOLUTE MAXIMUM POWER DISSIPATION AS A FUNCTION OF AMBIENT TEMPERATURE



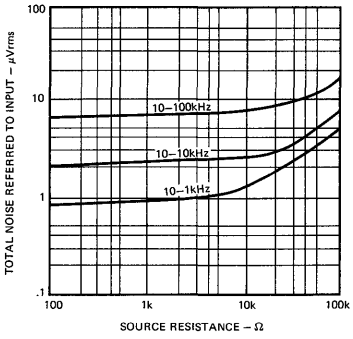
INPUT NOISE VOLTAGE AS A FUNCTION OF FREQUENCY



INPUT NOISE CURRENT AS A FUNCTION OF FREQUENCY

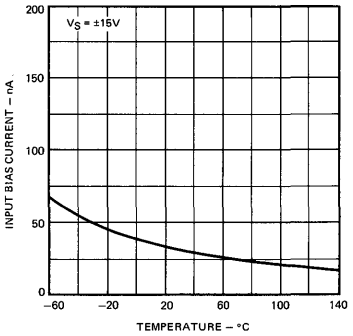


BROADBAND NOISE FOR VARIOUS BANDWIDTHS

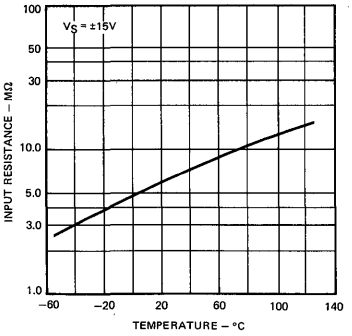


TYPICAL PERFORMANCE CURVES FOR 741A

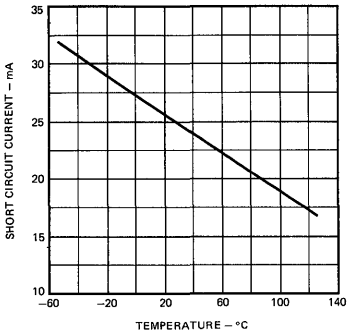
INPUT BIAS CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



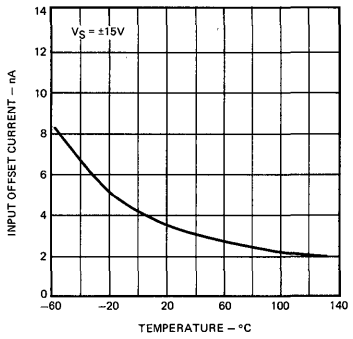
INPUT RESISTANCE AS A FUNCTION OF AMBIENT TEMPERATURE



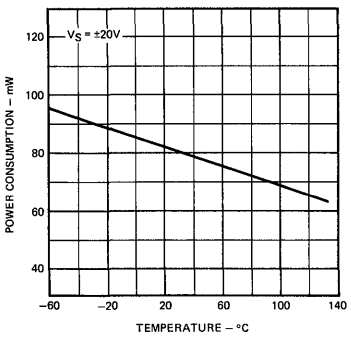
OUTPUT SHORT-CIRCUIT CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



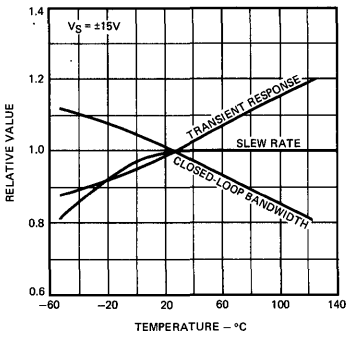
INPUT OFFSET CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



POWER CONSUMPTION AS A FUNCTION OF AMBIENT TEMPERATURE

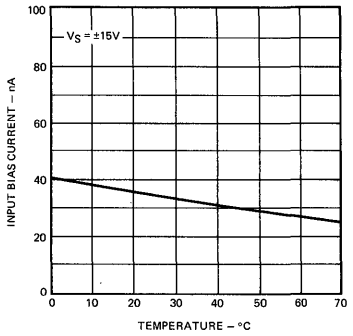


FREQUENCY CHARACTERISTICS AS A FUNCTION OF AMBIENT TEMPERATURE

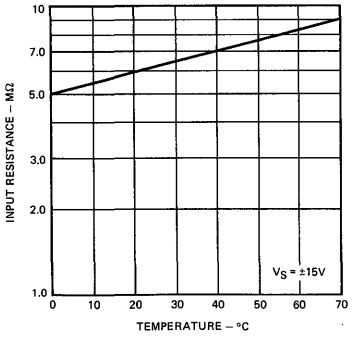


TYPICAL PERFORMANCE CURVES FOR 741E

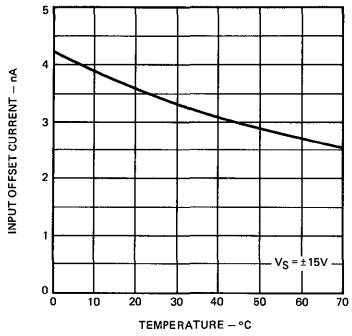
INPUT BIAS CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



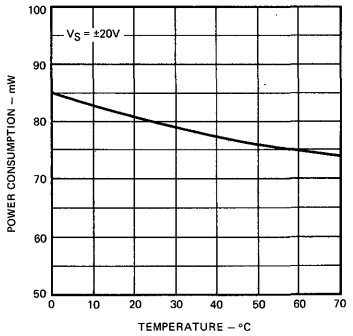
INPUT RESISTANCE AS A FUNCTION OF AMBIENT TEMPERATURE



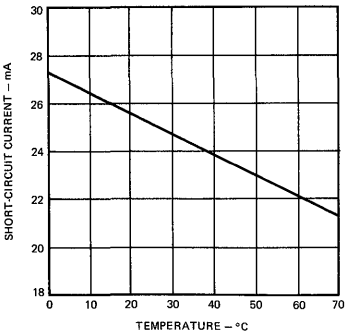
INPUT OFFSET CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



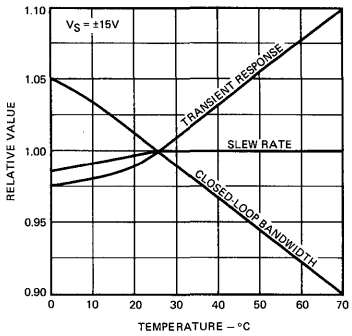
POWER CONSUMPTION AS A FUNCTION OF AMBIENT TEMPERATURE



OUTPUT SHORT-CIRCUIT CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



FREQUENCY CHARACTERISTICS AS A FUNCTION OF AMBIENT TEMPERATURE



μA747

DUAL FREQUENCY COMPENSATED OPERATIONAL AMPLIFIER

FAIRCHILD LINEAR INTEGRATED CIRCUITS

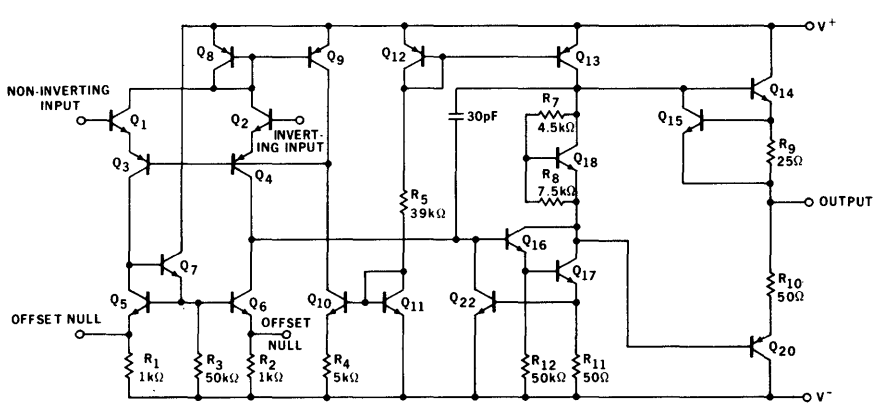
GENERAL DESCRIPTION — The μA747 is a pair of high performance monolithic Operational Amplifiers constructed using the Fairchild Planar* epitaxial process. They are intended for a wide range of analog applications where board space or weight are important. High common mode voltage range and absence of "latch-up" make the μA747 ideal for use as a voltage follower. The high gain and wide range of operating voltage provides superior performance in integrator, summing amplifier, and general feedback applications. The μA747 is short-circuit protected and requires no external components for frequency compensation. The internal 6 dB/octave roll-off insures stability in closed loop applications. For single amplifier performance, see μA741 data sheet.

- **NO FREQUENCY COMPENSATION REQUIRED**
- **SHORT-CIRCUIT PROTECTION**
- **OFFSET VOLTAGE NULL CAPABILITY**
- **LARGE COMMON-MODE AND DIFFERENTIAL VOLTAGE RANGES**
- **LOW POWER CONSUMPTION**
- **NO LATCH UP**

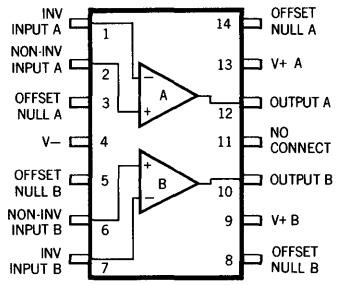
ABSOLUTE MAXIMUM RATINGS

Supply Voltage	
Military (747)	±22 V
Commercial (747C)	±18 V
Internal Power Dissipation (Note 1)	
Metal Can	500 mW
DIP	670 mW
Differential Input Voltage	±30 V
Input Voltage (Note 2)	±15 V
Voltage between Offset Null and V_	±0.5 V
Storage Temperature Range	−65°C to +150°C
Operating Temperature Range	
Military (747)	−55° C to +125°C
Commercial (747C)	0°C to 70°C
Lead Temperature (Soldering, 60 seconds)	300°C
Output Short-Circuit Duration (Note 3)	Indefinite

EQUIVALENT CIRCUIT (Each Side)



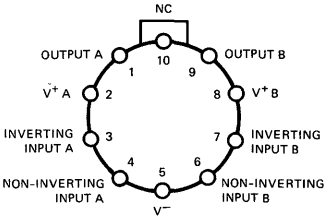
CONNECTION DIAGRAMS
14-LEAD DIP
(TOP VIEW)
PACKAGE OUTLINE 7A



ORDER INFORMATION

TYPE	PART NO.
747	747DM
747C	747DC

10-LEAD METAL CAN
(TOP VIEW)
PACKAGE OUTLINE 5F



ORDER INFORMATION

TYPE	PART NO.
747	747HM
747C	747HC

Notes on following pages.

*Planar is a patented Fairchild process.

ELECTRICAL CHARACTERISTICS FOR 747 – Each Amplifier (V_S = ±15 V, T_A = 25°C unless otherwise specified)

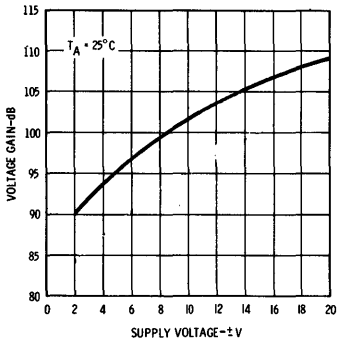
PARAMETERS (see definitions)		CONDITIONS	MIN.	TYP.	MAX.	UNITS
Input Offset Voltage		$R_S \leq 10$ kΩ		1.0	5.0	mV
Input Offset Current				20	200	nA
Input Bias Current				80	500	nA
Input Resistance			0.3	2.0		MΩ
Input Capacitance				1.4		pF
Offset Voltage Adjustment Range				±15		mV
Large Signal Voltage Gain		$R_L \geq 2$ kΩ, V_{OUT} = ±10 V	50,000	200,000		V/V
Output Resistance				75		Ω
Output Short-Circuit Current				25		mA
Supply Current				1.7	2.8	mA
Power Consumption				50	85	mW
Transient Response (Unity Gain)	Risetime	V_{IN} = 20 mV, R_L = 2 kΩ, $C_L \leq 100$ pF		0.3		μs
	Overshoot			5.0		%
Slew Rate		$R_L \geq 2$ kΩ		0.5		V/μs
Channel Separation				120		dB

The following specifications apply for −55°C ≤ T_A ≤ +125°C.

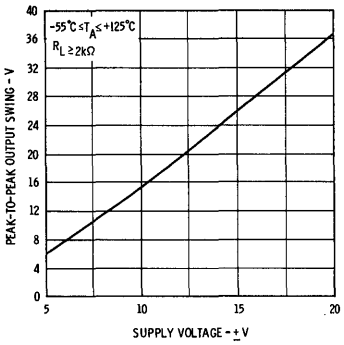
Input Offset Voltage		$R_S \leq 10$ kΩ		1.0	6.0	mV
Input Offset Current		T_A = +125°C		7.0	200	nA
		T_A = −55°C		85	500	nA
Input Bias Current		T_A = +125°C		0.03	0.5	μA
		T_A = −55°C		0.3	1.5	μA
Input Voltage Range			±12	±13		V
Common Mode Rejection Ratio		$R_S \leq 10$ kΩ	70	90		dB
Supply Voltage Rejection Ratio		$R_S \leq 10$ kΩ		30	150	μV/V
Large Signal Voltage Gain		$R_L \geq 2$ kΩ, V_{OUT} = ±10 V	25,000			V/V
Output Voltage Swing		$R_L \geq 10$ kΩ	±12	±14		V
		$R_L \geq 2$ kΩ	±10	±13		V
Supply Current		T_A = +125°C		1.5	2.5	mA
		T_A = −55°C		2.0	3.3	mA
Power Consumption		T_A = +125°C		45	75	mW
		T_A = −55°C		60	100	mW

TYPICAL PERFORMANCE CURVES (Each Amplifier) FOR 747 AND 747C

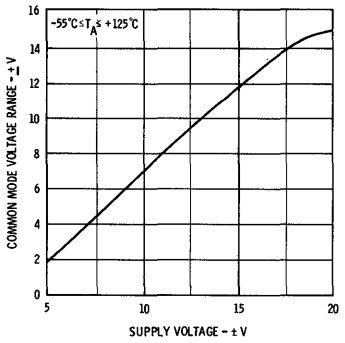
OPEN LOOP VOLTAGE GAIN AS A FUNCTION OF SUPPLY VOLTAGE



OUTPUT VOLTAGE SWING AS A FUNCTION OF SUPPLY VOLTAGE



INPUT COMMON MODE VOLTAGE RANGE AS A FUNCTION OF SUPPLY VOLTAGE



ELECTRICAL CHARACTERISTICS FOR 747C — Each Amplifier (V_S = ±15 V, T_A = 25°C unless otherwise specified)

PARAMETERS (see definitions)		CONDITIONS	MIN.	TYP.	MAX.	UNITS
Input Offset Voltage		$R_S \leq 10$ kΩ		1.0	6.0	mV
Input Offset Current				20	200	nA
Input Bias Current				80	500	nA
Input Resistance			0.3	2.0		MΩ
Input Capacitance				1.4		pF
Offset Voltage Adjustment Range				±15		mV
Large-Signal Voltage Gain		$R_L \geq 2$ kΩ, V_{OUT} = ±10 V	25,000	200,000		V/V
Output Resistance				75		Ω
Output Short-Circuit Current				25		mA
Supply Current				1.7	2.8	mA
Power Consumption				50	85	mW
Transient Response (Unity Gain)	Risetime	V_{IN} = 20 mV, R_L = 2 kΩ, $C_L \leq 100$ pF		0.3		μs
	Overshoot			5.0		%
Slew Rate		$R_L \geq 2$ kΩ		0.5		V/μs
Channel Separation				120		dB

The following specifications apply for 0°C ≤ T_A ≤ +70°C.

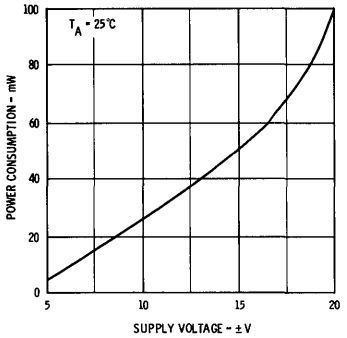
Input Offset Voltage	$R_S \leq 10$ kΩ		1.0	7.5	mV
Input Offset Current			7.0	300	nA
Input Bias Current			0.03	0.8	μA
Input Voltage Range		±12	±13		V
Common Mode Rejection Ratio	$R_S \leq 10$ kΩ	70	90		dB
Supply Voltage Rejection Ratio	$R_S \leq 10$ kΩ		30	150	μV/V
Large Signal Voltage Gain	$R_L \geq 2$ kΩ, V_{OUT} = ±10 V	15,000			V/V
Output Voltage Swing	$R_L \geq 10$ kΩ	±12	±14		V
	$R_L \geq 2$ kΩ	±10	±13		V
Supply Current			2.0	3.3	mA
Power Consumption			60	100	mW

NOTES
1. Rating applies to ambient temperatures up to 70°C. Above 70°C ambient derate linearly at 6.3 mW/°C for the Metal Can and 8.3 mW/°C for the DIP.
2. For supply voltages less than ±15 V, the absolute maximum input voltage is equal to the supply voltage.
3. Short circuit may be to ground or either supply. Military rating applies to +125°C case temperature or +60°C ambient temperature for each side.

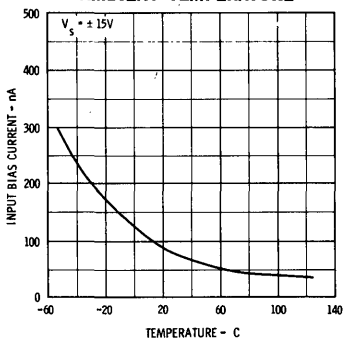
3

TYPICAL PERFORMANCE CURVES (Each Amplifier) FOR 747 AND 747C

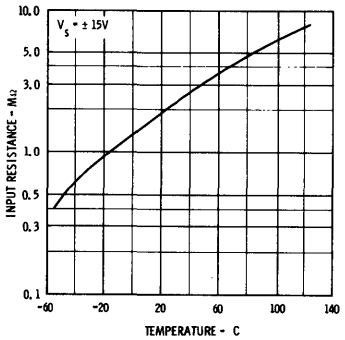
POWER CONSUMPTION AS A FUNCTION OF SUPPLY VOLTAGE



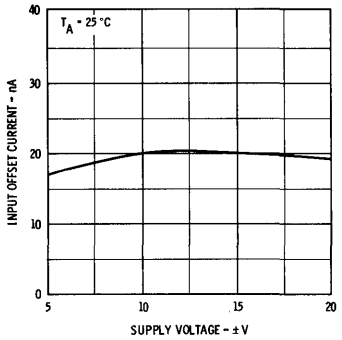
INPUT BIAS CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



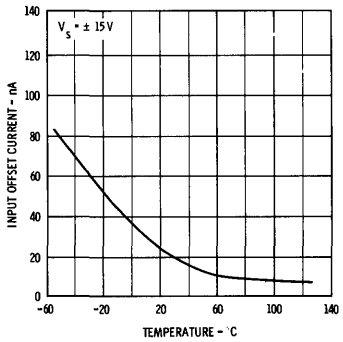
INPUT RESISTANCE AS A FUNCTION OF AMBIENT TEMPERATURE



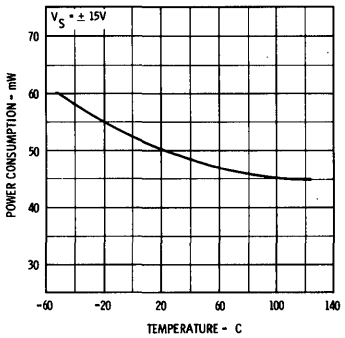
INPUT OFFSET CURRENT AS A FUNCTION OF SUPPLY VOLTAGE



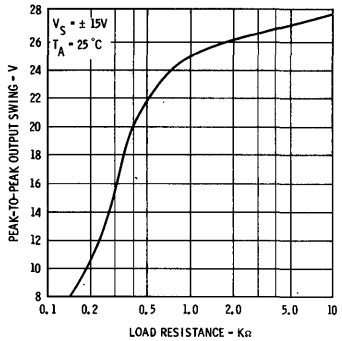
INPUT OFFSET CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



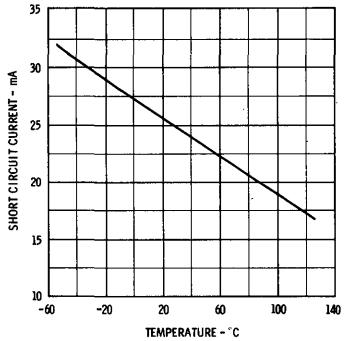
POWER CONSUMPTION AS A FUNCTION OF AMBIENT TEMPERATURE



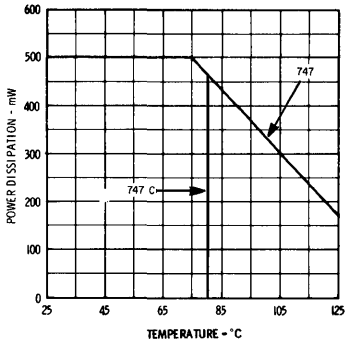
OUTPUT VOLTAGE SWING AS A FUNCTION OF LOAD RESISTANCE



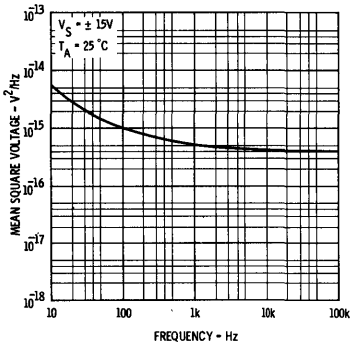
OUTPUT SHORT-CIRCUIT CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



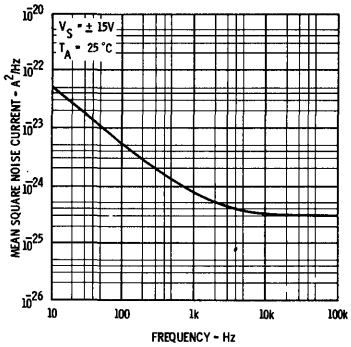
ABSOLUTE MAXIMUM POWER DISSIPATION AS A FUNCTION OF AMBIENT TEMPERATURE



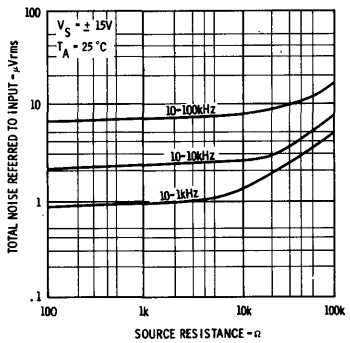
INPUT NOISE VOLTAGE AS A FUNCTION OF FREQUENCY



INPUT NOISE CURRENT AS A FUNCTION OF FREQUENCY

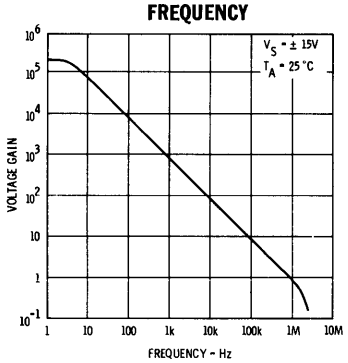


BROADBAND NOISE FOR VARIOUS BANDWIDTHS

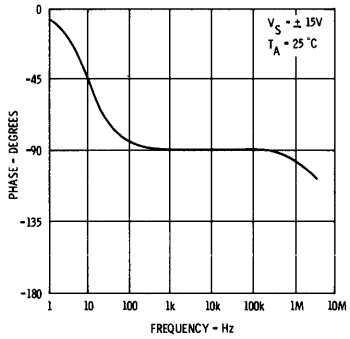


TYPICAL PERFORMANCE CURVES (Each Amplifier) FOR 747 AND 747C

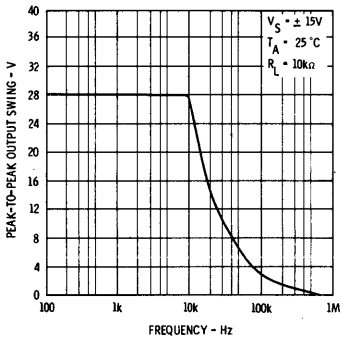
OPEN LOOP VOLTAGE GAIN AS A FUNCTION OF FREQUENCY



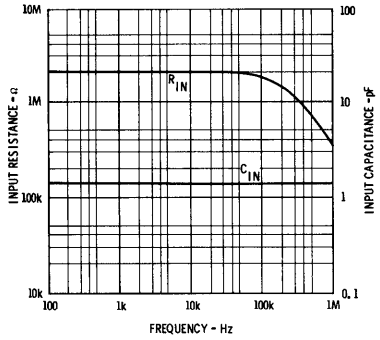
OPEN LOOP PHASE RESPONSE AS A FUNCTION OF FREQUENCY



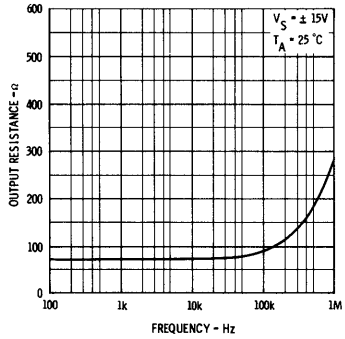
OUTPUT VOLTAGE SWING AS A FUNCTION OF FREQUENCY



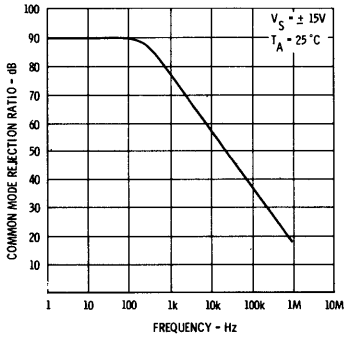
INPUT RESISTANCE AND INPUT CAPACITANCE AS A FUNCTION OF FREQUENCY



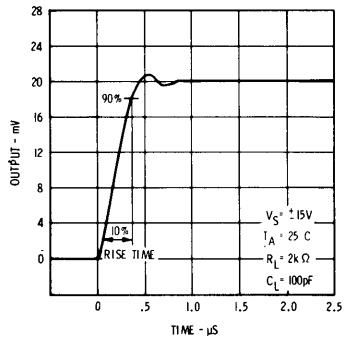
OUTPUT RESISTANCE AS A FUNCTION OF FREQUENCY



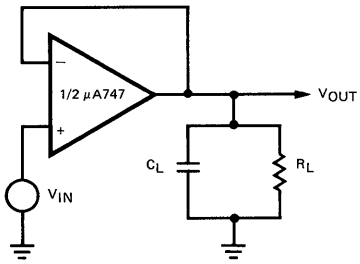
COMMON MODE REJECTION RATIO AS A FUNCTION OF FREQUENCY



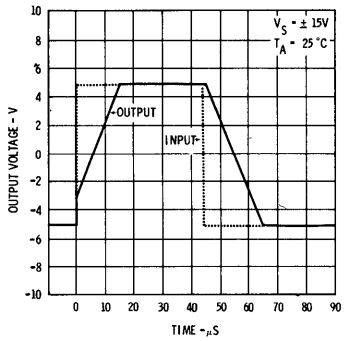
TRANSIENT RESPONSE



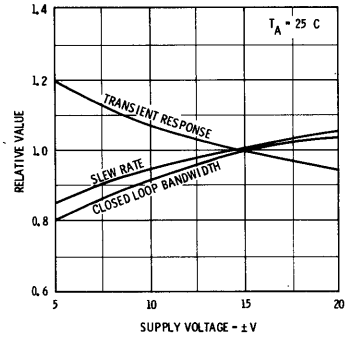
TRANSIENT RESPONSE TEST CIRCUIT



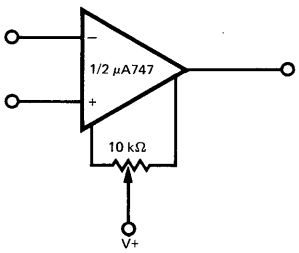
VOLTAGE FOLLOWER LARGE SIGNAL PULSE RESPONSE



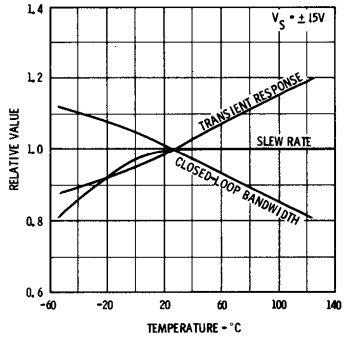
FREQUENCY CHARACTERISTICS AS A FUNCTION OF SUPPLY VOLTAGE



VOLTAGE OFFSET NULL CIRCUIT



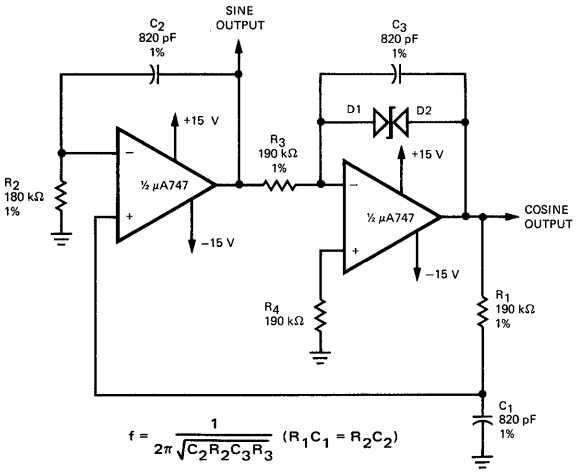
FREQUENCY CHARACTERISTICS AS A FUNCTION OF AMBIENT TEMPERATURE



3

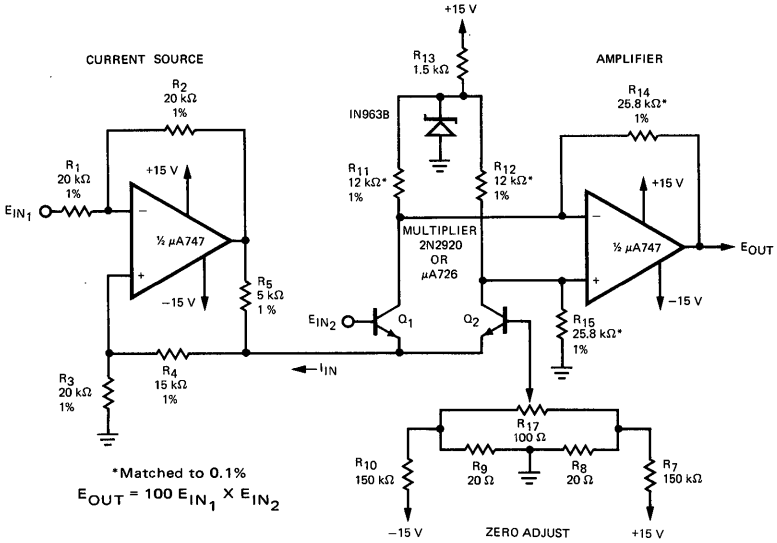
TYPICAL APPLICATIONS

QUADRATURE OSCILLATOR



$$f = \frac{1}{2\pi\sqrt{C_2R_2C_3R_3}} \quad (R_1C_1 = R_2C_2)$$

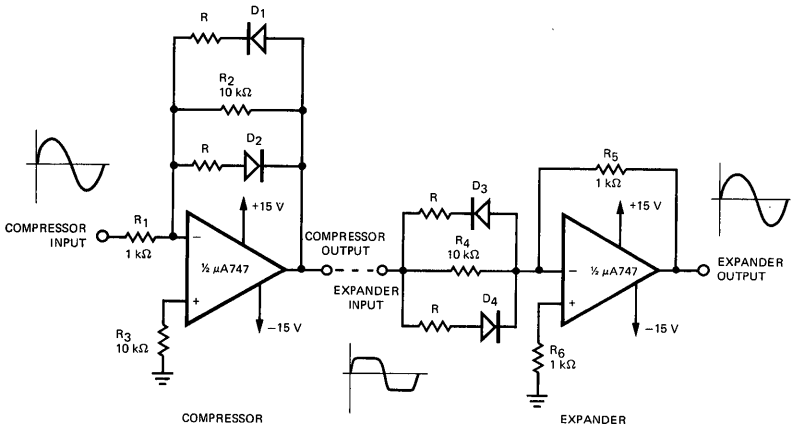
ANALOG MULTIPLIER



*Matched to 0.1%

$E_{OUT} = 100\, E_{IN_1} \times E_{IN_2}$

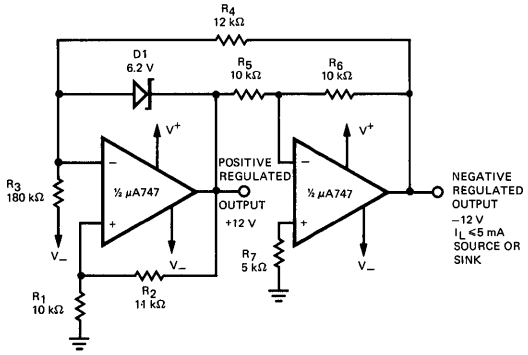
COMPRESSOR/EXPANDER AMPLIFIERS



MAXIMUM COMPRESSION EXPANSION RATIO = R_1/R ($10\,k\Omega > R \geqslant 0$)

NOTE: DIODES D_1 THROUGH D_4 ARE MATCHED FD6666 OR EQUIVALENT

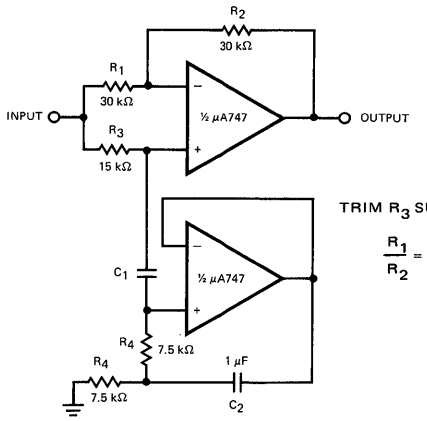
TRACKING POSITIVE AND NEGATIVE VOLTAGE REFERENCES



$$\text{POSITIVE OUTPUT} = V_{D1} \times \frac{R_1 + R_2}{R_2}$$

$$\text{NEGATIVE OUTPUT} = -\text{POSITIVE OUTPUT} \times \frac{R_6}{R_5}$$

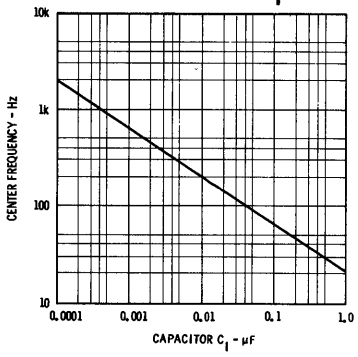
NOTCH FILTER USING THE μA747 AS A GYRATOR



TRIM R_3 SUCH THAT

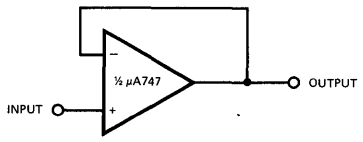
$$\frac{R_1}{R_2} = \frac{R_3}{2R_4}$$

NOTCH FREQUENCY AS A FUNCTION OF C_1



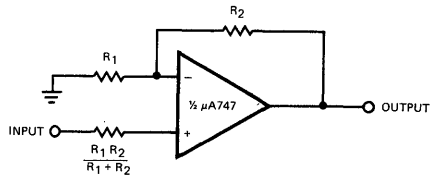
TYPICAL APPLICATIONS

UNITY-GAIN VOLTAGE FOLLOWER



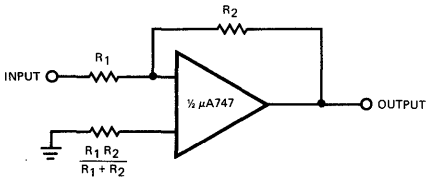
R_{IN} = 400 MΩ
C_{IN} = 1 pF
R_{OUT} << 1 Ω
B W = 1 MHz

NON-INVERTING AMPLIFIER



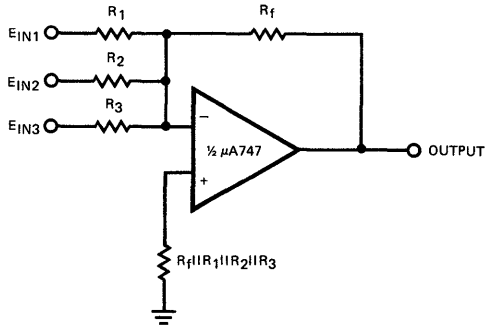
GAIN	R_1	R_2	B.W.	R_{IN}
10	1 kΩ	9 kΩ	100 kHz	400 MΩ
100	100 Ω	9.9 kΩ	10 kHz	280 MΩ
1000	100 Ω	99.9 kΩ	1 kHz	80 MΩ

INVERTING AMPLIFIER



GAIN	R_1	R_2	B W	R_{IN}
1	10 kΩ	10 kΩ	1 MHz	10 kΩ
10	1 kΩ	10 kΩ	100 kHz	1 kΩ
100	1 kΩ	100 kΩ	10 kHz	1 kΩ
1000	100 Ω	100 kΩ	1 kHz	100 Ω

WEIGHTED AVERAGING AMPLIFIER



$$-E_{OUT} = E_{IN1}\left(\frac{R_f}{R_1}\right) + E_{IN2}\left(\frac{R_f}{R_2}\right) + E_{IN3}\left(\frac{R_f}{R_3}\right)$$

μA747A • μA747E

DUAL FREQUENCY COMPENSATED OPERATIONAL AMPLIFIER

FAIRCHILD LINEAR INTEGRATED CIRCUITS

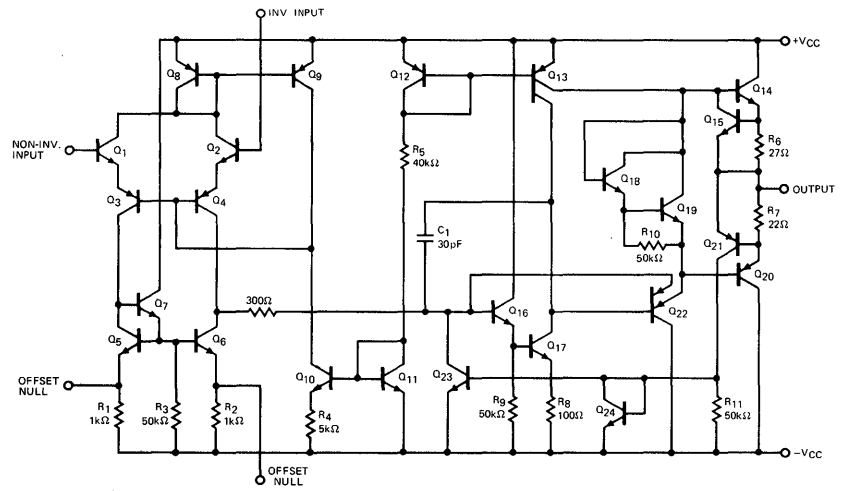
GENERAL DESCRIPTION — The μA747A and E are pairs of high performance monolithic Operational Amplifiers constructed using the Fairchild Planar* epitaxial process. They are intended for a wide range of analog applications where board space or weight are important. High common mode voltage range and absence of "latch-up" make the μA747A and E ideal for use as voltage followers. The accuracy of long interval integrators, timers and sample and hold circuits is improved due to the low drift and low bias currents. The μA747A and E are short-circuit protected and require no external components for frequency compensation. The internal 6 dB/octave roll-off insures stability in closed loop applications. Electrical characteristics are identical to MIL-M-38510/10102.

- **NO FREQUENCY COMPENSATION REQUIRED**
- **SHORT-CIRCUIT PROTECTION**
- **OFFSET VOLTAGE NULL CAPABILITY**
- **LARGE COMMON-MODE AND DIFFERENTIAL VOLTAGE RANGES**
- **LOW POWER CONSUMPTION**
- **OFFSET VOLTAGE . . . 3.0 mV MAX**
- **OFFSET CURRENT . . . 30 nA MAX**

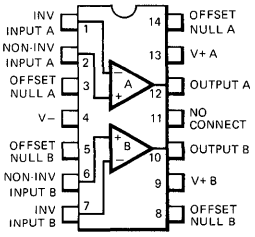
ABSOLUTE MAXIMUM RATINGS

Supply Voltage	±22 V
Internal Power Dissipation (Note 1)	
Metal Can	500 mW
DIP	670 mW
Differential Input Voltage	±30 V
Input Voltage (Note 2)	±15 V
Voltage between Offset Null and V_	±0.5 V
Storage Temperature Range	−65°C to +150°C
Operating Temperature Range	
Military (747A)	−55°C to +125°C
Commercial (747E)	0°C to +70°C
Lead Temperature (Soldering, 60 seconds)	300°C
Output Short-Circuit Duration (Note 3)	Indefinite

EQUIVALENT CIRCUIT (Each Side)



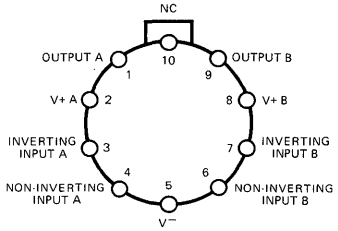
CONNECTION DIAGRAMS
14-LEAD DIP
(TOP VIEW)
PACKAGE OUTLINE 7A



ORDER INFORMATION

TYPE	PART NO.
747A	747ADM
747E	747EDC

10-LEAD METAL CAN
(TOP VIEW)
PACKAGE OUTLINE 5F



ORDER INFORMATION

TYPE	PART NO.
747A	747AHM
747E	747EHC

*Planar is a patented Fairchild Process.

747A

ELECTRICAL CHARACTERISTICS ±5 V ≤ V_S ≤ ±20 V, T_A = 25°C unless otherwise specified)

PARAMETERS (see definitions)		CONDITIONS		MIN.	TYP.	MAX.	UNITS
Input Offset Voltage		R_S ≤ 50Ω			0.8	3.0	mV
Average Input Offset Voltage Drift						15	μV/°C
Input Offset Current					3.0	30	nA
Average Input Offset Current Drift						0.5	nA/°C
Input Bias Current					30	80	nA
Power Supply Rejection Ratio		V_S = +10, −20; V_S = 20, −10 V R_S = 50 Ω			15	50	μV/V
Output Short Circuit Current				10	25	35	mA
Power Dissipation		V_S = ±20 V			80	150	mW
Input Impedance		V_S = ±20 V		1.0	6		MΩ
Large Signal Voltage Gain		V_S = ±20 V, R_L = 2 kΩ V_{OUT} = ±15 V		50			V/mV
Transient Response (Unity Gain)	Rise Time				0.25	0.8	μs
	Overshoot				6.0	20	%
Bandwidth (Note 4)				0.437	1.5		MHz
Slew Rate (Unity Gain)		V_{IN} = ±10 V		0.3	0.7		V/μs
The following specifications apply for −55°C ≤ T_A ≤ +125°C							
Input Offset Voltage						4.0	mV
Input Offset Current						70	nA
Input Bias Current						210	nA
Common Mode Rejection Ratio		V_S = ±20 V, V_{IN} = ±15 V R_S = 50 Ω		80	95		dB
Adjustment for Input Offset Voltage		V_S = ±20 V		10			mV
Output Short Circuit Current				10		40	mA
Power Dissipation		V_S = ±20 V	−55°C			165	mW
			+125°C			135	mW
Input Impedance		V_S = ±20 V		0.5			MΩ
Output Voltage Swing		V_S = ±20 V, R_L = 10 kΩ		±16			V
		R_L = 2 kΩ		±15			V
Large Signal Voltage Gain		V_S = ±20 V, R_L = 2 kΩ, V_{OUT} = ±15 V		32			V/mV
		V_S = ± 5 V, R_L = 2 kΩ, V_{OUT} = ± 2 V		10			V/mV
Channel Separation		V_S = ±20 V		100			dB

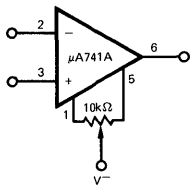
NOTES:
1. Rating applies to ambient temperatures uo to 70°C. Above 70°C ambient derate linearly at 6.3 mW/°C for the Metal Can, 8.3 mW/°C for the DIP.
2. For supply voltages less than ±15 V, the absolute maximum input voltage is equal to the supply voltage.
3. Short circuit may be to ground or either supply. Rating applies to +125°C case temperature or 75°C ambient temperature.
4. Calculated value from: BW (MHz) = $\frac{0.35}{\text{RISETIME } (\mu s)}$

747E

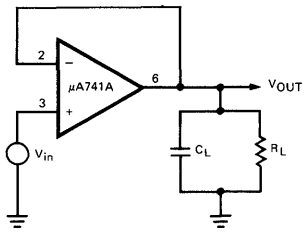
ELECTRICAL CHARACTERISTICS ($\pm 5\ V \leq V_S \leq \pm 20\ V$, $T_A = 25°C$ unless otherwise specified)

PARAMETERS (see definitions)		CONDITIONS	MIN.	TYP.	MAX.	UNITS
Input Offset Voltage		$R_S \leq 50\Omega$		0.8	3.0	mV
Average Input Offset Voltage Drift					15	μV/°C
Input Offset Current				3	30	nA
Average Input Offset Current Drift					0.5	nA/°C
Input Bias Current				30	80	nA
Power Supply Rejection Ratio		$V_S = +10, -20$; $V_S = 20, -10$ V $R_S = 50\ \Omega$		15	50	μV/V
Output Short Circuit Current			10	25	35	mA
Power Dissipation		$V_S = \pm 20$ V		80	150	mW
Input Impedance		$V_S = \pm 20$ V	1.0	6		MΩ
Large Signal Voltage Gain		$V_S = \pm 20$ V, $R_L = 2\ k\Omega$, $V_{OUT} = \pm 15$ V	50			V/mV
Transient Response (Unity Gain)	Rise Time			0.25	0.8	μs
	Overshoot			6	20	%
Bandwidth (Note 4)			0.45	1.5		MHz
Slew Rate (Unity Gain)		$V_{IN} = \pm 10$ V	0.3	0.7		V/μs
The following specifications apply for $0°C \leq T_A \leq 70°C$						
Input Offset Voltage					4.0	mV
Input Offset Current					70	nA
Input Bias Current					210	nA
Common Mode Rejection Ratio		$V_S = \pm 20$ V, $V_{IN} = \pm 15$ V $R_S = 50\ \Omega$	80	95		dB
Adjustment for Input Offset Voltage		$V_S = \pm 20$ V	10			mV
Output Short Circuit Current			10		40	mA
Power Dissipation		$V_S = \pm 20$ V			165	mW
Input Impedance		$V_S = \pm 20$ V	0.5			MΩ
Output Voltage Swing		$V_S = \pm 20$ V, $R_L = 10\ k\Omega$	±16			V
		$R_L = 2\ k\Omega$	±15			V
Large Signal Voltage Gain		$V_S = \pm 20$ V, $R_L = 2\ k\Omega$, $V_{OUT} = \pm 15$ V	32			V/mV
		$V_S = \pm 5$ V, $R_L = 2\ k\Omega$, $V_{OUT} = \pm 2$ V	10			V/mV
Channel Separation		$V_S = \pm 20$ V	100			dB

VOLTAGE OFFSET NULL CIRCUIT

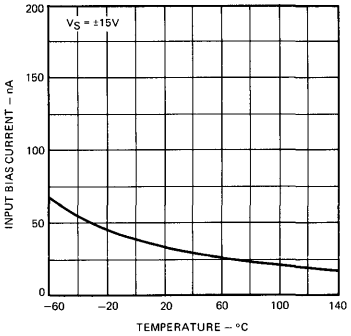


TRANSIENT RESPONSE TEST CIRCUIT

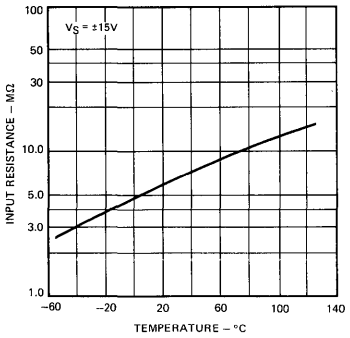


TYPICAL PERFORMANCE CURVES FOR 747A

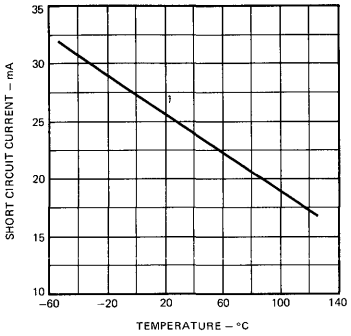
INPUT BIAS CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



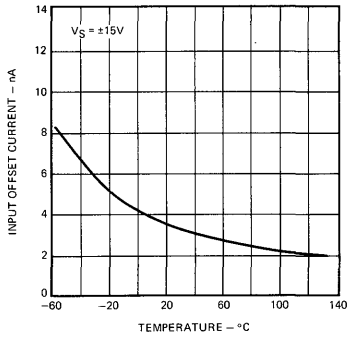
INPUT RESISTANCE AS A FUNCTION OF AMBIENT TEMPERATURE



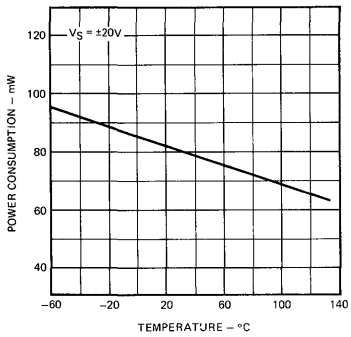
OUTPUT SHORT-CIRCUIT CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



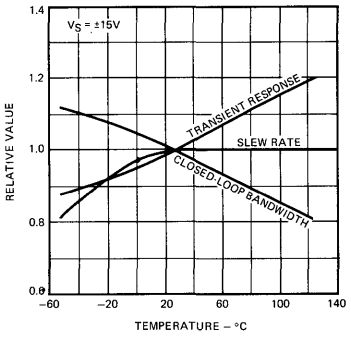
INPUT OFFSET CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



POWER CONSUMPTION AS A FUNCTION OF AMBIENT TEMPERATURE

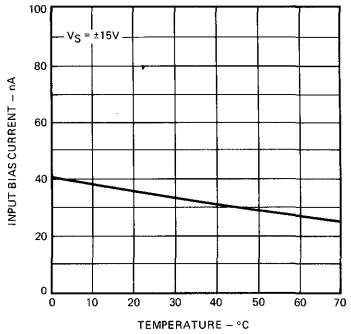


FREQUENCY CHARACTERISTICS AS A FUNCTION OF AMBIENT TEMPERATURE

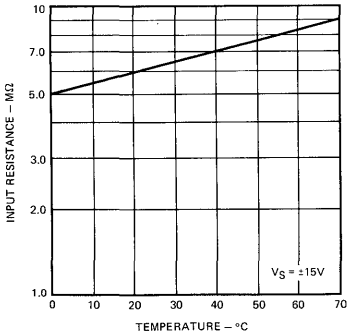


TYPICAL PERFORMANCE CURVES FOR 747E

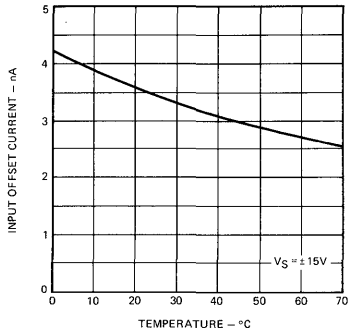
INPUT BIAS CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



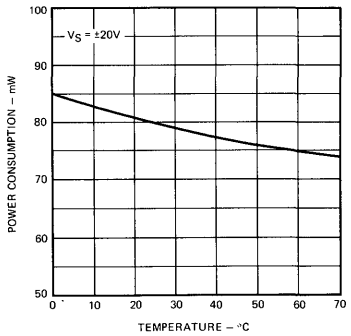
INPUT RESISTANCE AS A FUNCTION OF AMBIENT TEMPERATURE



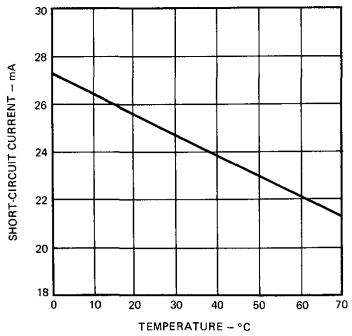
INPUT OFFSET CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



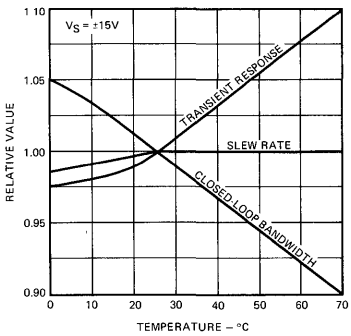
POWER CONSUMPTION AS A FUNCTION OF AMBIENT TEMPERATURE



OUTPUT SHORT-CIRCUIT CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE

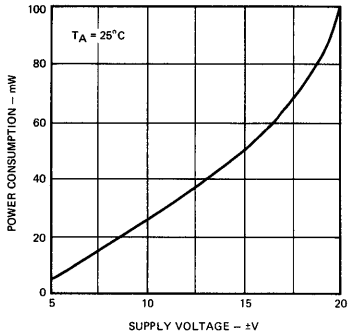


FREQUENCY CHARACTERISTICS AS A FUNCTION OF AMBIENT TEMPERATURE

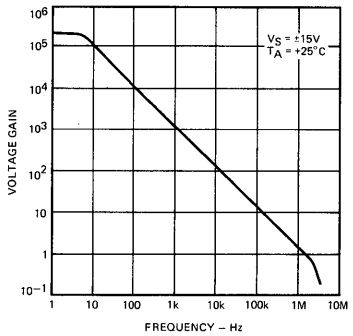


TYPICAL PERFORMANCE CURVES FOR 747A AND 747E

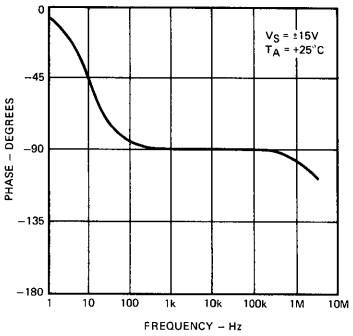
POWER CONSUMPTION AS A FUNCTION OF SUPPLY VOLTAGE



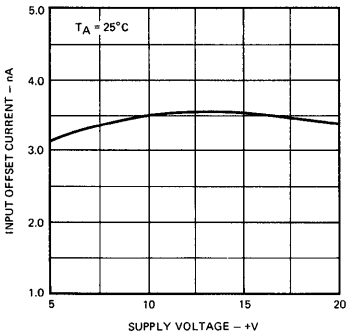
OPEN LOOP VOLTAGE GAIN AS A FUNCTION OF FREQUENCY



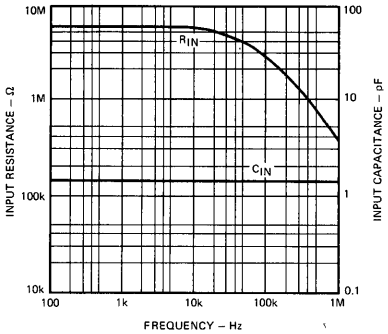
OPEN LOOP PHASE RESPONSE AS A FUNCTION OF FREQUENCY



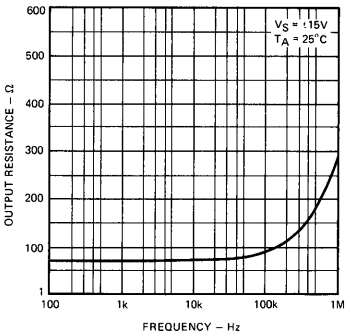
INPUT OFFSET CURRENT AS A FUNCTION OF SUPPLY VOLTAGE



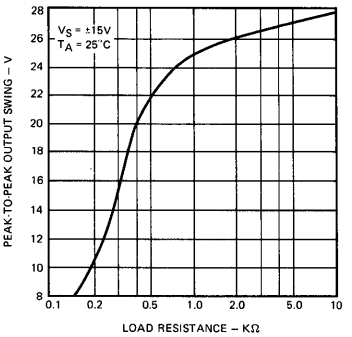
INPUT RESISTANCE AND INPUT CAPACITANCE AS A FUNCTION OF FREQUENCY



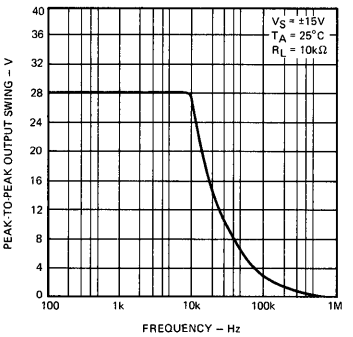
OUTPUT RESISTANCE AS A FUNCTION OF FREQUENCY



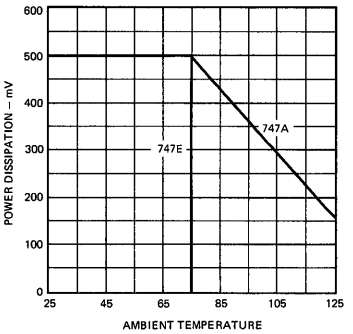
OUTPUT VOLTAGE SWING AS A FUNCTION OF LOAD RESISTANCE



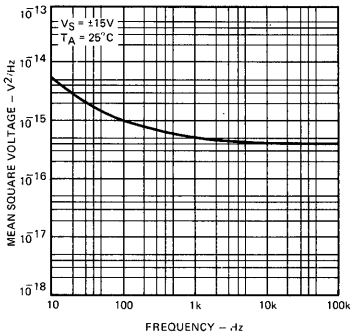
OUTPUT VOLTAGE SWING AS A FUNCTION OF FREQUENCY



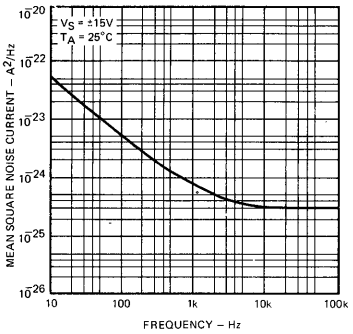
ABSOLUTE MAXIMUM POWER DISSIPATION AS A FUNCTION OF AMBIENT TEMPERATURE



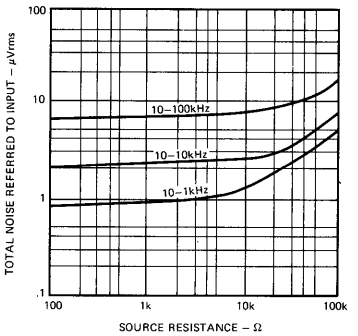
INPUT NOISE VOLTAGE AS A FUNCTION OF FREQUENCY



INPUT NOISE CURRENT AS A FUNCTION OF FREQUENCY



BROADBAND NOISE FOR VARIOUS BANDWIDTHS



μA748

HIGH PERFORMANCE OPERATIONAL AMPLIFIER

FAIRCHILD LINEAR INTEGRATED CIRCUITS

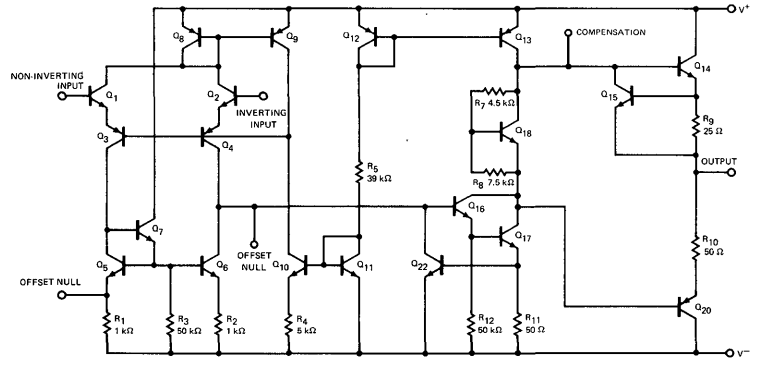
GENERAL DESCRIPTION – The μA748 is a High Performance Monolithic Operational Amplifier constructed using the Fairchild Planar* epitaxial process. It is intended for a high wide range of analog applications where tailoring of frequency characteristics is desirable. High common mode voltage range and absence of "latch-up" make the μA748 ideal for use as a voltage follower. The high gain and wide range of operating voltages provide superior performance in integrator, summing amplifier, and general feedback applications. The μA748 is short-circuit protected and has the same pin configuration as the popular μA741 operational amplifier. Unity gain frequency compensation is achieved by means of a single 30 pF capacitor. For superior performance, see μA777 data sheet.

- **SHORT-CIRCUIT PROTECTION**
- **OFFSET VOLTAGE NULL CAPABILITY**
- **LARGE COMMON-MODE AND DIFFERENTIAL VOLTAGE RANGES**
- **LOW POWER CONSUMPTION**
- **NO LATCH UP**

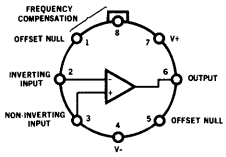
ABSOLUTE MAXIMUM RATINGS

Supply Voltage	±22 V
Internal Power Dissipation (Note 1)	
Metal Can	500 mW
DIP	670 mW
Mini DIP	310 mW
Flatpak	570 mW
Differential Input Voltage	±30 V
Input Voltage (Note 2)	±15 V
Storage Temperature Range	
Metal Can, DIP, and Flatpak	−65°C to +150°C
Mini DIP	−55°C to +125°C
Operating Temperature Range	
Military (748)	−55°C to +125°C
Commercial (748C)	0°C to +70°C
Lead Temperature (Soldering, 60 Seconds)	
Metal Can, DIP and Flatpak	300°C
Mini DIP	260°C
Output Short Circuit Duration (Note 3)	Indefinite

EQUIVALENT CIRCUIT



CONNECTION DIAGRAMS
8-LEAD METAL CAN
(TOP VIEW)
PACKAGE OUTLINE 5B

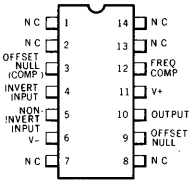


NOTE: Pin 4 connected to case

ORDER INFORMATION

TYPE	PART NO.
748	748HM
748C	748HC

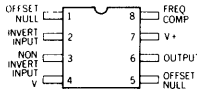
14-LEAD DIP
(TOP VIEW)
PACKAGE OUTLINE 6A



ORDER INFORMATION

TYPE	PART NO.
748	748DM
748C	748DC

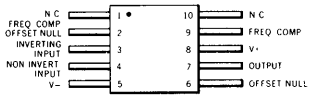
8-LEAD MINI DIP
(TOP VIEW)
PACKAGE OUTLINE 9T



ORDER INFORMATION

TYPE	PART NO.
748C	748TC

10-LEAD FLATPAK‡
(TOP VIEW)
PACKAGE OUTLINE 3F



‡Available on special request

ORDER INFORMATION

TYPE	PART NO.
748	748FM

Notes on following pages.

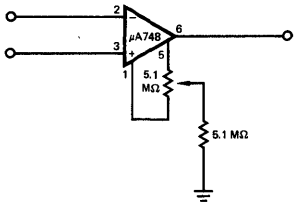
*Planar is a patented Fairchild process.

748

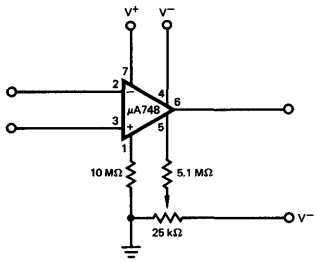
ELECTRICAL CHARACTERISTICS (V_S = ±15 V, T_A = 25°C, C_C = 30 pF unless otherwise specified)

PARAMETERS (see definitions)		CONDITIONS	MIN.	TYP.	MAX.	UNITS
Input Offset Voltage		$R_S \leq 10$ kΩ		1.0	5.0	mV
Input Offset Current				20	200	nA
Input Bias Current				80	500	nA
Input Resistance			0.3	2.0		MΩ
Input Capacitance				2.0		pF
Offset Voltage Adjustment Range				±15		mV
Large Signal Voltage Gain		$R_L \geq 2$ kΩ, V_{OUT} = ±10 V	50,000	150,000		V/V
Output Resistance				75		Ω
Output Short-Circuit Current				25		mA
Supply Current				1.9	2.8	mA
Power Consumption				60	85	mW
Transient Response (Voltage Follower, Gain of 1)	Risetime	V_{IN} = 20 mV, C_C = 30 pF, R_L = 2 kΩ, $C_L \leq 100$ pF		0.3		μs
	Overshoot			5.0		%
Slew Rate (Voltage Follower, Gain of 1)		$R_L \geq 2$ kΩ		0.5		V/μs
Transient Response (Voltage Follower, Gain of 10)	Risetime	V_{IN} = 20 mV, C_C = 3.5 pF, R_L = 2 kΩ, $C_L \leq 100$ pF		0.2		μs
	Overshoot			5.0		%
Slew Rate (Voltage Follower, Gain of 10)		$R_L \geq 2$ kΩ, C_C = 3.5 pF		5.5		V/μs
The following specifications apply for −55°C ≤ T_A ≤ +125°C:						
Input Offset Voltage		$R_S \leq 10$ kΩ		1.0	6.0	mV
Input Offset Current		T_A = +125°C		10	200	nA
		T_A = −55°C		50	500	nA
Input Bias Current		T_A = +125°C		0.03	0.5	μA
		T_A = −55°C		0.3	1.5	μA
Input Voltage Range			±12	±13		V
Common Mode Rejection Ratio		$R_S \leq 10$ kΩ	70	90		dB
Supply Voltage Rejection Ratio		$R_S \leq 10$ kΩ		30	150	μV/V
Large Signal Voltage Gain		$R_L \geq 2$ kΩ, V_{OUT} = ±10 V	25,000			V/V
Output Voltage Swing		$R_L \geq 10$ kΩ	±12	±14		V
		$R_L \geq 2$ kΩ	±10	±13		V
Supply Current		T_A = +125°C		1.5	2.5	mA
		T_A = −55°C		2.0	3.3	mA
Power Consumption		T_A = +125°C		45	75	mW
		T_A = −55°C		60	100	mW

VOLTAGE OFFSET NULL CIRCUIT



SUGGESTED



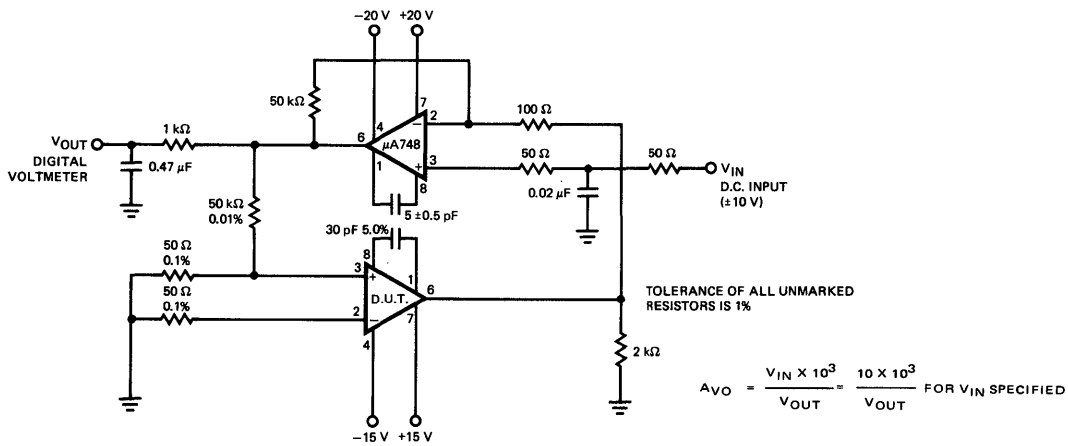
ALTERNATE

748C

ELECTRICAL CHARACTERISTICS (V_S = ±15 V, T_A = 25°C, C_C = 30 pF unless otherwise specified)

PARAMETERS (see definitions)		CONDITIONS	MIN.	TYP.	MAX.	UNITS
Input Offset Voltage		$R_S \leq 10$ kΩ		2.0	6.0	mV
Input Offset Current				20	200	nA
Input Bias Current				80	500	nA
Input Resistance			0.3	2.0		MΩ
Input Capacitance				2.0		pF
Offset Voltage Adjustment Range				±15		mV
Large Signal Voltage Gain		$R_L \geq 2$ kΩ, V_{OUT} = ±10 V	20,000	150,000		V/V
Output Resistance				75		Ω
Output Short-Circuit Current				25		mA
Supply Current				1.9	2.8	mA
Power Consumption				60	85	mW
Transient Response (Voltage Follower, Gain of 1)	Risetime	V_{IN} = 20 mV, C_C = 30 pF, R_L = 2 kΩ, $C_L \leq 100$ pF		0.3		μs
	Overshoot			5.0		%
Slew Rate (Voltage Follower, Gain of 1)		$R_L \geq 2$ kΩ		0.5		V/μs
Transient Response (Voltage Follower, Gain of 10)	Risetime	V_{IN} = 20 mV, C_C = 3.5 pF, R_L = 2 kΩ, $C_L \leq 100$ pF		0.2		μs
	Overshoot			5.0		%
Slew Rate (Voltage Follower, Gain of 10)		$R_L \geq 2$ kΩ		5.5		V/μs
The following specifications apply for 0°C ≤ T_A ≤ +70°C:						
Input Offset Voltage		$R_S \leq 10$ kΩ			7.5	mV
Input Offset Current					300	nA
Input Bias Current					800	nA
Input Voltage Range			±12	±13		V
Common Mode Rejection Ratio		$R_S \leq 10$ kΩ	70	90		dB
Supply Voltage Rejection Ratio		$R_S \leq 10$ kΩ		30	150	μV/V
Large Signal Voltage Gain		$R_L \geq 2$ kΩ, V_{OUT} = ±10 V	15,000			V/V
Output Voltage Swing		$R_L \geq 10$ kΩ	±12	±14		V
		$R_L \geq 2$ kΩ	±10	±13		V
Power Consumption				60	100	mW

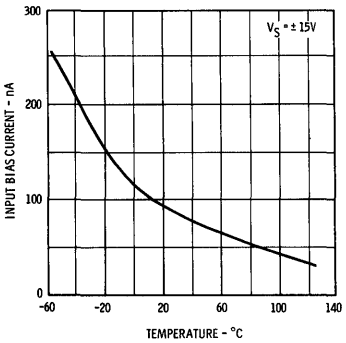
GAIN TEST CIRCUIT



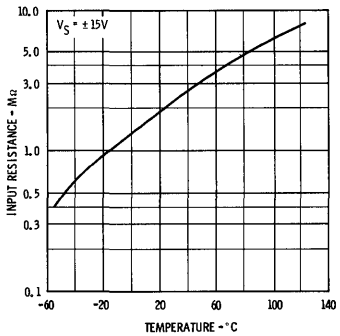
$$A_{VO} = \frac{V_{IN} \times 10^3}{V_{OUT}} = \frac{10 \times 10^3}{V_{OUT}} \text{ FOR } V_{IN} \text{ SPECIFIED}$$

TYPICAL PERFORMANCE CURVES FOR 748

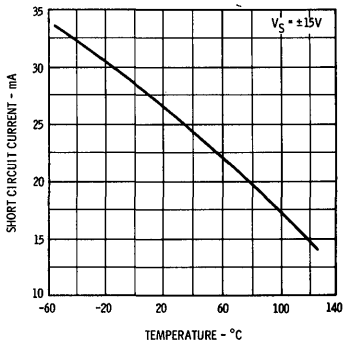
INPUT BIAS CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



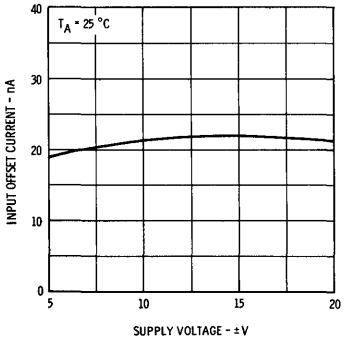
INPUT RESISTANCE AS A FUNCTION OF AMBIENT TEMPERATURE



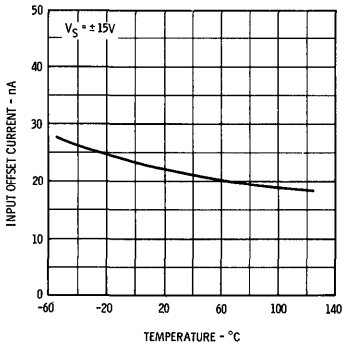
OUTPUT SHORT-CIRCUIT CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



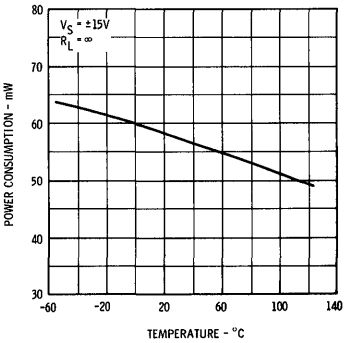
INPUT OFFSET CURRENT AS A FUNCTION OF SUPPLY VOLTAGE



INPUT OFFSET CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE

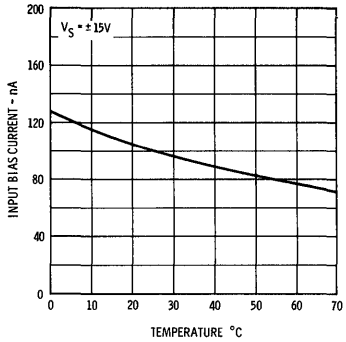


POWER CONSUMPTION AS A FUNCTION OF AMBIENT TEMPERATURE

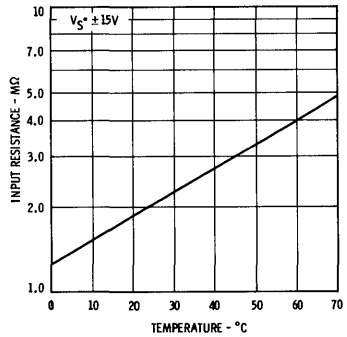


TYPICAL PERFORMANCE CURVES FOR 748C

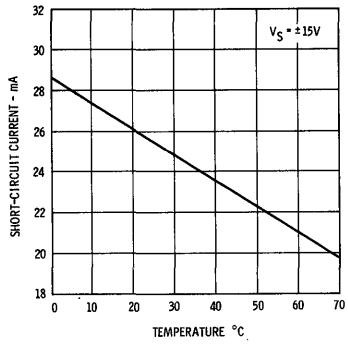
INPUT BIAS CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



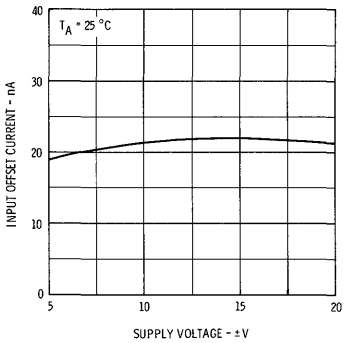
INPUT RESISTANCE AS A FUNCTION OF AMBIENT TEMPERATURE



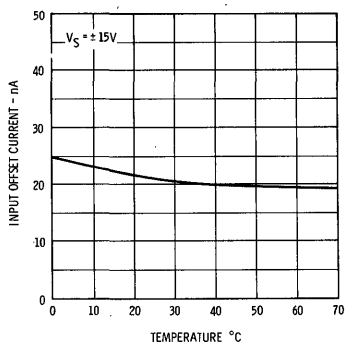
OUTPUT SHORT-CIRCUIT CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



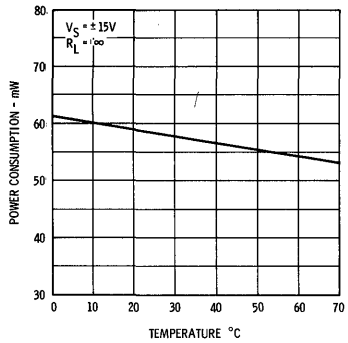
INPUT OFFSET CURRENT AS A FUNCTION OF SUPPLY VOLTAGE



INPUT OFFSET CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE

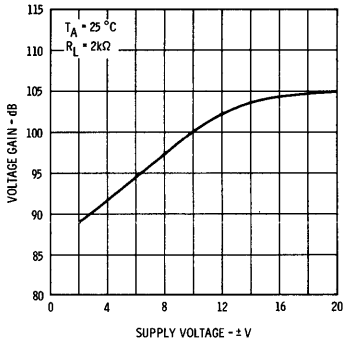


POWER CONSUMPTION AS A FUNCTION OF AMBIENT TEMPERATURE

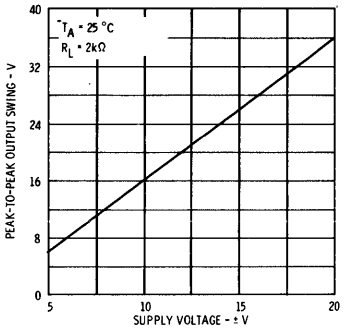


TYPICAL PERFORMANCE CURVES FOR 748 AND 748C

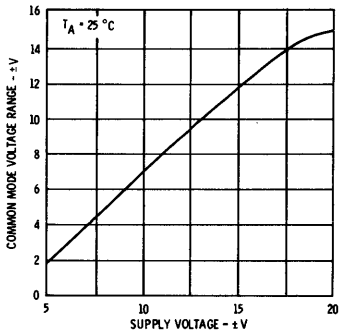
OPEN LOOP VOLTAGE GAIN AS A FUNCTION OF SUPPLY VOLTAGE



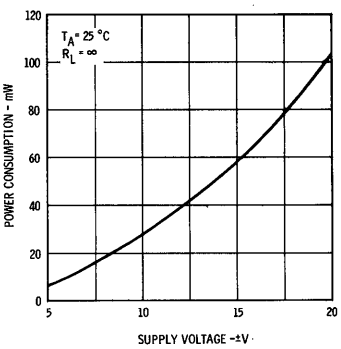
OUTPUT VOLTAGE SWING AS A FUNCTION OF SUPPLY VOLTAGE



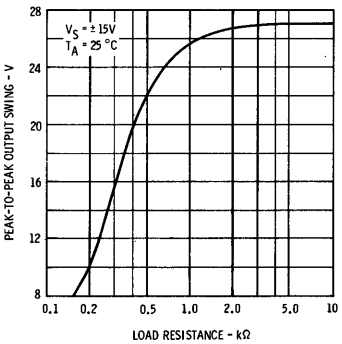
INPUT COMMON MODE VOLTAGE RANGE AS A FUNCTION OF SUPPLY VOLTAGE



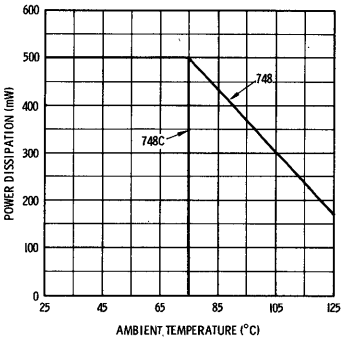
POWER CONSUMPTION AS A FUNCTION OF SUPPLY VOLTAGE



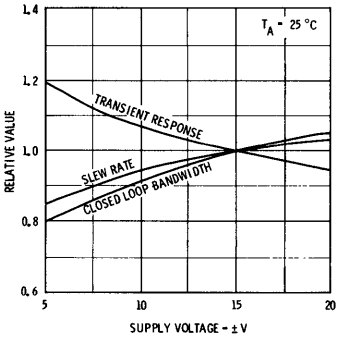
OUTPUT VOLTAGE SWING AS A FUNCTION OF LOAD RESISTANCE



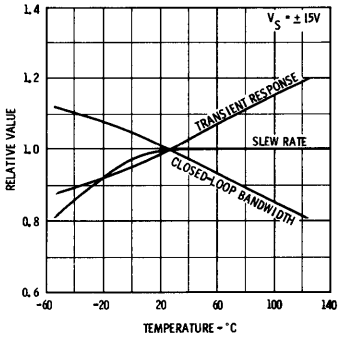
ABSOLUTE MAXIMUM POWER DISSIPATION AS A FUNCTION OF AMBIENT TEMPERATURE



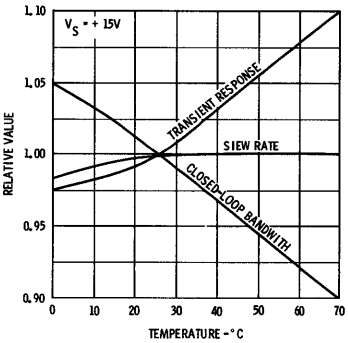
FREQUENCY CHARACTERISTICS AS A FUNCTION OF SUPPLY VOLTAGE



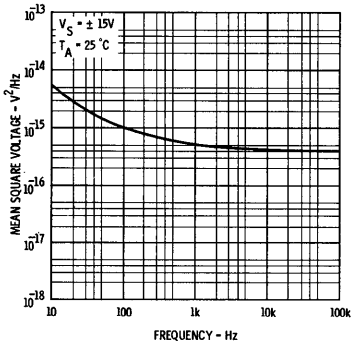
748 FREQUENCY CHARACTERISTICS AS A FUNCTION OF AMBIENT TEMPERATURE



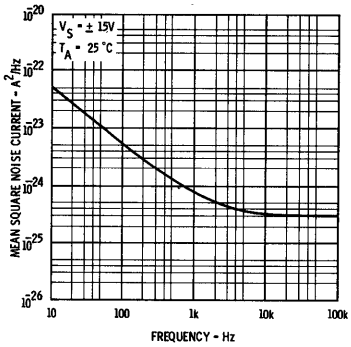
748C FREQUENCY CHARACTERISTICS AS A FUNCTION OF AMBIENT TEMPERATURE



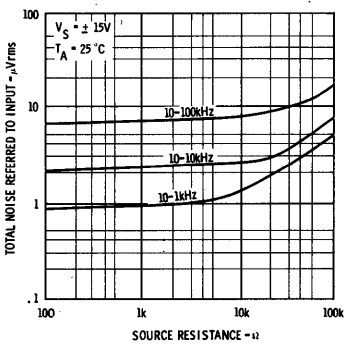
INPUT NOISE VOLTAGE AS A FUNCTION OF FREQUENCY



INPUT NOISE CURRENT AS A FUNCTION OF FREQUENCY

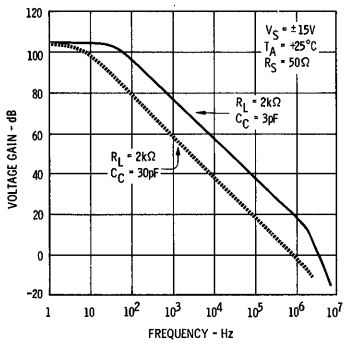


BROADBAND NOISE FOR VARIOUS BANDWIDTHS

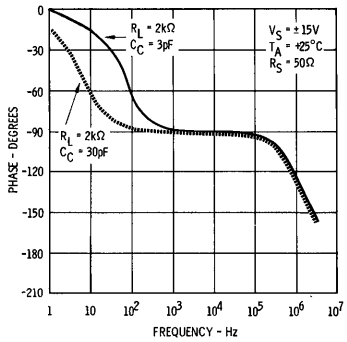


TYPICAL PERFORMANCE CURVES FOR 748 AND 748C

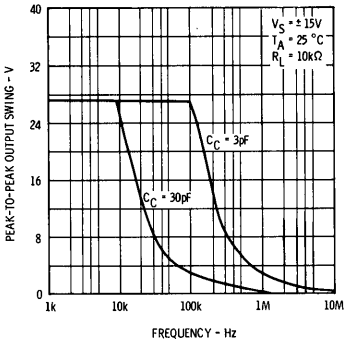
OPEN LOOP VOLTAGE GAIN AS A FUNCTION OF FREQUENCY



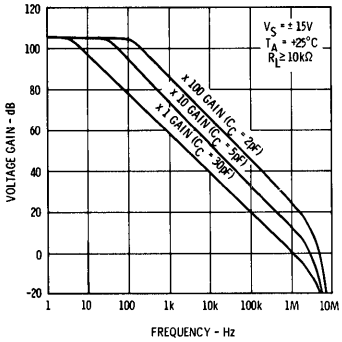
OPEN LOOP PHASE RESPONSE AS A FUNCTION OF FREQUENCY



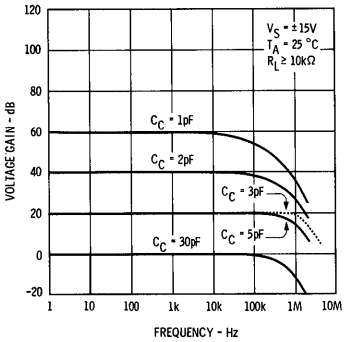
OUTPUT VOLTAGE SWING AS A FUNCTION OF FREQUENCY



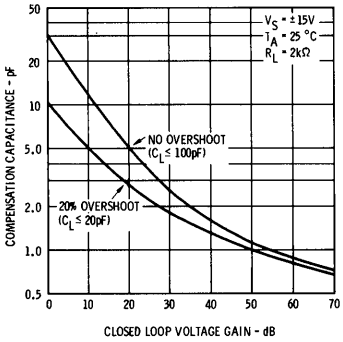
OPEN LOOP VOLTAGE GAIN AS A FUNCTION OF FREQUENCY FOR VARIOUS GAIN/COMPENSATION OPTIONS



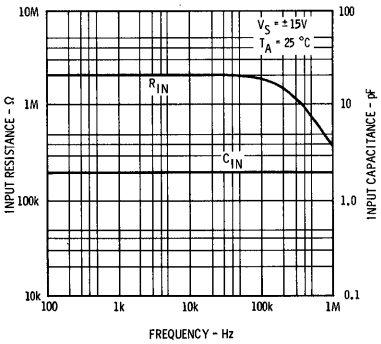
FREQUENCY RESPONSE FOR VARIOUS CLOSED-LOOP GAINS



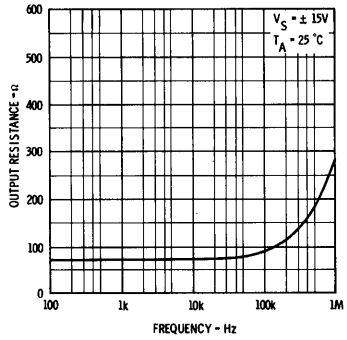
COMPENSATION CAPACITANCE AS A FUNCTION OF CLOSED LOOP VOLTAGE GAIN



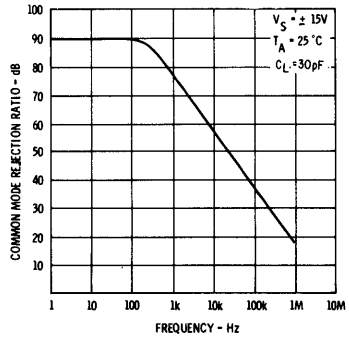
INPUT RESISTANCE AND INPUT CAPACITANCE AS A FUNCTION OF FREQUENCY



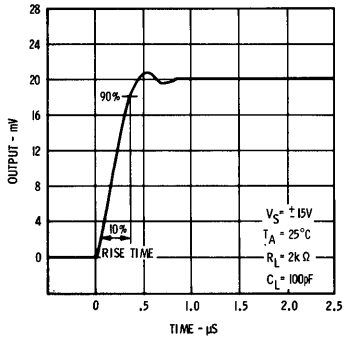
OUTPUT RESISTANCE AS A FUNCTION OF FREQUENCY



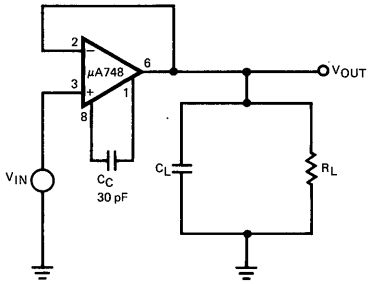
COMMON MODE REJECTION RATIO AS A FUNCTION OF FREQUENCY



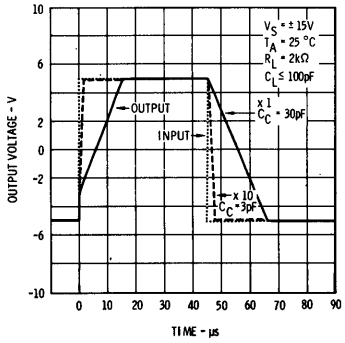
VOLTAGE FOLLOWER TRANSIENT RESPONSE (GAIN OF 1)



TRANSIENT RESPONSE TEST CIRCUIT

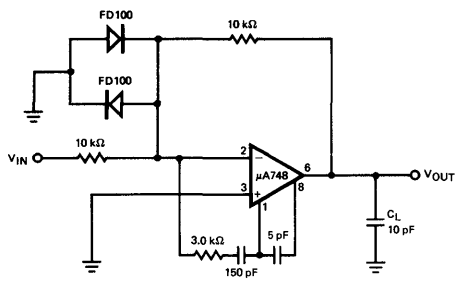


VOLTAGE FOLLOWER LARGE-SIGNAL PULSE RESPONSE

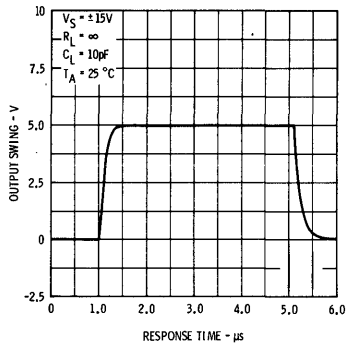


TYPICAL PERFORMANCE CURVES FOR 748 AND 748C

FEED-FORWARD COMPENSATION

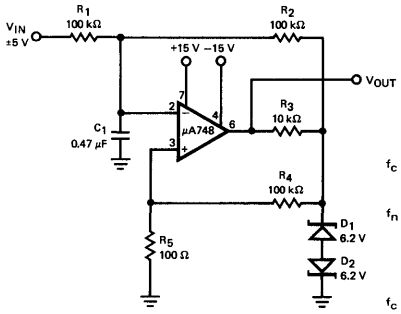


LARGE SIGNAL FEED–FORWARD TRANSIENT RESPONSE



TYPICAL APPLICATIONS

PULSE WIDTH MODULATOR

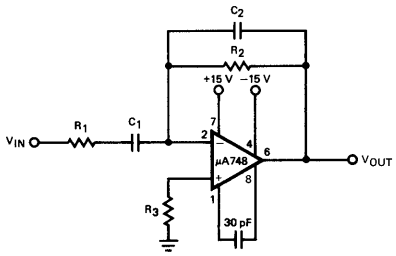


$$f_c = \frac{1}{2\pi R_2 C_1}$$

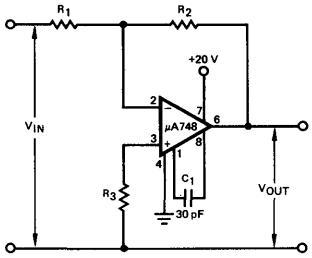
$$f_n = \frac{1}{2\pi R_1 C_1} = \frac{1}{2\pi R_2 C_2}$$

$f_c < f_n < f_{unity\ gain}$

PRACTICAL DIFFERENTIATOR



CIRCUIT FOR OPERATING THE μA748 WITHOUT A NEGATIVE SUPPLY



NOTES

1. Rating applies to ambient temperature up to 70°C. Above 70°C ambient derate linearly at 6.3 mW/°C for the Metal Can, 8.3 mW/°C for the DIP, 5.6 mW/°C for the Mini DIP and 7.1 mW/°C for the Flatpak.
2. For supply voltages less than ±15 V, the absolute maximum input voltage is equal to the supply voltage.
3. Short circuit may be to ground or either supply. Rating applies to +125°C case temperature or +75°C case temperature or +75°C ambient temperature.

μA776

MULTI-PURPOSE PROGRAMMABLE OPERATIONAL AMPLIFIER

FAIRCHILD LINEAR INTEGRATED CIRCUIT

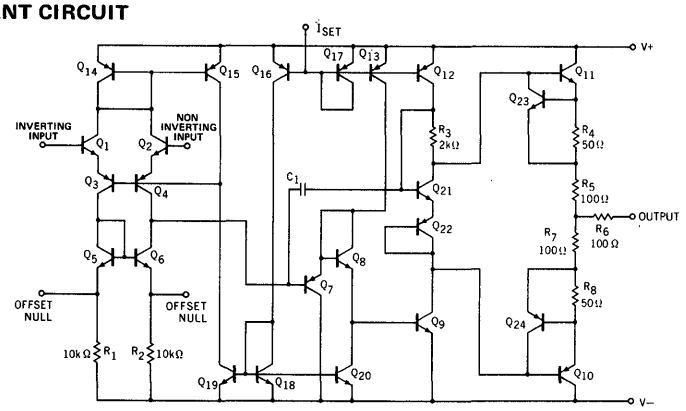
DESCRIPTION — The μA776 Programmable Operational Amplifier is constructed using the Fairchild Planar* epitaxial process. High input impedance, low supply currents, and low input noise over a wide range of operating supply voltages coupled with programmable electrical characteristics result in an extremely 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 or current source that sets the chip quiescent current for nano-watt power consumption or for characteristics similar to the μA741. Internal frequency compensation, absence of latch up, high slew rate and short circuit current protection assure ease of use in long time integrators, active filters, and sample and hold circuits.

- **MICROPOWER CONSUMPTION**
- **±1.2V to ±18V OPERATION**
- **NO FREQUENCY COMPENSATION REQUIRED**
- **LOW INPUT BIAS CURRENTS**
- **WIDE PROGRAMMING RANGE**
- **HIGH SLEW RATE**
- **LOW NOISE**
- **SHORT CIRCUIT PROTECTION**
- **OFFSET NULL CAPABILITY**
- **NO LATCH UP**

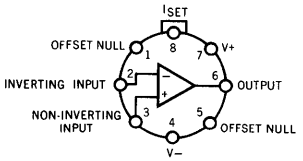
ABSOLUTE MAXIMUM RATINGS

Supply Voltage	±18 V
Internal Power Dissipation (Note 1)	
Metal Can	500 mW
DIP	670 mW
Mini DIP	310 mW
Differential Input Voltage	±30 V
Input Voltage (Note 2)	±15 V
Voltage Between Offset Null and V−	±0.5 V
I_{SET} (Maximum Current at I_{SET})	500 μA
V_{SET} (Maximum Voltage to Ground at I_{SET})	$(V_+ - 2.0\ V) \leq V_{SET} \leq V_+$
Storage Temperature Range	
Metal Can, DIP	−65°C to +150°C
Mini DIP	−55°C to +125°C
Operating Temperature Range	
Military (776)	−55°C to +125°C
Commercial (776C)	0°C to +70°C
Lead Temperature (Soldering, 60 seconds)	
Metal Can, DIP	300°C
Mini DIP	260°C
Output Short-Circuit Duration (Note 3)	Indefinite

EQUIVALENT CIRCUIT



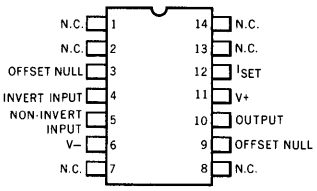
CONNECTION DIAGRAMS
8-LEAD METAL CAN
(TOP VIEW)
PACKAGE OUTLINE 5B



ORDER INFORMATION

TYPE	PART NO.
776	776HM
776C	776HC

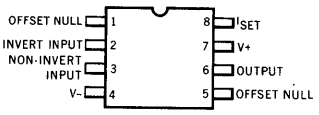
14-LEAD DIP
(TOP VIEW)
PACKAGE OUTLINE 6A



ORDER INFORMATION

TYPE	PART NO.
776	776DM
776C	776DC

8-LEAD MINI DIP
(TOP VIEW)
PACKAGE OUTLINE 9T



ORDER INFORMATION

TYPE	PART NO.
776C	776TC

*Planar is a patented Fairchild process.

±15 VOLT OPERATION FOR 776

ELECTRICAL CHARACTERISTICS (T_A = 25°C, Unless Otherwise Specified)

PARAMETERS	CONDITIONS	I_{SET} = 1.5μA MIN.	TYP.	MAX.	I_{SET} = 15μA MIN.	TYP.	MAX.	UNITS
Input Offset Voltage	$R_S \leq 10k\Omega$		2.0	5.0		2.0	5.0	mV
Input Offset Current	$R_S \leq 10k\Omega$		0.7	3.0		2.0	15	nA
Input Bias Current			2.0	7.5		15	50	nA
Input Resistance			50			5.0		MΩ
Input Capacitance			2.0			2.0		pF
Offset Voltage Adjustment Range			9.0			18		mV
Large Signal Voltage Gain	$R_L \geq 75k\Omega$, V_{OUT} = ±10V	200k	400k					V/V
	$R_L \geq 5k\Omega$, V_{OUT} = ±10V				100k	400k		V/V
Output Resistance			5.0k			1.0k		Ω
Output Short-Circuit Current			3.0			12		mA
Supply Current			20	25		160	180	μA
Power Consumption				0.75			5.4	mW
Transient Response (unity gain) — Risetime	V_{IN} = 20mV, $R_L \geq 5k\Omega$, C_L = 100pF		1.6			0.35		μs
Transient Response (unity gain) — Overshoot			0			10		%
Slew Rate	$R_L \geq 5k\Omega$		0.1			0.8		V/μs
Output Voltage Swing	$R_L \geq 75k\Omega$	±12	±14					V
	$R_L \geq 5k\Omega$				±10	±13		V
The following specifications apply −55°C ≤ T_A ≤ +125°C								
Input Offset Voltage	$R_S \leq 10k\Omega$			6.0			6.0	mV
Input Offset Current	T_A = +125°C			5.0			15	nA
	T_A = −55°C			10			40	nA
Input Bias Current	T_A = +125°C			7.5			50	nA
	T_A = −55°C			20			120	nA
Input Voltage Range		±10			±10			V
Common Mode Rejection Ratio	$R_S \leq 10k\Omega$	70	90		70	90		dB
Supply Voltage Rejection Ratio	$R_S \leq 10k\Omega$		25	150		25	150	μV/V
Large Signal Voltage Gain	$R_L \geq 75k\Omega$, V_{OUT} = ±10V	100k			75k			V/V
Output Voltage Swing	$R_L \geq 75k\Omega$	±10			±10			V
Supply Current				30			200	μA
Power Consumption				0.9			6.0	mW

3

±3 VOLT OPERATION FOR 776

ELECTRICAL CHARACTERISTICS (T_A = 25°C, Unless Otherwise Specified)

PARAMETERS	CONDITIONS	I_{SET} = 1.5μA MIN.	TYP.	MAX.	I_{SET} = 15μA MIN.	TYP.	MAX.	UNITS
Input Offset Voltage	$R_S \leq 10k\Omega$		2.0	5.0		2.0	5.0	mV
Input Offset Current			0.7	3.0		2.0	15	nA
Input Bias Current			2.0	7.5		15	50	nA
Input Resistance			50			5.0		MΩ
Input Capacitance			2.0			2.0		pF
Offset Voltage Adjustment Range			9.0			18		mV
Large Signal Voltage Gain	$R_L \geq 75k\Omega$, V_{OUT}=±1V	50k	200k					V/V
	$R_L \geq 5k\Omega$, V_{OUT}=±1V				50k	200k		V/V
Output Resistance			5k			1k		Ω
Output Short-Circuit Current			3.0			5.0		mA
Supply Current			13	20		130	160	μA
Power Consumption			78	120		780	960	μW
Transient Response (unity gain) — Risetime	V_{IN} = 20mV, $R_L \geq 5k\Omega$, $C_L \leq 100pF$		3.0			0.6		μs
Transient Response (unity gain) — Overshoot			0			5		%
Slew Rate	$R_L \geq 5k\Omega$		0.03			0.35		V/μs
The following specifications apply for $-55°C \leq T_A \leq +125°C$								
Input Offset Voltage	$R_S \leq 10k\Omega$			6.0			6.0	mV
Input Offset Current	T_A = +125°C			5.0			15	nA
	T_A = −55°C			10			40	nA
Input Bias Current	T_A = +125°C			7.5			50	nA
	T_A = −55°C			20			120	nA
Input Voltage Range		±1.0			±1.0			V
Common Mode Rejection Ratio	$R_S \leq 10k\Omega$	70	86		70	86		dB
Supply Voltage Rejection Ratio	$R_S \leq 10k\Omega$		25	150		25	150	μV/V
Large Signal Voltage Gain	$R_L \geq 75k\Omega$, V_{OUT}=±1V	25k						V/V
	$R_L \geq 5k\Omega$, V_{OUT}=±1V				25k			V/V
Output Voltage Swing	$R_L \geq 75k\Omega$	±2.0	±2.4					V
	$R_L \geq 5k\Omega$				±1.9	±2.1		V
Supply Current				25			180	μA
Power Consumption				150			1080	μW

NOTES

1. Rating applies to ambient temperatures up to 70°C. Above 70°C ambient derate linearly at 6.3 mW/°C for Metal Can, 8.3 mW/°C for the DIP, and 5.6 mW/°C for the Mini DIP.
2. For supply voltages less than ±15 V, the absolute maximum input voltage is equal to the supply voltage.
3. Short Circuit may be to ground or either supply. Rating applies to +125°C case temperature or +75°C ambient temperature for $I_{SET} \leq 30$ μA.

±15 VOLT OPERATION FOR 776C

ELECTRICAL CHARACTERISTICS (T_A = 25°C, Unless Otherwise Specified)

PARAMETERS	CONDITIONS	I_{SET} = 1.5μA MIN.	TYP.	MAX.	I_{SET} = 15μA MIN.	TYP.	MAX.	UNITS
Input Offset Voltage	$R_S \leq 10k\Omega$		2.0	6.0		2.0	6.0	mV
Input Offset Current			0.7	6.0		2.0	25	nA
Input Bias Current			2.0	10		15	50	nA
Input Resistance			50			5.0		MΩ
Input Capacitance			2.0			2.0		pF
Offset Voltage Adjustment Range			9.0			18		mV
Large Signal Voltage Gain	$R_L \geq 75k\Omega$, V_{OUT}=±10V	50k	400k					V/V
	$R_L \geq 5k\Omega$, V_{OUT}=±10V				50k	400k		V/V
Output Resistance			5.0			1.0		kΩ
Output Short-Circuit Current			3.0			12		mA
Supply Current			20	30		160	190	μA
Power Consumption				0.9			5.7	mW
Transient Response (unity gain) — Risetime	V_{IN} = 20mV, $R_L \geq 5k\Omega$, $C_L \leq 100pF$		1.6			0.35		μs
Transient Response (unity gain) — Overshoot			0			10		%
Slew Rate	$R_L \geq 5k\Omega$		0.1			0.8		V/μs
Output Voltage Swing	$R_L \geq 75k\Omega$	±12	±14					V
	$R_L \geq 5k\Omega$				±10	±13		V
The following specifications apply to 0°C≤T_A≤+70°C								
Input Offset Voltage	$R_S \leq 10k\Omega$			7.5			7.5	mV
Input Offset Current	T_A = +70°C			6.0			25	nA
	T_A = 0°C			10			40	nA
Input Bias Current	T_A = +70°C			10			50	nA
	T_A = 0°C			20			100	nA
Input Voltage Range		±10			±10			V
Common Mode Rejection Ratio	$R_S \leq 10k\Omega$	70	90		70	90		dB
Supply Voltage Rejection Ratio	$R_S \leq 10k\Omega$		25	200		25	200	μV/V
Large Signal Voltage Gain	$R_L \geq 75k\Omega$, V_{OUT}=±10V	50k			50k			V/V
Output Voltage Swing	$R_L \geq 75k\Omega$	±10			±10			V
Supply Current				35			200	μA
Power Consumption				1.05			6.0	mW

3

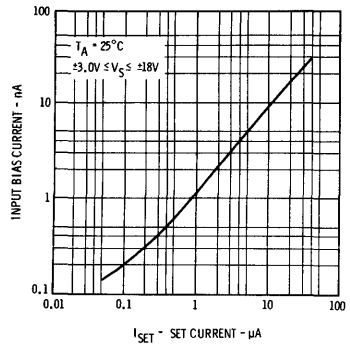
±3 VOLT OPERATION FOR 776C

ELECTRICAL CHARACTERISTICS (T_A = 25°C, Unless Otherwise Specified)

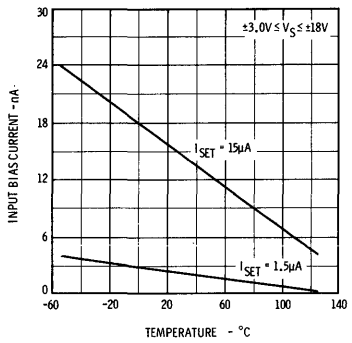
PARAMETERS	CONDITIONS	I_{SET} = 1.5μA MIN.	TYP.	MAX.	I_{SET} = 15μA MIN.	TYP.	MAX.	UNITS
Input Offset Voltage	$R_S \leq 10k\Omega$		2.0	6.0		2.0	6.0	mV
Input Offset Current			0.7	6.0		2.0	25	nA
Input Bias Current			2.0	10		15	50	nA
Input Resistance			50			5.0		MΩ
Input Capacitance			2.0			2.0		pF
Offset Voltage Adjustment Range			9.0			18		mV
Large Signal Voltage Gain	$R_L \geq 75k\Omega$, V_{OUT}=±1V	25k	200k					V/V
	$R_L \geq 5k\Omega$, V_{OUT}=±1V				25 k	200k		V/V
Output Resistance			5.0			1.0		kΩ
Output Short-Circuit Current			3.0			5.0		mA
Supply Current			13	20		130	170	μA
Power Consumption			78	120		780	1020	μW
Transient Response (unity gain) — Risetime	V_{IN} = 20mV, $R_L \geq 5k\Omega$, C_L = 100pF		3.0			0.6		μs
Transient Response (unity gain) — Overshoot			0			5		%
Slew Rate	$R_L \geq 5k\Omega$		0.03			0.35		V/μs
The following specifications apply for 0°C≤T_A≤+70°C								
Input Offset Voltage	$R_S \leq 10k\Omega$			7.5			7.5	mV
Input Offset Current	T_A = +70°C			6.0			25	nA
	T_A = 0°C			10			40	nA
Input Bias Current	T_A = +70°C			10			50	nA
	T_A = 0°C			20			100	nA
Input Voltage Range		±1.0			±1.0			V
Common Mode Rejection Ratio	$R_S \leq 10k\Omega$	70	86		70	86		dB
Supply Voltage Rejection Ratio	$R_S \leq 10k\Omega$		25	200		25	200	μV/V
Large Signal Voltage Gain	$R_L \geq 75k\Omega$, V_{OUT}=±1V	25k						V/V
	$R_L \geq 5k\Omega$, V_{OUT}=±1V				25k			V/V
Output Voltage Swing	$R_L \geq 75k\Omega$	±2.0	±2.4					V
	$R_L \geq 5k\Omega$				±2.0	±2.1		V
Supply Current				25			180	μA
Power Consumption				150			1080	μW

TYPICAL PERFORMANCE CURVES FOR 776 AND 776C

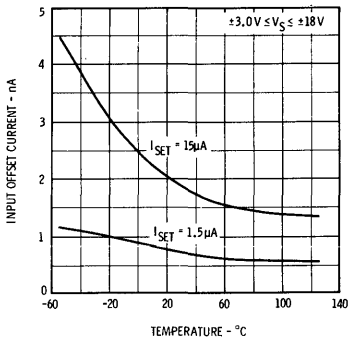
INPUT BIAS CURRENT AS A FUNCTION OF SET CURRENT



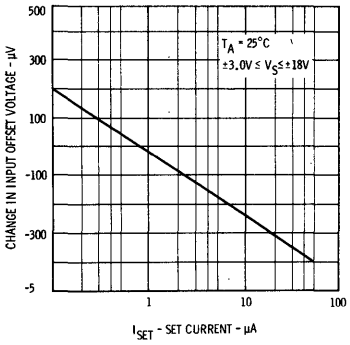
INPUT BIAS CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



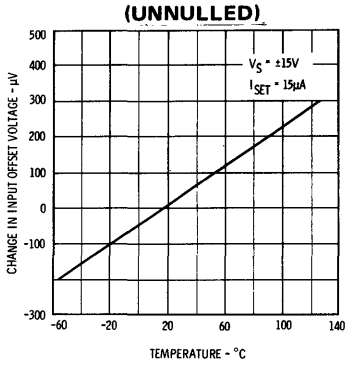
INPUT OFFSET CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



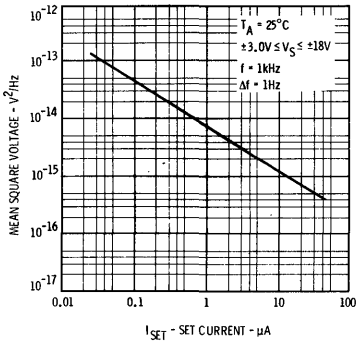
CHANGE IN INPUT OFFSET VOLTAGE AS A FUNCTION OF SET CURRENT



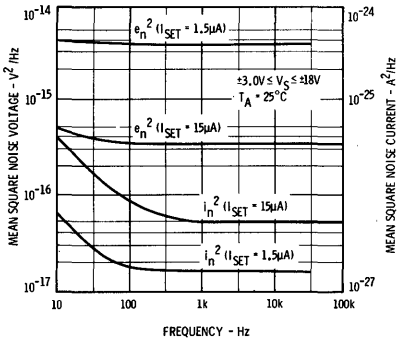
CHANGE IN INPUT OFFSET VOLTAGE AS A FUNCTION OF AMBIENT TEMPERATURE (UNNULLED)



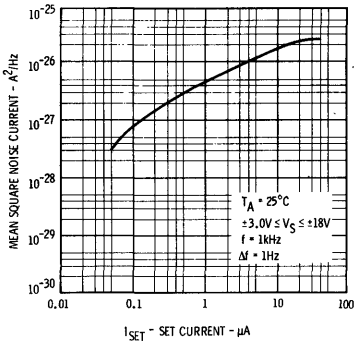
INPUT NOISE VOLTAGE AS A FUNCTION OF SET CURRENT



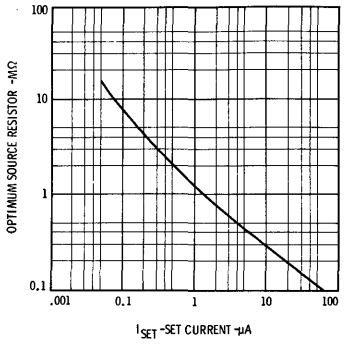
INPUT NOISE VOLTAGE AND CURRENT AS A FUNCTION OF FREQUENCY



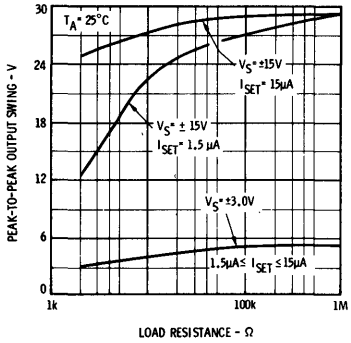
INPUT NOISE CURRENT AS A FUNCTION OF SET CURRENT



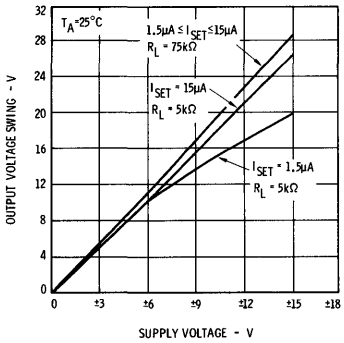
OPTIMUM SOURCE RESISTOR FOR MINIMUM NOISE AS A FUNCTION OF SET CURRENT



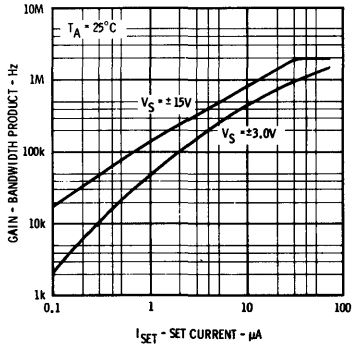
OUTPUT VOLTAGE SWING AS A FUNCTION OF LOAD RESISTANCE



OUTPUT VOLTAGE SWING AS A FUNCTION OF SUPPLY VOLTAGE



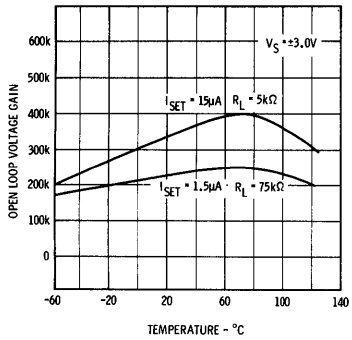
GAIN-BANDWIDTH PRODUCT AS A FUNCTION OF SET CURRENT



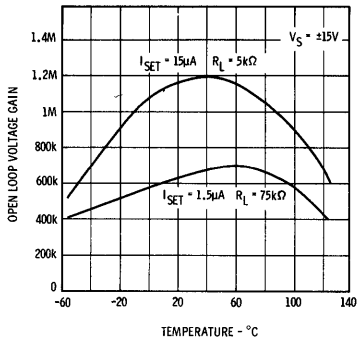
3

TYPICAL PERFORMANCE CURVES FOR 776 AND 776C

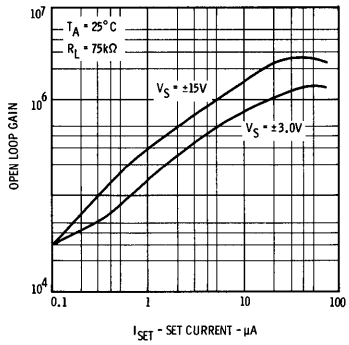
OPEN LOOP VOLTAGE GAIN AS A FUNCTION OF AMBIENT TEMPERATURE



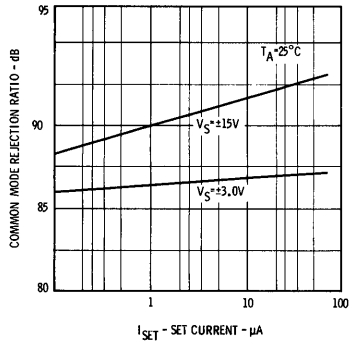
OPEN LOOP VOLTAGE GAIN AS A FUNCTION OF AMBIENT TEMPERATURE



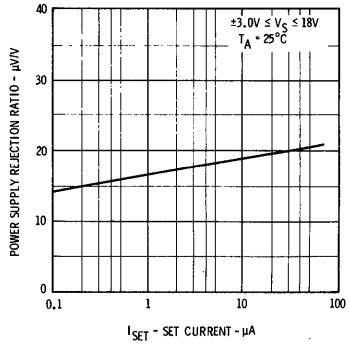
OPEN LOOP VOLTAGE GAIN AS A FUNCTION OF SET CURRENT



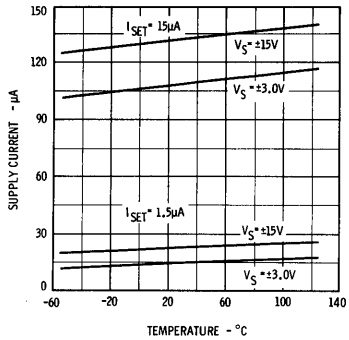
COMMON MODE REJECTION RATIO AS A FUNCTION OF SET CURRENT



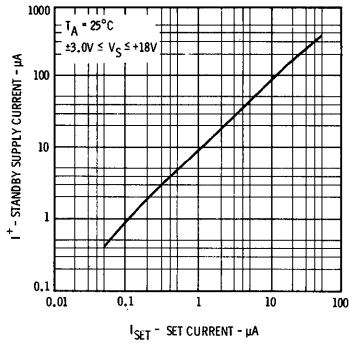
POWER SUPPLY REJECTION RATIO AS A FUNCTION OF SET CURRENT



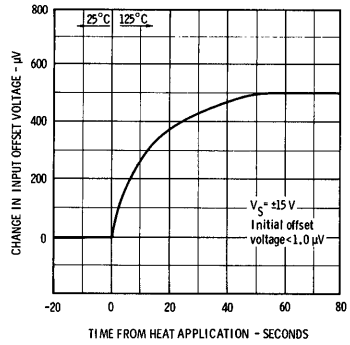
SUPPLY CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



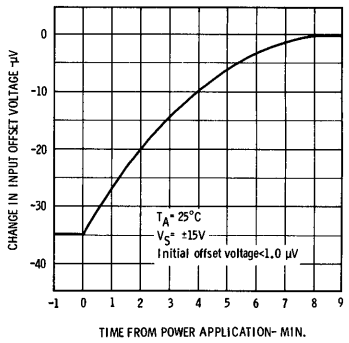
STANDBY SUPPLY CURRENT AS A FUNCTION OF SET CURRENT



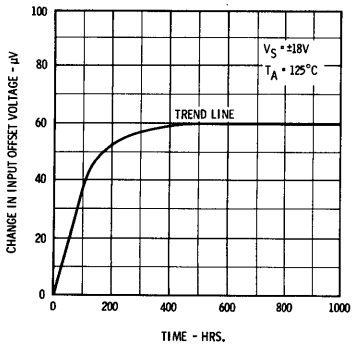
THERMAL RESPONSE OF INPUT OFFSET VOLTAGE TO STEP CHANGE OF CASE TEMPERATURE



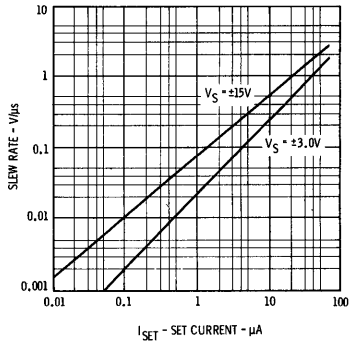
STABILIZATION TIME OF INPUT OFFSET VOLTAGE FROM POWER ON



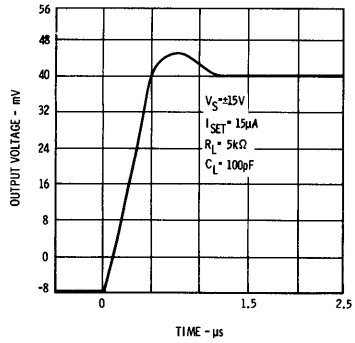
INPUT OFFSET VOLTAGE DRIFT AS A FUNCTION OF TIME



SLEW RATE AS A FUNCTION OF SET CURRENT

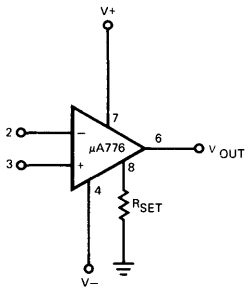


VOLTAGE FOLLOWER TRANSIENT RESPONSE (UNITY GAIN)

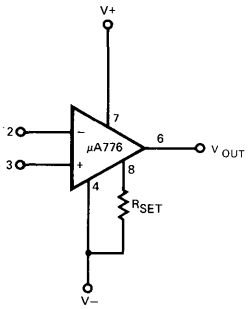


BIASING CIRCUITS

RESISTOR BIASING



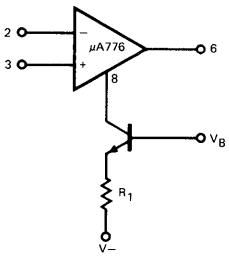
R_{SET} CONNECTED TO GROUND



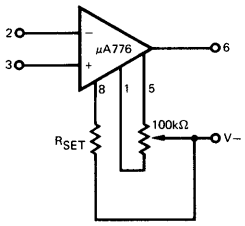
R_{SET} CONNECTED TO V^-

* Recommended for supply voltages less than ±6V.

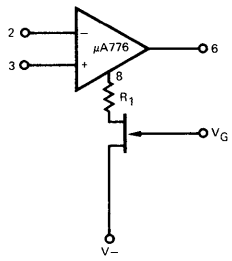
TRANSISTOR CURRENT SOURCE BIASING



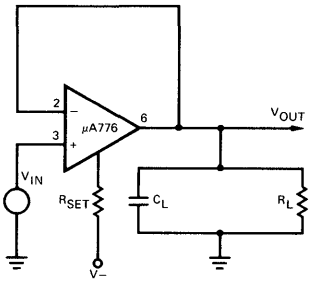
VOLTAGE OFFSET NULL CIRCUIT



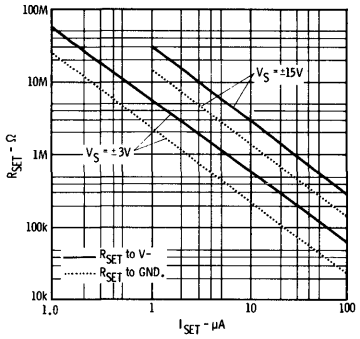
FET CURRENT SOURCE BIASING



TRANSIENT RESPONSE TEST CIRCUIT



SET CURRENT AS A FUNCTION OF SET RESISTOR



QUIESCENT CURRENT SETTING RESISTOR (I_{SET} TO V^-)

V_S	I_{SET}	
	1.5μA	15μA
±1.5 V	1.7MΩ	170kΩ
±3.0 V	3.6MΩ	360kΩ
±6.0 V	7.5MΩ	750kΩ
±15 V	20MΩ	2.0MΩ

Note: The μA776 may be operated with R_{SET} connected to ground or V−.

I_{SET} EQUATIONS:

$$I_{SET} = \frac{V^+ - 0.7 - V^-}{R_{SET}}$$

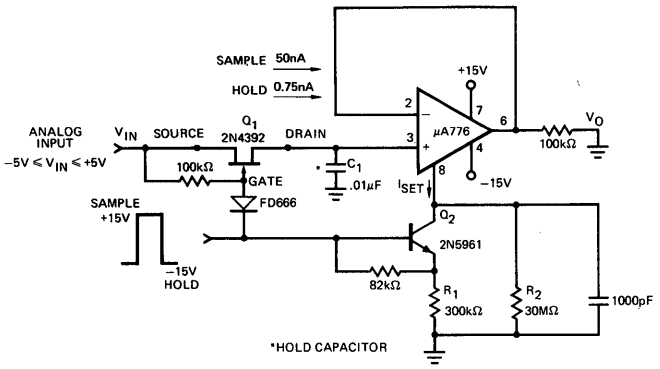
where R_{SET} is connected to V^-

$$I_{SET} = \frac{V^+ - 0.7}{R_{SET}}$$

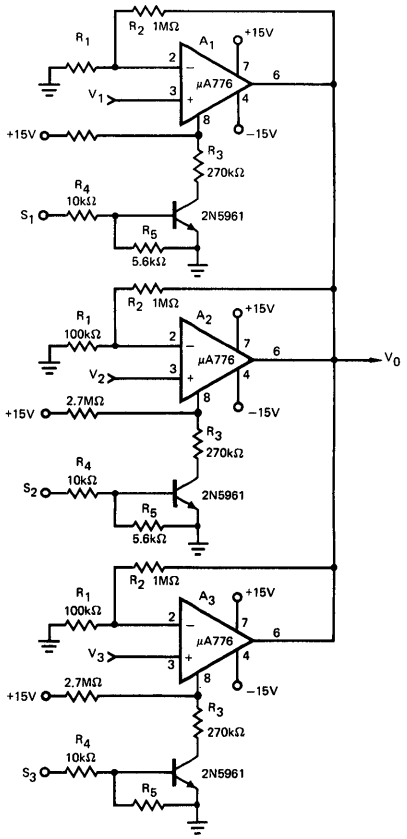
where R_{SET} is connected to ground.

TYPICAL APPLICATIONS

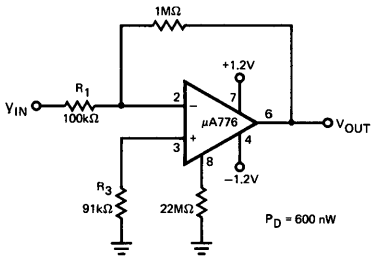
HIGH ACCURACY SAMPLE AND HOLD



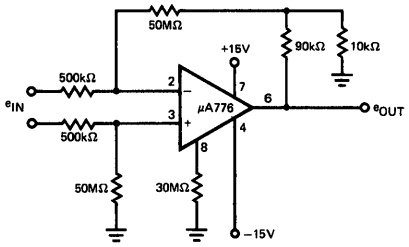
MULTIPLEXING AND SIGNAL CONDITIONING WITHOUT FET'S



NANO-WATT AMPLIFIER



HIGH INPUT IMPEDANCE AMPLIFIER



μA777

PRECISION OPERATIONAL AMPLIFIER

FAIRCHILD LINEAR INTEGRATED CIRCUIT

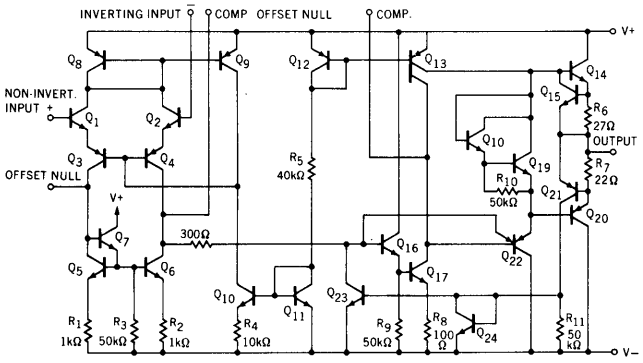
GENERAL DESCRIPTION — The μA777 is a monolithic Precision Operational Amplifier constructed using a low noise Fairchild Planar* epitaxial process. It is an excellent choice when performance versus cost trade-offs are possible between super beta or FET input operational amplifiers and low cost general purpose operational amplifiers. Low offset and bias currents improve system accuracy when used in applications such as long term integrators, sample and hold circuits and high source impedance summing amplifiers. Even though the input bias current is extremely low, the μA777 maintains full ±30 V differential voltage range. The internal construction utilizes isothermal layout and special electrical design to maintain system performance despite variations in temperature or output load. High common mode input voltage range, latch-up protection, short circuit protection and simple frequency compensation make the device versatile and easily used.

- **LOW OFFSET VOLTAGE AND OFFSET CURRENT**
- **LOW OFFSET VOLTAGE AND CURRENT DRIFT**
- **LOW INPUT BIAS CURRENT**
- **LOW INPUT NOISE VOLTAGE**
- **LARGE COMMON-MODE AND DIFFERENTIAL VOLTAGE RANGES**

ABSOLUTE MAXIMUM RATINGS

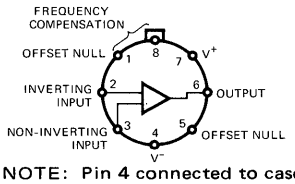
Supply Voltage	±22 V
Internal Power Dissipation (Note 1)	
Metal Can	500 mW
DIP	670 mW
Mini DIP	310 mW
Flatpak	570 mW
Differential Input Voltage	±30 V
Input Voltage (Note 2)	±15 V
Storage Temperature Range	
Metal Can, DIP, and Flatpak	-65° C to +150° C
Mini DIP	-55° C to +125° C
Operating Temperature Range	
Military (777)	-55° C to +125° C
Commercial (777C)	0° C to 70° C
Lead Temperature	
Metal Can, DIP and Flatpak (Soldering, 60 seconds)	300° C
Mini DIP (Soldering, 10 seconds)	260° C
Output Short-Circuit Duration (Note 3)	Indefinite

EQUIVALENT CIRCUIT



CONNECTION DIAGRAMS

8-LEAD METAL CAN
(TOP VIEW)
PACKAGE OUTLINE 5B

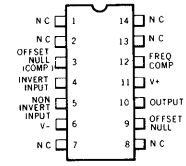


NOTE: Pin 4 connected to case

ORDER INFORMATION

TYPE	PART NO.
777	777 HM
777C	777 HC

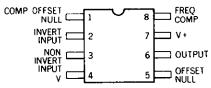
14-LEAD DIP
(TOP VIEW)
PACKAGE OUTLINE 6A



ORDER INFORMATION

TYPE	PART NO.
777	777DM
777C	777DC

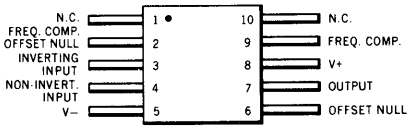
8-LEAD MINI DIP
(TOP VIEW)
PACKAGE OUTLINE 9T



ORDER INFORMATION

TYPE	PART NO.
777C	777TC

10-LEAD FLATPAK‡
(TOP VIEW)
PACKAGE OUTLINE 3F



‡ Available on special request

ORDER INFORMATION

TYPE	PART NO.
777	777FM

Notes on following pages.

*Planar is a patented Fairchild process.

ELECTRICAL CHARACTERISTICS FOR 777 (V_S = ±15 V, T_A = 25°C, C_C = 30 pF unless otherwise specified)

PARAMETERS		CONDITIONS	MIN.	TYP.	MAX.	UNITS
Input Offset Voltage		$R_S \leq 50$ kΩ		0.5	2.0	mV
Input Offset Current				0.25	3.0	nA
Input Bias Current				8.0	25	nA
Input Resistance			2.0	10.0		MΩ
Input Capacitance				3.0		pF
Offset Voltage Adjustment Range				±25		mV
Large Signal Voltage Gain		$R_L \geq 2$ kΩ, V_{OUT} = ±10V	50,000	250,000		V/V
Output Resistance				100		Ω
Output Short-Circuit Current				±25		mA
Supply Current				1.9	2.8	mA
Power Consumption				60	85	mW
Transient Response (Voltage Follower, Gain of 1)	Risetime	V_{IN} = 20 mV, C_C = 30 pF, R_L = 2 kΩ, $C_L \leq 100$ pF		0.3		μs
	Overshoot			5.0		%
Slew Rate (Voltage Follower, Gain of 1)		$R_L \geq 2$kΩ		0.5		V/μs
Transient Response (Voltage Follower, Gain of 10)	Risetime	V_{IN} = 20 mV, C_C = 3.5 pF, R_L = 2 kΩ, $C_L \leq 100$ pF		0.2		μs
	Overshoot			5.0		%
Slew Rate (Voltage Follower, Gain of 10)		$R_L \geq 2$ kΩ, C_C = 3.5 pF		5.5		V/μs
The following specifications apply for −55°C ≤ T_A ≤ +125°C:						
Input Offset Voltage		$R_S \leq 50$ kΩ		0.5	3.0	mV
Average Input Offset Voltage Drift		$R_S \leq 50$ kΩ		2.5	15	μV/°C
Input Offset Current					10	nA
Average Input Offset Current Drift		25°C ≤ T_A ≤ +125°C		2.5	30	pA/°C
		−55°C ≤ T_A ≤ 25°C		6.5	150	pA/°C
Input Bias Current					75	nA
Input Voltage Range			±12	±13		V
Common Mode Rejection Ratio		$R_S \leq 50$ kΩ	80	95		dB
Supply Voltage Rejection Ratio		$R_S \leq 50$ kΩ		13	100	μV/V
Large Signal Voltage Gain		$R_L \geq 2$ kΩ, V_{OUT} = ±10 V	25,000			V/V
Output Voltage Swing		$R_L \geq 10$ kΩ	±12	±14		V
		$R_L \geq 2$ kΩ	±10	±13		V
Supply Current		T_A = +125°C		1.5	2.5	mA
		T_A = −55°C		2.0	3.3	mA
Power Consumption		T_A = +125°C		40	75	mW
		T_A = −55°C		60	100	mW

ELECTRICAL CHARACTERISTICS FOR 777C (V_S = ±15 V, T_A = 25°C, C_C = 30 pF unless otherwise specified)

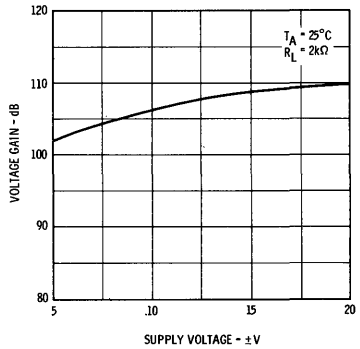
PARAMETERS		CONDITIONS	MIN.	TYP.	MAX.	UNITS
Input Offset Voltage		$R_S \leq 50$ kΩ		0.7	5.0	mV
Input Offset Current				0.7	20.0	nA
Input Bias Current				25	100	nA
Input Resistance			1.0	2.0		MΩ
Input Capacitance				3.0		pF
Offset Voltage Adjustment Range				±25		mV
Large Signal Voltage Gain		$R_L \geq 2$ kΩ, V_{OUT} = ±10V	25,000	250,000		V/V
Output Resistance				100		Ω
Output Short-Circuit Current				±25		mA
Supply Current				1.9	2.8	mA
Power Consumption				60	85	mW
Transient Response (Voltage Follower, Gain of 1)	Risetime	V_{IN} = 20 mV, C_C = 30 pF, R_L = 2 kΩ, $C_L \leq 100$ pF		0.3		μs
	Overshoot			5.0		%
Slew Rate (Voltage Follower, Gain of 1)		$R_L \geq 2$ kΩ		0.5		V/μs
Transient Response (Voltage Follower, Gain of 10)	Risetime	V_{IN} = 20 mV, C_C = 3.5 pF, R_L = 2 kΩ, $C_L \leq 100$ pF		0.2		μs
	Overshoot			5.0		%
Slew Rate (Voltage Follower, Gain of 10)		$R_L \geq 2$ kΩ		5.5		V/μs
The following specifications apply for 0°C ≤ T_A ≤ +70°C						
Input Offset Voltage		$R_S \leq 50$ kΩ		0.8	5.0	mV
Average Input Offset Voltage Drift		$R_S \leq 50$ kΩ		4.0	30	μV/°C
Input Offset Current					40	nA
Average Input Offset Current Drift		25°C ≤ T_A ≤ +70°C		0.01	0.3	nA/°C
		0°C ≤ T_A ≤ +25°C		0.02	0.6	nA/°C
Input Bias Current					200	nA
Input Voltage Range			±12	±13		V
Common Mode Rejection Ratio		$R_S \leq 50$ kΩ	70	95		dB
Supply Voltage Rejection Ratio		$R_S \leq 50$ kΩ		15	150	μV/V
Large Signal Voltage Gain		$R_L \geq 2$ kΩ, V_{OUT} = ±10 V	15,000			V/V
Output Voltage Swing		$R_L \geq 10$ kΩ	±12	±14		V
		$R_L \geq 2$ kΩ	±10	±13		V
Power Consumption				60	100	mW

NOTES

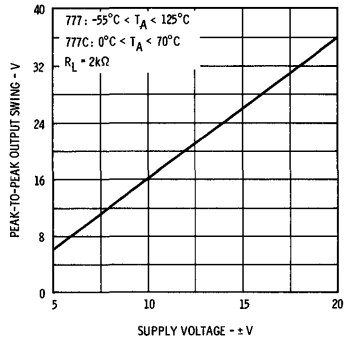
1. Rating applies to ambient temperatures up to 70°C. Above 70°C ambient derate linearly at 6.3 mW/°C for Metal Can, 8.3 mW/°C for the DIP 5.6 mW/°C for the Mini DIP and 7.1 mW/°C for the Flatpak.
2. For supply voltages less than ±15 V, the absolute maximum input voltage is equal to the supply voltage.
3. Short circuit may be to ground or either supply. Rating applies to +125°C case temperature or +75°C ambient temperature.

TYPICAL PERFORMANCE CURVES FOR 777 AND 777C

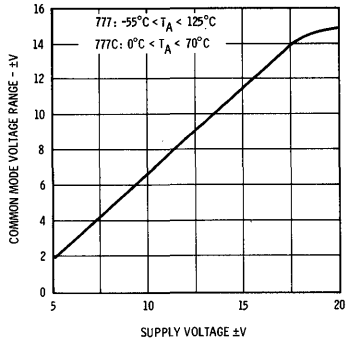
OPEN LOOP VOLTAGE GAIN AS A FUNCTION OF SUPPLY VOLTAGE



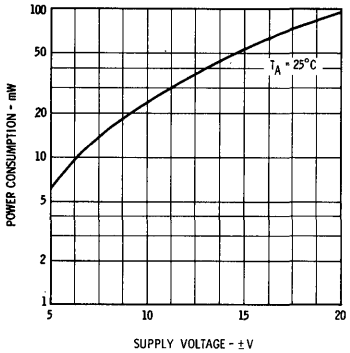
OUTPUT VOLTAGE SWING AS A FUNCTION OF SUPPLY VOLTAGE



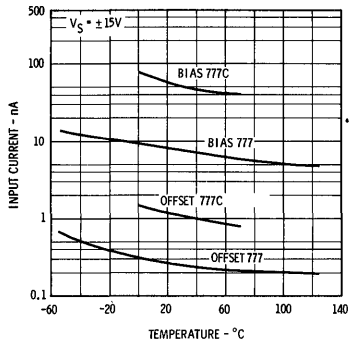
INPUT COMMON MODE VOLTAGE RANGE AS A FUNCTION OF SUPPLY VOLTAGE



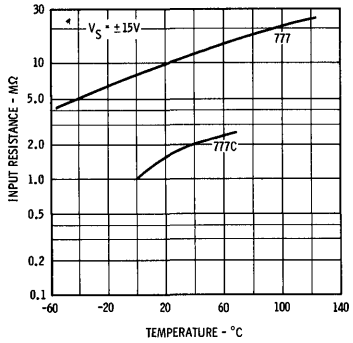
POWER CONSUMPTION AS A FUNCTION OF SUPPLY VOLTAGE



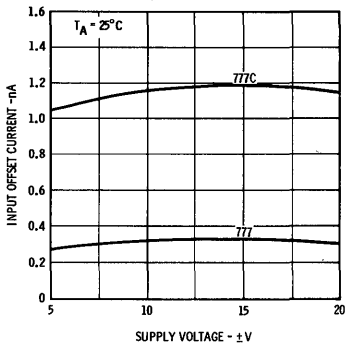
INPUT CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



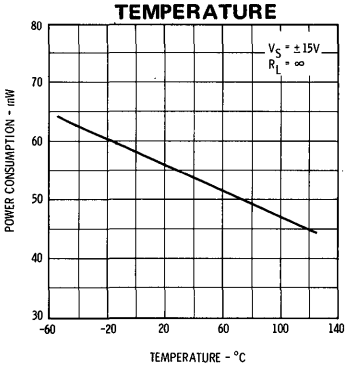
INPUT RESISTANCE AS A FUNCTION OF AMBIENT TEMPERATURE



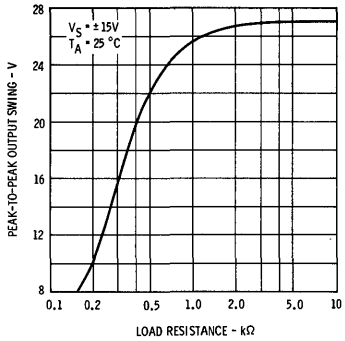
INPUT OFFSET CURRENT AS A FUNCTION OF SUPPLY VOLTAGE



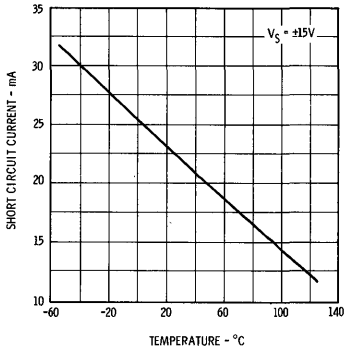
POWER CONSUMPTION AS A FUNCTION OF AMBIENT TEMPERATURE



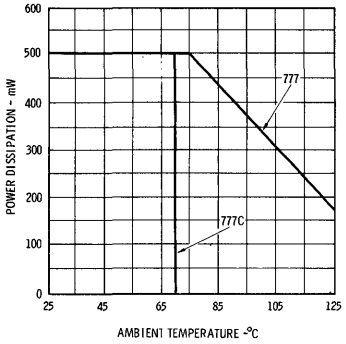
OUTPUT VOLTAGE SWING AS A FUNCTION OF LOAD RESISTANCE



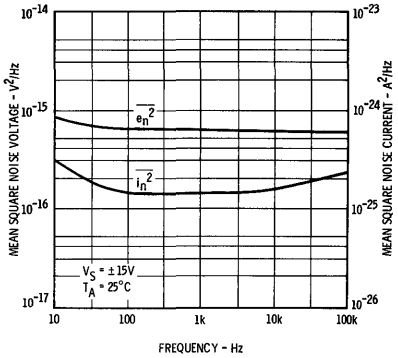
OUTPUT SHORT-CIRCUIT CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



ABSOLUTE MAXIMUM POWER DISSIPATION AS A FUNCTION OF AMBIENT TEMPERATURE

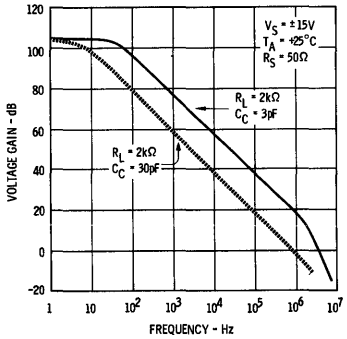


INPUT NOISE VOLTAGE AND CURRENT AS A FUNCTION OF FREQUENCY

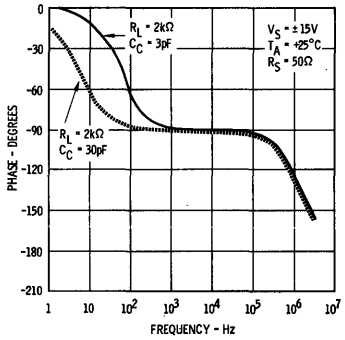


TYPICAL PERFORMANCE CURVES FOR 777 AND 777C

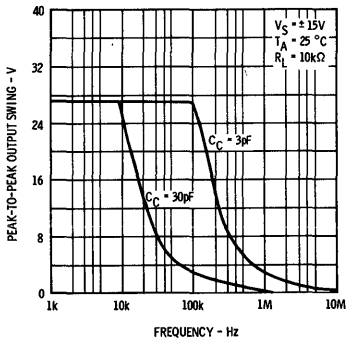
OPEN LOOP VOLTAGE GAIN AS A FUNCTION OF FREQUENCY



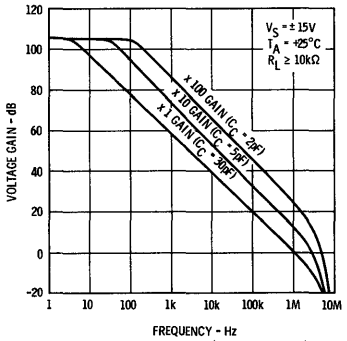
OPEN LOOP PHASE RESPONSE AS A FUNCTION OF FREQUENCY



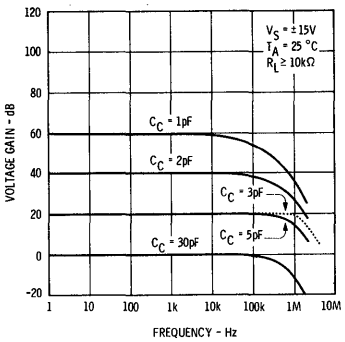
OUTPUT VOLTAGE SWING AS A FUNCTION OF FREQUENCY



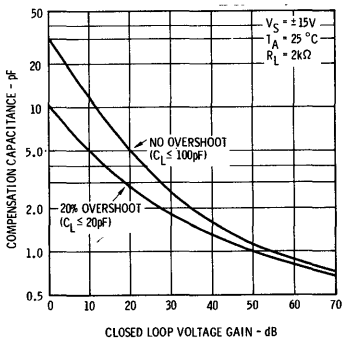
OPEN LOOP VOLTAGE GAIN AS A FUNCTION OF FREQUENCY FOR VARIOUS GAIN/COMPENSATION OPTIONS



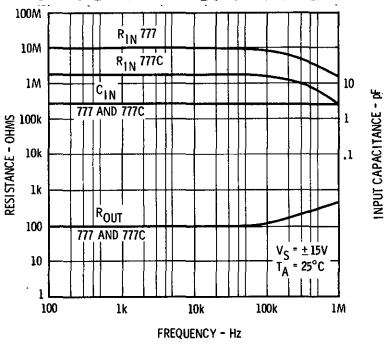
FREQUENCY RESPONSE FOR VARIOUS CLOSED-LOOP GAINS



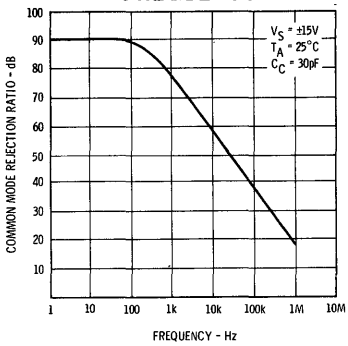
COMPENSATION CAPACITANCE AS A FUNCTION OF CLOSED LOOP VOLTAGE GAIN



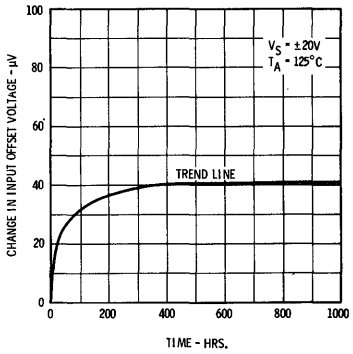
INPUT RESISTANCE, OUTPUT RESISTANCE, AND INPUT CAPACITANCE AS A FUNCTION OF FREQUENCY



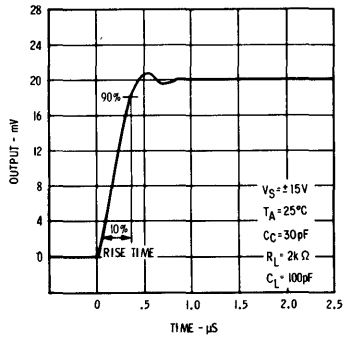
COMMON MODE REJECTION RATIO AS A FUNCTION OF FREQUENCY



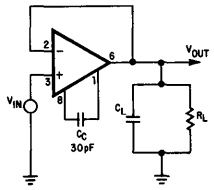
INPUT OFFSET VOLTAGE DRIFT AS A FUNCTION OF TIME



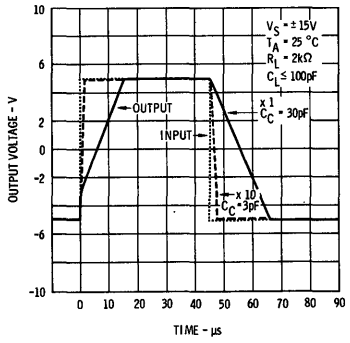
VOLTAGE FOLLOWER TRANSIENT RESPONSE (GAIN OF 1)



TRANSIENT RESPONSE TEST CIRCUIT

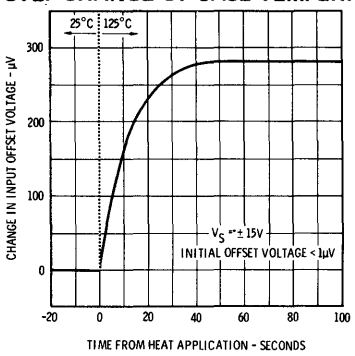


VOLTAGE FOLLOWER LARGE SIGNAL PULSE RESPONSE

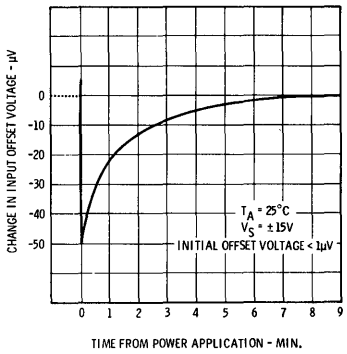


TYPICAL PERFORMANCE CURVES FOR 777 AND 777C

THERMAL RESPONSE OF INPUT OFFSET VOLTAGE TO STEP CHANGE OF CASE TEMPERATURE

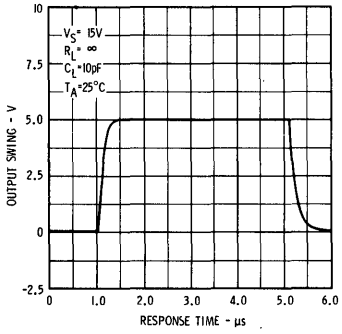


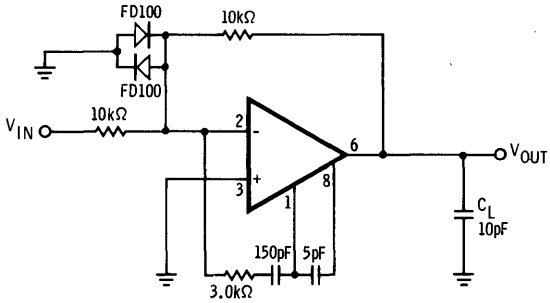
STABILIZATION TIME OF INPUT OFFSET VOLTAGE FROM POWER TURN-ON



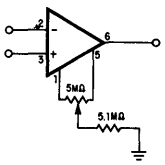
FEED-FORWARD COMPENSATION

LARGE SIGNAL FEEDFORWARD TRANSIENT RESPONSE

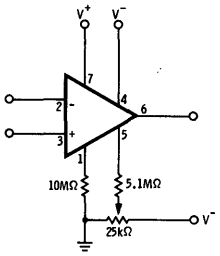




VOLTAGE OFFSET NULL CIRCUIT

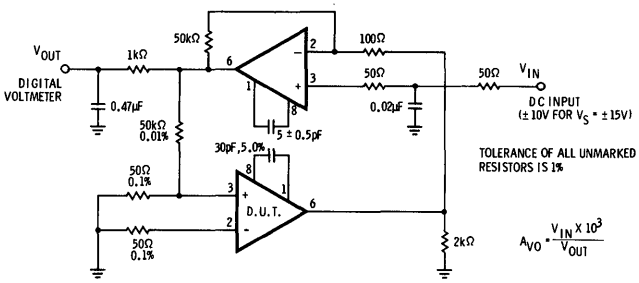


SUGGESTED



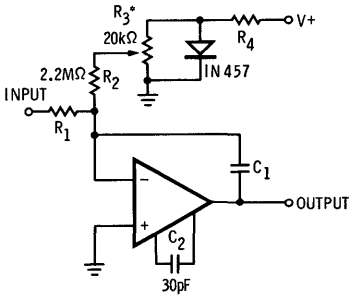
ALTERNATE

GAIN TEST CIRCUIT



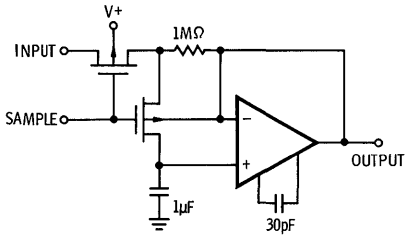
TYPICAL APPLICATIONS

BIAS COMPENSATED LONG TIME INTEGRATOR

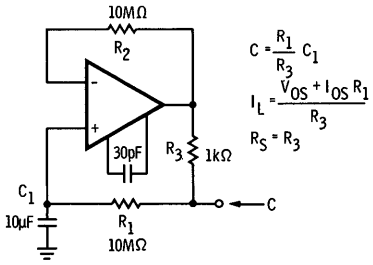


*Adjust R_3 for minimum integrator drift

SAMPLE AND HOLD



CAPACITANCE MULTIPLIER

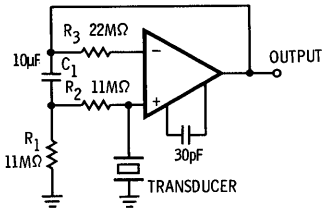


$$C = \frac{R_1}{R_3} C_1$$

$$I_L = \frac{V_{OS} + I_{OS} R_1}{R_3}$$

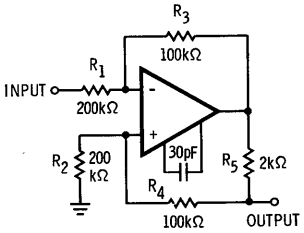
$$R_S = R_3$$

AMPLIFIER FOR CAPACITANCE TRANSDUCERS



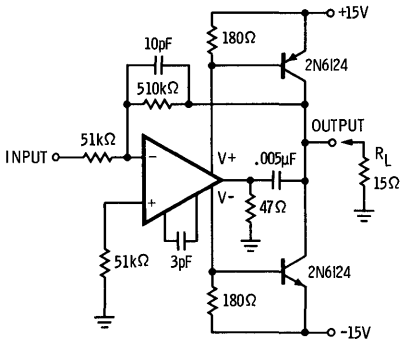
Low Frequency Cutoff $R_1 \times C_1$

BILATERAL CURRENT SOURCE

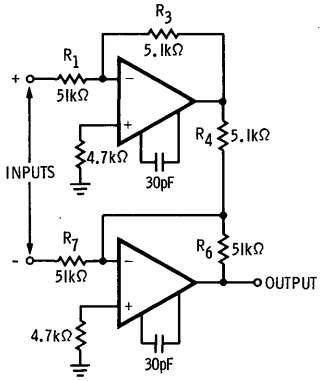


$$I_{OUT} = \frac{R_3 V_{IN}}{R_1 R_5} \; ; R_1 = R_2; R_3 = R_4 + R_5$$

HIGH SLEW RATE POWER AMPLIFIER



± 100 V COMMON MODE RANGE INSTRUMENTATION AMPLIFIER



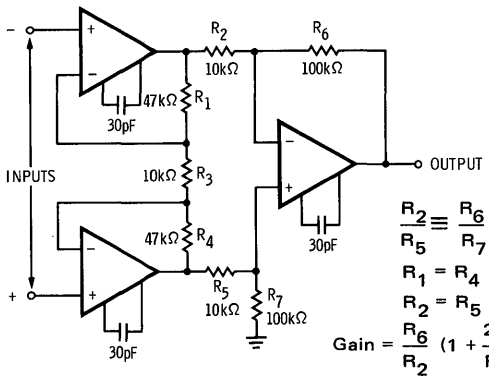
$$\frac{R_1}{R_7} \equiv \frac{R_3}{R_4} \text{ for best CMRR}$$

$R_3 = R_4$

$R_1 = R_6 = 10R_3$

$$\text{Gain} = \frac{R_7}{R_6}$$

INSTRUMENTATION AMPLIFIER WITH HIGH COMMON MODE REJECTION



$$\frac{R_2}{R_5} \equiv \frac{R_6}{R_7} \text{ for best CMRR}$$

$R_1 = R_4$

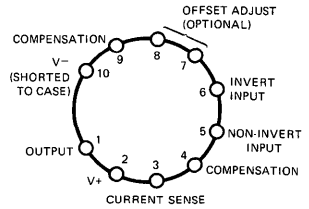
$R_2 = R_5$

$$\text{Gain} = \frac{R_6}{R_2}\left(1 + \frac{2R_1}{R_3}\right)$$

μA791
POWER OPERATIONAL AMPLIFIER
FAIRCHILD LINEAR INTEGRATED CIRCUIT

GENERAL DESCRIPTION — The μA791 is a high performance Monolithic Operational Amplifier constructed using the Fairchild Planar* Epitaxial process with input characteristics similar to the μA741 operational amplifier and 1 amp available output current. It is intended for use in a wide variety of applications including audio amplifiers, servo amplifiers, and power supplies. The high gain and high output power capability provide superior performance wherever an operational amplifier/power booster combination is required. The μA791 is thermal and short circuit protected.

CONNECTION DIAGRAM
10-LEAD METAL CAN
(TOP VIEW)
PACKAGE OUTLINE 5H

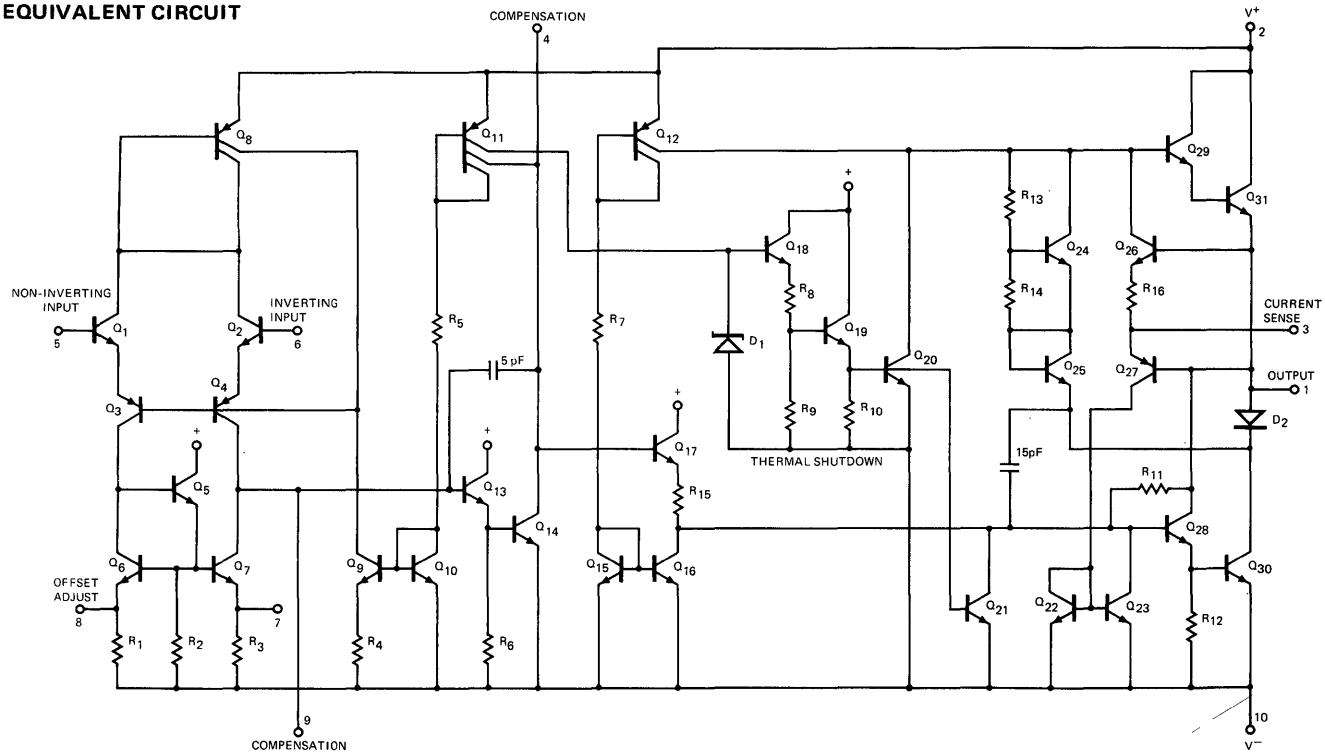


ORDER INFORMATION

TYPE	PART NO.
791	791KM
791C	791KC

- **CURRENT OUTPUT TO 1 AMP**
- **SHORT CIRCUIT PROTECTION**
- **OFFSET VOLTAGE NULL CAPABILITY**
- **NO LATCH-UP**
- **LARGE COMMON-MODE AND DIFFERENTIAL MODE RANGES**
- **THERMAL OVERLOAD PROTECTION**

EQUIVALENT CIRCUIT



*Planar is a patented Fairchild process.

ABSOLUTE MAXIMUM RATINGS

Supply Voltage (Note 3)	
Military (791)	±22 V
Commercial (791C)	±18 V
Peak Output Current (Note 3)	1.25 A
Continuous Internal Power Dissipation (Total Package) (Note 1)	15 W
Continuous Internal Power Dissipation (Per Output Transistor) (Note 1)	10 W
Peak Internal Power Dissipation (Per Output Transistor for t ⩽ 5 seconds)	15 W
Differential Input Voltage	±30 V
Input Voltage (Note 2)	±15 V
Voltages between offset Null and V_	± 0.5 V
Operating Temperature Range	
Military (791)	−55°C to +125°C
Commercial (791C)	0°C to +70°C
Storage Temperature Range	−65°C to +150°C
Lead Temperature (Soldering, 60 seconds max.)	+280°C

NOTES

1. Rating applies for 25°C case temperature, maximum power dissipation and safe area limitations must be observed for case temperatures above 25°C.
2. For supply voltages less than ±15 V, the absolute maximum input voltage is equal to the supply voltage.
3. Under short circuit conditions, the safe operating area and dc power dissipation limitations must be observed.

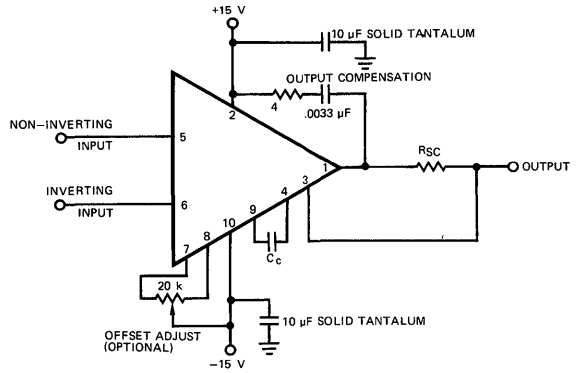
3

±15 VOLT OPERATION FOR 791

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise specified)

PARAMETERS	CONDITIONS	MIN.	TYP.	MAX.	UNITS
Input Offset Voltage	R_S ⩽ 10 kΩ		1.0	5.0	mV
Input Offset Current			20	200	nA
Input Bias Current			80	500	nA
Input Resistance		0.3	2.0		MΩ
Offset Voltage Adjustment Range			±15		mV
Input Voltage Range		±12	±13		V
Common Mode Rejection Ratio		70			dB
Power Supply Rejection Ratio				150	μV/V
Large Signal Voltage Gain	R_L = 1 kΩ	50,000			V/V
	R_L = 11Ω	50,000			V/V
Output Voltage Swing	R_{SC} = 0, R_L = 1 kΩ	±12	±14		V
	R_{SC} = 0, R_L = 11Ω	±12	±12.2		V
Output Short Circuit Current	R_{SC} = 0.7Ω		1000		mA
	R_{SC} = 1.5Ω		500		mA
Supply Current (Zero Signal)				25	mA
The following specifications apply for −55°C ⩽ T_C ⩽ +125°C					
Input Offset Voltage	R_S ⩽ 10 kΩ			6	mV
Input Offset Current				500	nA
Input Bias Current				1.5	μA
Common Mode Rejection Ratio		70			dB
Power Supply Rejection Ratio				150	μV/V
Large Signal Voltage Gain	R_L = 1 kΩ	25,000			V/V
	R_L = 11Ω	25,000			V/V
Output Voltage Swing	R_{SC} = 0, R_L = 1 kΩ	±11.5			V
	R_{SC} = 0, R_L = 11Ω	±11.5			V
Supply Current (Zero Signal)				30	mA

FREQUENCY COMPENSATION



GAIN	C_C
1	100 pF
10	5 pF
100	Not. Req.

R_{SC}	I_{SC}
0.6Ω	1.0 A
1.5Ω	500 mA
3.0Ω	250 mA

NOTE

1. Power supply decoupling capacitors and compensation networks must have short leads and must be located at the amplifier pins.

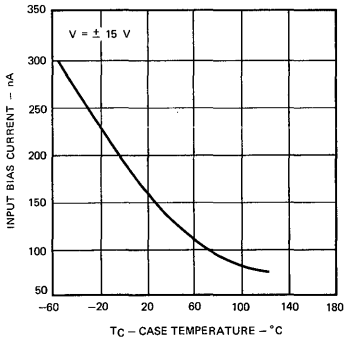
±15 VOLT OPERATION FOR 791C

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise specified)

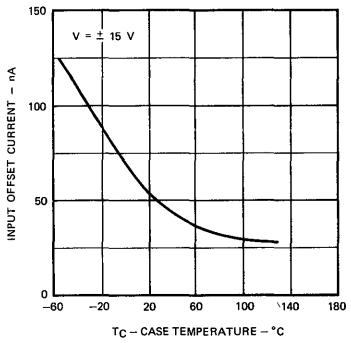
PARAMETERS	CONDITIONS	MIN.	TYP.	MAX.	UNITS
Input Offset Voltage	$R_S \leq 10$ kΩ		2.0	6.0	mV
Input Offset Current			20	200	nA
Input Bias Current			80	500	nA
Input Resistance		0.3	1.0		MΩ
Offset Voltage Adjustment Range			±15		mV
Input Voltage Range		±12	±13		V
Common Mode Rejection Ratio		70			dB
Power Supply Rejection Ratio				150	μV/V
Large Signal Voltage Gain	R_L = 1 kΩ	20k			V/V
	R_L = 11Ω	20k			V/V
Output Voltage Swing	R_{SC} = 0, R_L = 1 kΩ	±11.5	±14		V
	R_{SC} = 0, R_L = 11Ω	±11.5	±12.2		V
Output Short Circuit Current	R_{SC} = 0.7Ω		1000		mA
	R_{SC} = 1.5Ω		500		mA
Supply Current (Zero Signal)				25	mA
The following specifications apply for 0°C < T_C < 70°C					
Input Offset Voltage	$R_S \leq 10$ kΩ			7.5	mV
Input Offset Current				300	nA
Input Bias Current				800	nA
Common Mode Rejection Ratio		70			dB
Power Supply Rejection Ratio				150	μV/V
Large Signal Voltage Gain	R_L = 1 kΩ	15k			V/V
	R_L = 11Ω	15k			V/V
Output Voltage Swing	R_{SC} = 0, R_L = 1 kΩ	±11.0			V
	R_{SC} = 0, R_L = 11Ω	±11.0			V
Supply Current (Zero signal)				30	mA

TYPICAL PERFORMANCE CURVES FOR 791 AND 791C

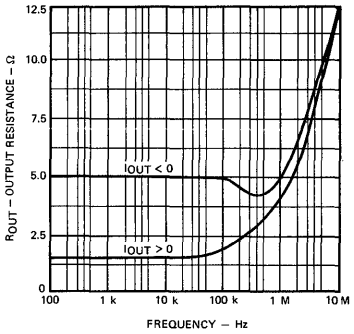
TYPICAL INPUT BIAS CURRENT AS A FUNCTION OF CASE TEMPERATURE



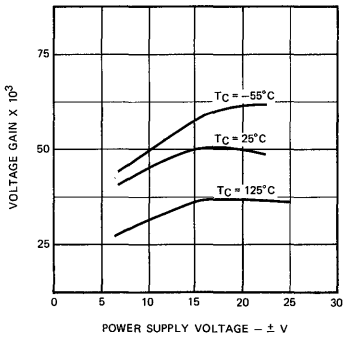
TYPICAL INPUT OFFSET CURRENT AS A FUNCTION OF CASE TEMPERATURE



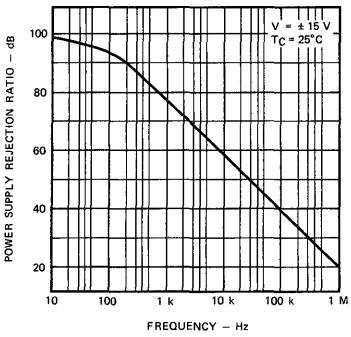
OUTPUT RESISTANCE AS A FUNCTION OF FREQUENCY (OPEN LOOP)



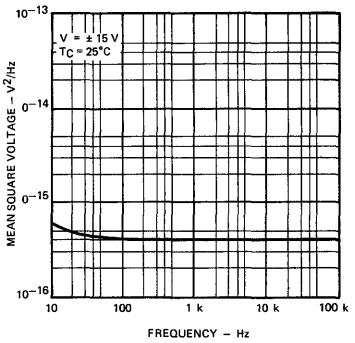
TYPICAL PERFORMANCE CURVE VOLTAGE GAIN AS A FUNCTION OF POWER SUPPLY VOLTAGE



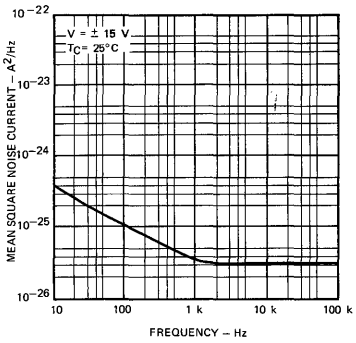
TYPICAL POWER SUPPLY REJECTION RATIO AS A FUNCTION OF FREQUENCY (791)



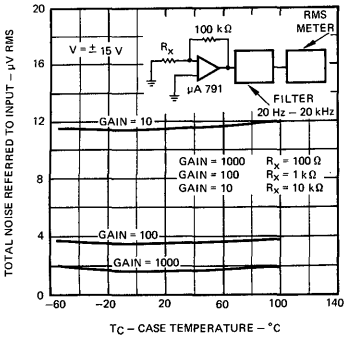
INPUT NOISE VOLTAGE AS A FUNCTION OF FREQUENCY



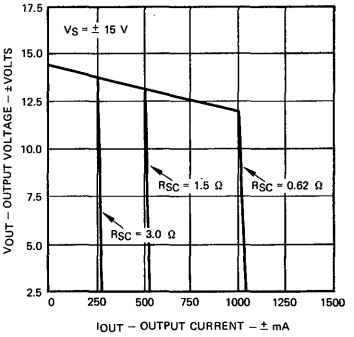
INPUT NOISE CURRENT AS A FUNCTION OF FREQUENCY



TOTAL NOISE (20 Hz–20 kHz) AS A FUNCTION OF CASE TEMPERATURE

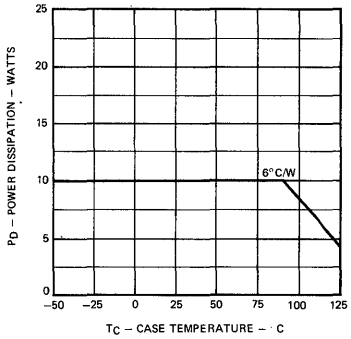


OUTPUT VOLTAGE SWING AS A FUNCTION OF OUTPUT CURRENT

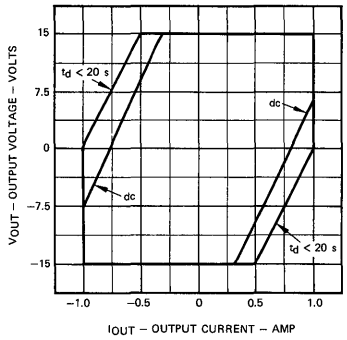


TYPICAL PERFORMANCE CURVES FOR 791 AND 791C (Cont'd)

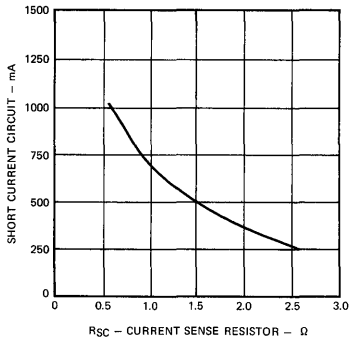
MAXIMUM POWER DISSIPATION PER OUTPUT TRANSISTOR AS A FUNCTION OF CASE TEMPERATURE



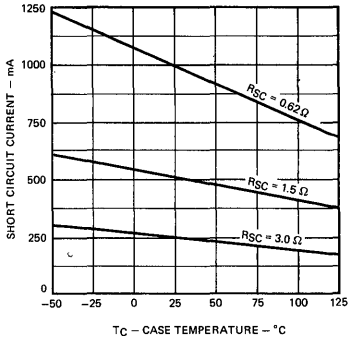
OUTPUT SAFE OPERATING AREA PER OUTPUT TRANSISTOR



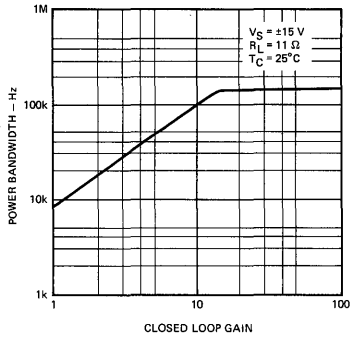
SHORT CIRCUIT CURRENT AS A FUNCTION OF CURRENT SENSE RESISTOR, R_{SC}



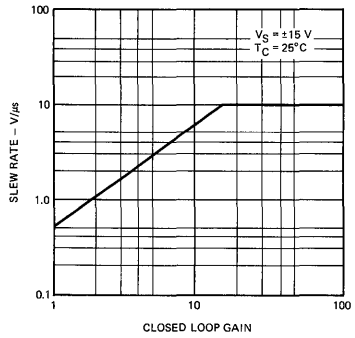
SHORT CIRCUIT CURRENT AS A FUNCTION OF CASE TEMPERATURE



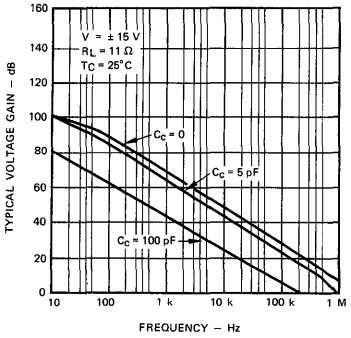
POWER BANDWIDTH AS A FUNCTION OF CLOSED LOOP GAIN



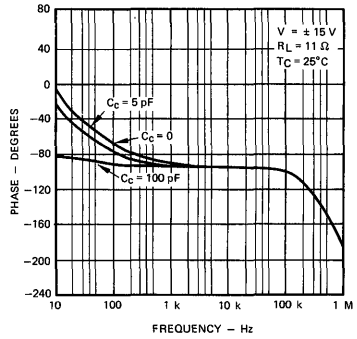
SLEW RATE AS A FUNCTION OF CLOSED LOOP GAIN



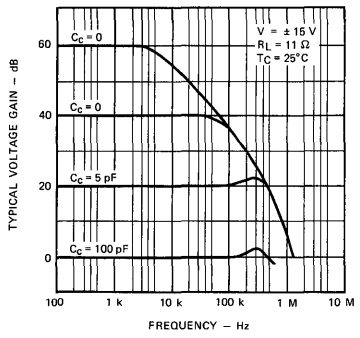
VOLTAGE GAIN AS A FUNCTION OF OPEN LOOP FREQUENCY RESPONSE



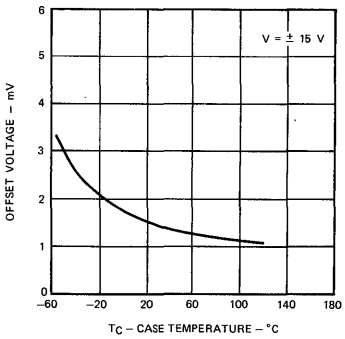
OPEN LOOP PHASE RESPONSE AS A FUNCTION OF FREQUENCY



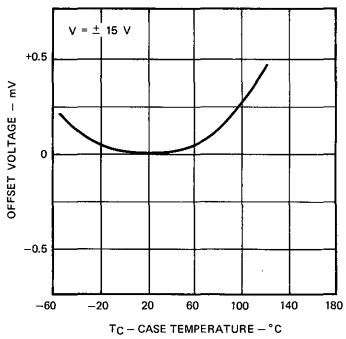
FREQUENCY RESPONSE FOR CLOSED LOOP GAINS



TYPICAL OFFSET VOLTAGE UN-NULLED AS A FUNCTION OF CASE TEMPERATURE

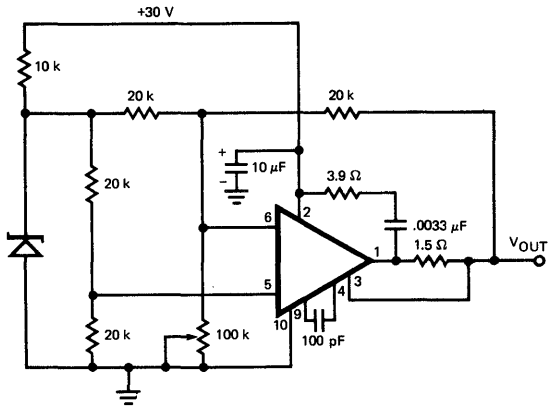


TYPICAL OFFSET VOLTAGE NULLED AS A FUNCTION OF CASE TEMPERATURE



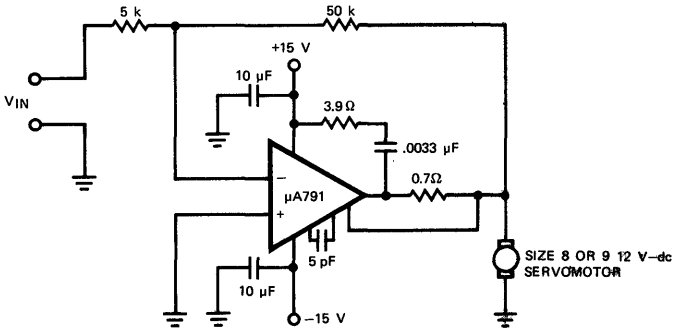
TYPICAL APPLICATIONS

POSITIVE VOLTAGE REGULATOR

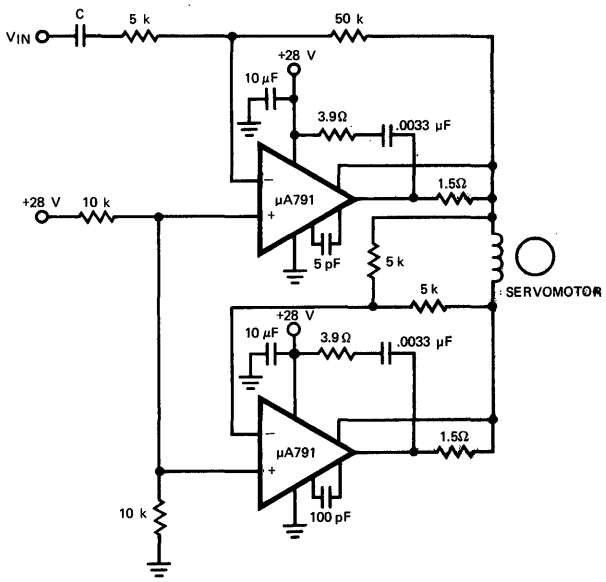


NOTES:
0 to 27 V regulator
500 mA output current

DC SERVO AMPLIFIER



AC SERVO AMPLIFIER
BRIDGE TYPE



101 • 201

GENERAL PURPOSE OPERATIONAL AMPLIFIERS

FAIRCHILD LINEAR INTEGRATED CIRCUITS

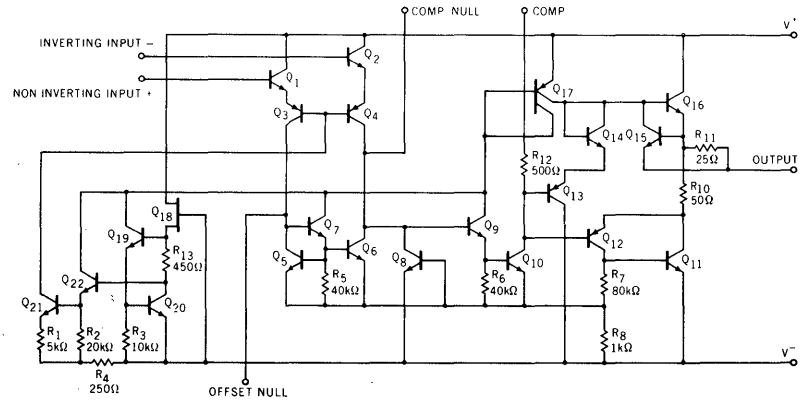
GENERAL DESCRIPTION — The 101 and 201 are General Purpose monolithic Operational Amplifiers constructed using the Fairchild Planar* epitaxial process. They are intended for a wide range of analog applications where tailoring of frequency characteristics is desirable. The 101 and 201 compensate easily with a single external component. High common mode voltage range and absence of "latch-up" make the 101 and 201 ideal for use as voltage followers. The high gain and wide range of operating voltages provide superior performance in integrator, summing amplifier, and general feedback applications. The 101 and 201 are short-circuit protected and have the same pin configuration as the popular μA741, μA748 and μA709.

- **SHORT-CIRCUIT PROTECTION**
- **OFFSET VOLTAGE NULL CAPABILITY**
- **LARGE COMMON-MODE AND DIFFERENTIAL VOLTAGE RANGES**
- **LOW POWER CONSUMPTION**
- **NO LATCH UP**

ABSOLUTE MAXIMUM RATINGS

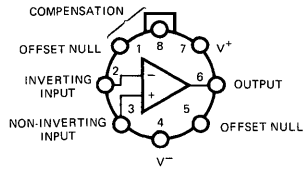
Supply Voltage	±22V
Internal Power Dissipation (Note 1)	
Metal Can	500mW
DIP	670mW
Differential Input Voltage	±30V
Input Voltage (Note 2)	±15V
Storage Temperature Range	
Metal Can, DIP	−65°C to +150°C
Operating Temperature Range	
Military (101)	−55°C to +125°C
Commercial (201)	0°C to +70°C
Lead Temperature (Soldering, 60 seconds)	300°C

EQUIVALENT CIRCUIT



CONNECTION DIAGRAMS

8-LEAD METAL CAN
(TOP VIEW)
PACKAGE OUTLINE 5B

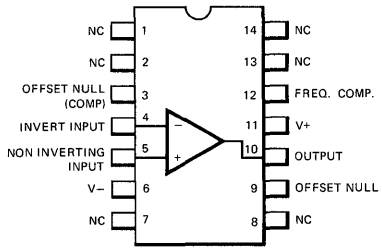


NOTE: Pin 4 connected to case.

ORDER INFORMATION

TYPE	PART NO.
101	LM101H
201	LM201H

14-LEAD DIP
(TOP VIEW)
PACKAGE OUTLINE 6A



ORDER INFORMATION

TYPE	PART NO.
101	LM101D
201	LM201D

Notes on following pages

*Planar is a patented Fairchild process.

ELECTRICAL CHARACTERISTICS FOR 101 ($\pm5.0V \leq V_S \leq \pm20V$, $T_A = 25°C$, $C_1 = 30pF$ unless otherwise specified)

PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNITS
Input Offset Voltage	$R_S \leq 10k\Omega$		1.0	5.0	mV
Input Offset Current			40	200	nA
Input Bias Current			120	500	nA
Input Resistance		300	800		kΩ
Supply Current	$V_S = \pm20V$		1.8	3.0	mA
Large Signal Voltage Gain	$V_S = \pm15V$ $V_{OUT} = \pm10V$, $R_L \geq 2k\Omega$	50	160		V/mV
The following specifications apply for $-55°C \leq T_A \leq +125°C$:					
Input Offset Voltage	$R_S \leq 10k\Omega$			6.0	mV
Average Temperature Coefficient of Input Offset Voltage	$R_S \leq 50\Omega$		3.0		μV/°C
	$R_S \leq 10k\Omega$		6.0		μV/°C
Input Offset Current	$T_A = +125°C$		10	200	nA
	$T_A = -55°C$		100	500	nA
Average Temperature Coefficient of Input Offset Current	$+25°C \leq T_A \leq +125°C$ $-55°C \leq T_A \leq +25°C$		0.01 0.02	0.1 0.2	nA/°C nA/°C
Input Bias Current	$T_A = -55°C$		0.28	1.5	μA
Supply Current	$T_A = +125°C$, $V_S = \pm20V$		1.2	2.5	mA
Large Signal Voltage Gain	$V_S = \pm15V$, $V_{OUT} = \pm10V$ $R_L \geq 2k\Omega$	25			V/mV
Output Voltage Swing	$V_S = \pm15V$, $R_L = 10k\Omega$	±12	±14		V
	$V_S = \pm15V$, $R_L = 2k\Omega$	±10	±13		V
Input Voltage Range	$V_S = \pm15V$	±12			V
Common Mode Rejection Ratio	$R_S \leq 10k\Omega$	70	90		dB
Supply Voltage Rejection Ratio	$R_S \leq 10k\Omega$	70	90		dB

NOTES

1. Rating applies to ambient temperature up to 70°C. Above 70°C ambient derate linearly at 6.3mW/°C for the Metal Can and 8.3mW/°C for the DIP.
2. For supply voltages less than ±15V, the absolute maximum input voltage is equal to the supply voltage.
3. Short circuit may be to ground or either supply. The 101 ratings apply to +125°C case temperature or +75°C ambient temperature. The 201 ratings apply to case temperatures up to +70°C.

3

ELECTRICAL CHARACTERISTICS FOR 201 ($\pm5.0V \leq V_S \leq \pm15V$, $T_A = 25°C$, $C_1 = 30pF$ unless otherwise specified)

PARAMETER	CONDITIONS		MIN.	TYP.	MAX.	UNITS
Input Offset Voltage	$R_S \leq 10k\Omega$			2.0	7.5	mV
Input Offset Current				100	500	nA
Input Bias Current				0.25	1.5	μA
Input Resistance			100	400		kΩ
Supply Current	$V_S = \pm15V$			1.8	3.0	mA
Large Signal Voltage Gain	$V_S = \pm15V$ $V_{OUT} = \pm10V$, $R_L \geq 2k\Omega$		20	150		V/mV
The following specifications apply for $0°C \leq T_A \leq 70°C$:						
Input Offset Voltage	$R_S \leq 10k\Omega$				10	mV
Average Temperature Coefficient of Input Offset Voltage	$R_S \leq 50\Omega$			6.0		μV/°C
	$R_S \leq 10k\Omega$			10.0		μV/°C
Input Offset Current	$T_A = 70°C$			50	400	nA
	$T_A = 0°C$			150	750	nA
Average Temperature Coefficient of Input Offset Current	$25°C \leq T_A \leq 70°C$ $0°C \leq T_A \leq 25°C$			0.01 0.02	0.3 0.6	nA/°C nA/°C
Input Bias Current	$T_A = 0°C$			0.32	2.0	μA
Large Signal Voltage Gain	$V_S = \pm15V$, $V_{OUT} = \pm10V$ $R_L \geq 2k\Omega$		15			V/mV
Output Voltage Swing	$V_S = \pm15V$	$R_L = 10k\Omega$	±12	±14		V
		$R_L = 2k\Omega$	±10	±13		V
Input Voltage Range	$V_S = \pm15V$		±12			V
Common Mode Rejection Ratio	$R_S \leq 10k\Omega$		65	90		dB
Supply Voltage Rejection Ratio	$R_S \leq 10k\Omega$		70	90		dB

101A • 201A • 301A

GENERAL PURPOSE OPERATIONAL AMPLIFIERS

FAIRCHILD LINEAR INTEGRATED CIRCUITS

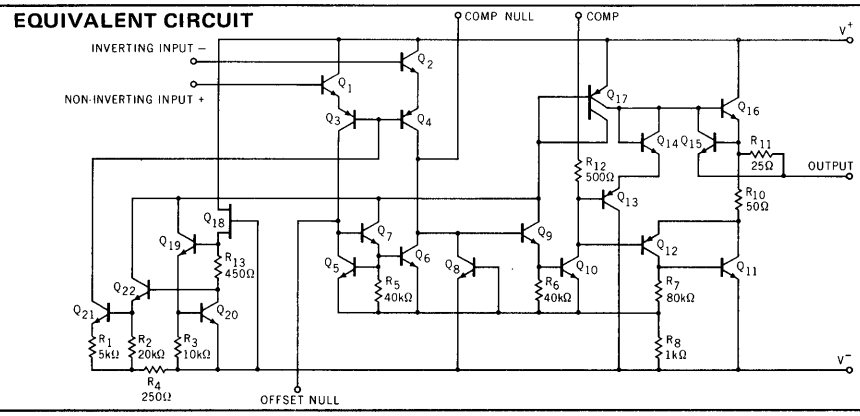
GENERAL DESCRIPTION – The 101A, 201A and 301A are General Purpose monolithic Operational Amplifiers constructed using the Fairchild Planar* epitaxial process. These integrated circuits are intended for applications requiring low input offset voltage or low input offset current. The accuracy of long interval integrators, timers and sample and hold circuits is improved due to the low drift and low bias currents of the 101A, 201A, or 301A. Frequency response may be matched to the individual circuit need with one external capacitor. The absence of "latch-up" coupled with internal short circuit protection make the 101A, 201A and 301A virtually foolproof. The 101A, 201A and 301A are pin compatible with the popular μA709, μA741, μA748 and μA777.

- **LOW OFFSET CURRENT AND VOLTAGE**
- **LOW OFFSET CURRENT DRIFT**
- **LOW BIAS CURRENT**
- **SHORT CIRCUIT PROTECTED**
- **LOW POWER CONSUMPTION**

ABSOLUTE MAXIMUM RATINGS

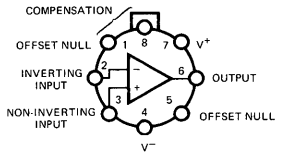
Supply Voltage	
Military and Instrument (101A and 201A)	±22V
Commercial (301A)	±18V
Internal Power Dissipation (Note 1)	
Metal Can	500mW
DIP	670mW
Flatpak	570mW
Mini DIP	310mW
Differential Input Voltage	±30V
Input Voltage (Note 2)	±15V
Storage Temperature Range	
Metal Can, DIP, and Flatpak	−65°C to +150°C
Mini DIP	−55°C to +125°C
Operating Temperature Range	
Military (101A)	−55°C to +125°C
Instrument (201A)	−25°C to +85°C
Commercial (301A)	0°C to +70°C
Lead Temperature (Soldering)	
Metal Can, DIP and Flatpak (60 seconds)	300°C
Mini DIP (10 seconds)	260°C
Output Short Circuit Duration (Note 3)	Indefinite

EQUIVALENT CIRCUIT



CONNECTION DIAGRAMS

8-LEAD METAL CAN
(TOP VIEW)
PACKAGE OUTLINE 5B

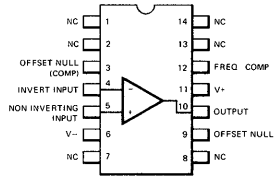


NOTE: PIN CONNECTED TO CASE

ORDER INFORMATION

TYPE	PART NO.
101A	LM101AH
201A	LM201AH
301A	LM301AH

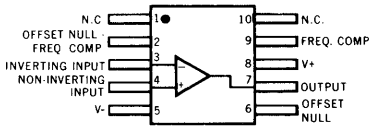
14-LEAD DIP
(TOP VIEW)
PACKAGE OUTLINE 6A



ORDER INFORMATION

TYPE	PART NO.
101A	LM101AD
201A	LM201AD
301A	LM301AD

10-LEAD FLATPACK
(TOP VIEW)
PACKAGE OUTLINE 3F

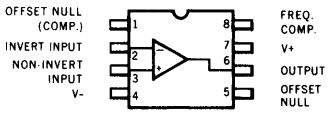


Available on special request

ORDER INFORMATION

TYPE	PART NO.
101A	LM101AF
201A	LM201AF

8-LEAD MINIDIP
(TOP VIEW)
PACKAGE OUTLINE 9T



ORDER INFORMATION

TYPE	PART NO.
301A	LM301AN

Notes on page 3

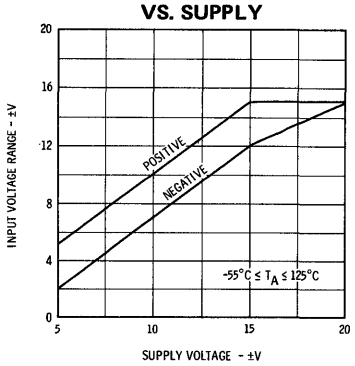
*Planar is a patented Fairchild process.

ELECTRICAL CHARACTERISTICS FOR 101A and 201A ($\pm5.0V \leq V_S \leq \pm20V$, $T_A = 25°C$, $C_1 = 30pF$ unless otherwise specified)

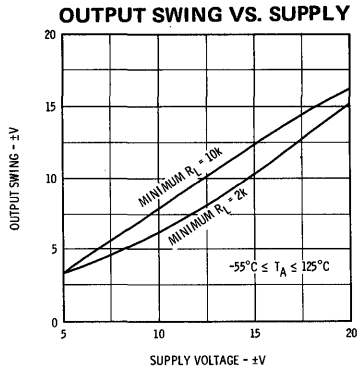
PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Input Offset Voltage	$R_S \leq 10k\Omega$		0.7	2.0	mV
Input Offset Current			1.5	10	nA
Input Bias Current			30	75	nA
Input Resistance		1.5	4.0		MΩ
Supply Current	$V_S = \pm20V$		1.8	3.0	mA
Large Signal Voltage Gain	$V_S = \pm15V$, $V_{OUT} = \pm10V$, $R_L \geq 2k\Omega$	50	160		V/mV
The following specifications apply for $-55°C \leq T_A \leq +125°C$: (Note 4)					
Input Offset Voltage	$R_S \leq 10k\Omega$			3.0	mV
Average Temperature Coefficient of Input Offset Voltage			3.0	15	μV/°C
Input Offset Current				20	nA
Average Temperature Coefficient of Input Offset Current	$+25°C \leq T_A \leq +125°C$		0.01	0.1	nA/°C
	$-55°C \leq T_A \leq +25°C$		0.02	0.2	nA/°C
Input Bias Current				100	nA
Supply Current	$T_A = +125°C$, $V_S = \pm20V$		1.2	2.5	mA
Large Signal Voltage Gain	$V_S = \pm15V$, $V_{OUT} = \pm10V$, $R_L \geq 2k\Omega$	25			V/mV
Output Voltage Swing	$V_S = \pm15V$, $R_L = 10k\Omega$	±12	±14		V
	$V_S = \pm15V$, $R_L = 2k\Omega$	±10	±13		V
Input Voltage Range	$V_S = \pm20V$	±15			V
Common Mode Rejection Ratio	$R_S \leq 10k\Omega$	80	96		dB
Supply Voltage Rejection Ratio	$R_S \leq 10k\Omega$	80	96		dB

GUARANTEED PERFORMANCE CURVES FOR 101A AND 201A

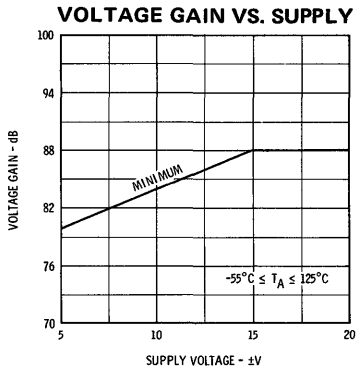
INPUT VOLTAGE RANGE VS. SUPPLY



OUTPUT SWING VS. SUPPLY



VOLTAGE GAIN VS. SUPPLY



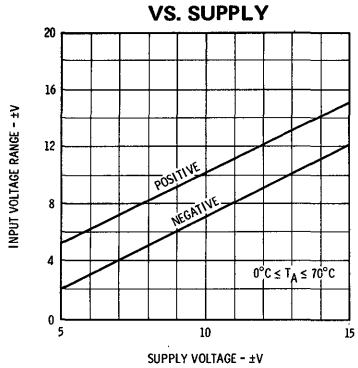
ELECTRICAL CHARACTERISTICS FOR 301A ($\pm 5.0V \leqslant V_S \leqslant \pm 15V$, $T_A = 25°C$, $C_1 = 30pF$ unless otherwise specified)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Input Offset Voltage	$R_S \leqslant 10k\Omega$		2.0	7.5	mV
Input Offset Current			3	50	nA
Input Bias Current			70	250	nA
Input Resistance		0.5	2		MΩ
Supply Current	$V_S = \pm 15V$		1.8	3.0	mA
Large Signal Voltage Gain	$V_S = \pm 15V$ $V_{OUT} = \pm 10V$, $R_L \geqslant 2k\Omega$	25	160		V/mV
The following specifications apply for $0°C \leqslant T_A \leqslant 70°C$:					
Input Offset Voltage	$R_S \leqslant 10k\Omega$			10	mV
Average Temperature Coefficient of Input Offset Voltage			6.0	30	μV/°C
Input Offset Current				70	nA
Average Temperature Coefficient of Input Offset Current	$25°C \leqslant T_A \leqslant 70°C$		0.01	0.3	nA/°C
	$0°C \leqslant T_A \leqslant 25°C$		0.02	0.6	nA/°C
Input Bias Current				300	nA
Large Signal Voltage Gain	$V_S = \pm 15V$, $V_{OUT} = \pm 10V$ $R_L \geqslant 2k\Omega$	15			V/mV
Output Voltage Swing	$V_S = \pm 15V$, $R_L = 10k\Omega$	±12	±14		V
	$V_S = \pm 15V$, $R_L = 2k\Omega$	±10	±13		V
Input Voltage Range	$V_S = \pm 15V$	±12			V
Common Mode Rejection Ratio	$R_S \leqslant 10k\Omega$	70	90		dB
Supply Voltage Rejection Ratio	$R_S \leqslant 10k\Omega$	70	90		dB

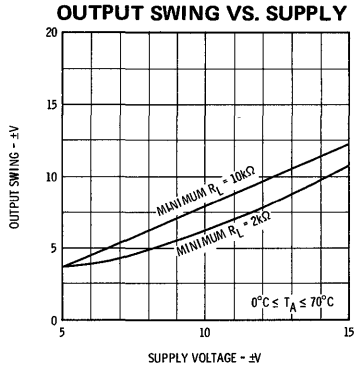
NOTES:
(1) Rating applies to ambient temperature up to 70°C. Above 70°C ambient derate linearly at 6.3 mW/°C for the Metal Can, 8.3 mW/°C for the DIP, 5.6 mW/°C for the Mini DIP and 7.1 mW/°C for the Flatpak.
(2) For supply voltages less than ±15 V, the absolute maximum input voltage is equal to the supply voltage.
(3) Short circuit may be to ground or either supply. 101A and 201A ratings apply to +125°C case temperature or +75°C ambient temperature. 301A ratings apply for case temperatures to 70°C.
(4) All 201A specifications apply for $-25°C \leqslant T_A \leqslant +85°C$ unless otherwise specified.

GUARANTEED PERFORMANCE CURVES FOR 301A

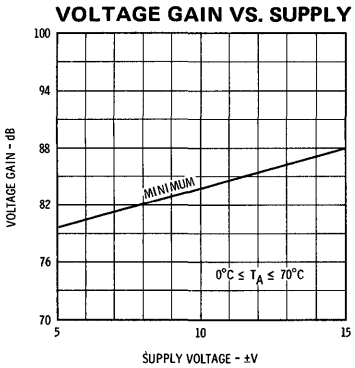
INPUT VOLTAGE RANGE VS. SUPPLY



OUTPUT SWING VS. SUPPLY

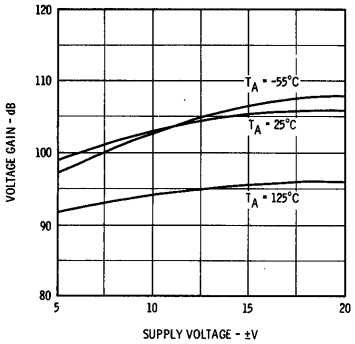


VOLTAGE GAIN VS. SUPPLY

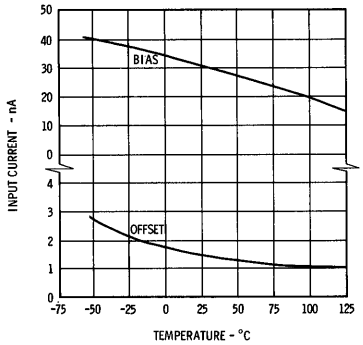


TYPICAL PERFORMANCE CURVES FOR 101A, 201A AND 301A (Unless Otherwise Specified)

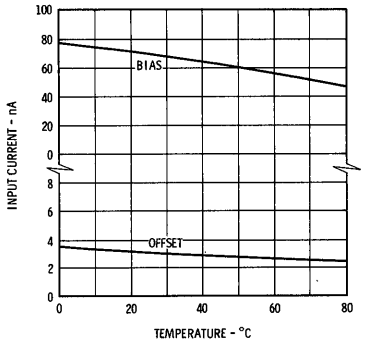
VOLTAGE GAIN



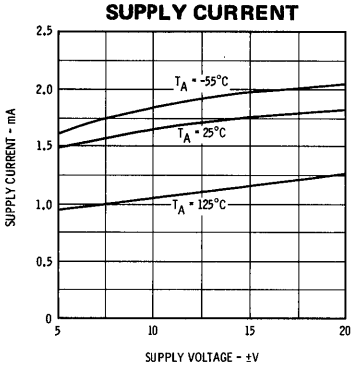
INPUT CURRENT 101A AND 201A



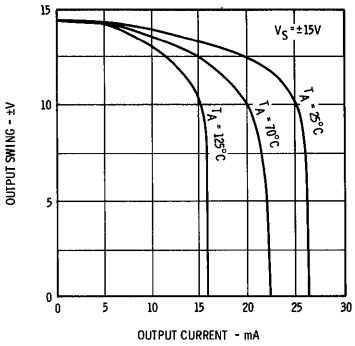
INPUT CURRENT 301A



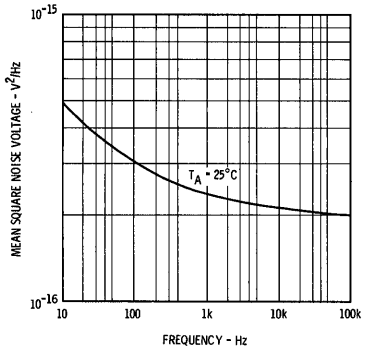
SUPPLY CURRENT



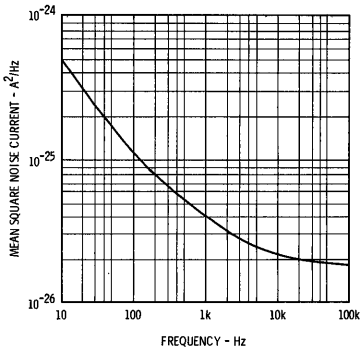
CURRENT LIMITING



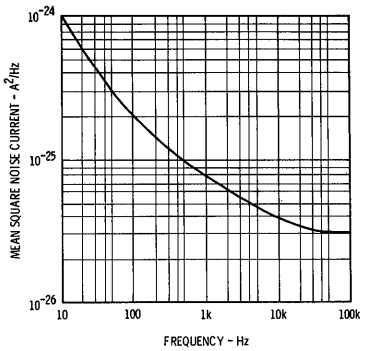
INPUT NOISE VOLTAGE



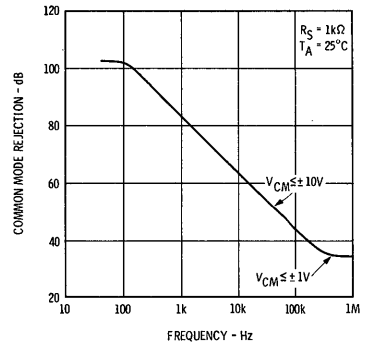
INPUT NOISE CURRENT 101A AND 201A



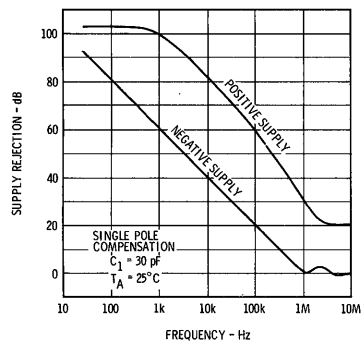
INPUT NOISE CURRENT 301A



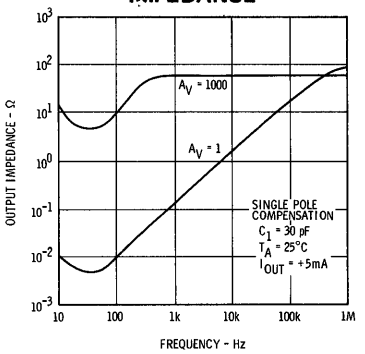
COMMON MODE REJECTION



POWER SUPPLY REJECTION

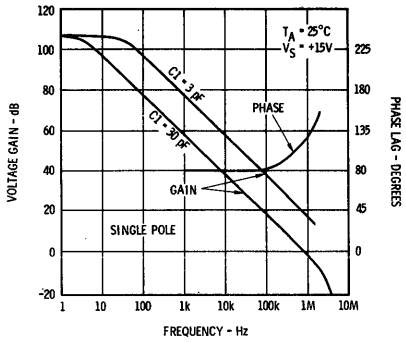


CLOSED LOOP OUTPUT IMPEDANCE

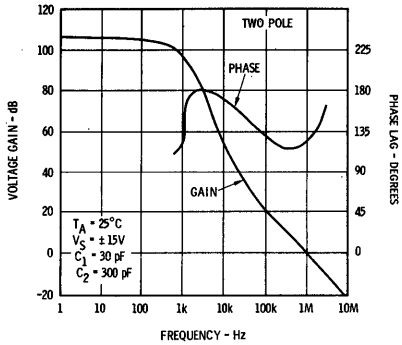


TYPICAL PERFORMANCE CURVES FOR 101A, 201A AND 301A

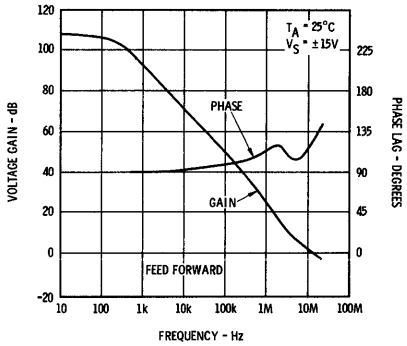
OPEN LOOP FREQUENCY RESPONSE



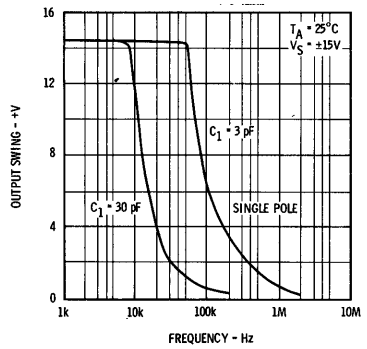
OPEN LOOP FREQUENCY RESPONSE



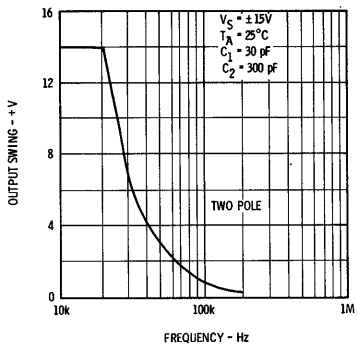
OPEN LOOP FREQUENCY RESPONSE



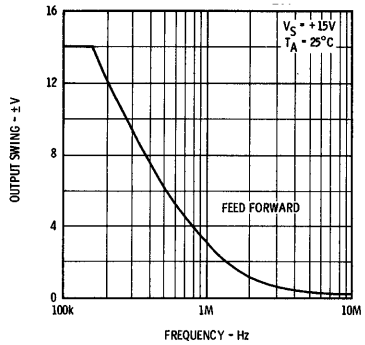
LARGE SIGNAL FREQUENCY RESPONSE



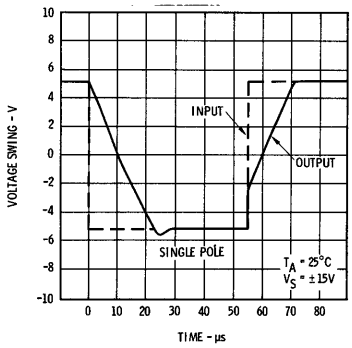
LARGE SIGNAL FREQUENCY RESPONSE



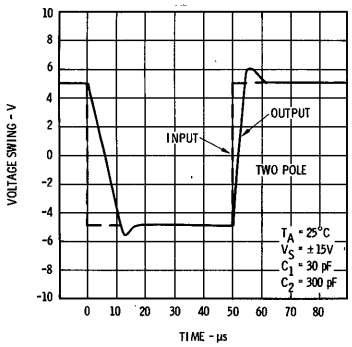
LARGE SIGNAL FREQUENCY RESPONSE



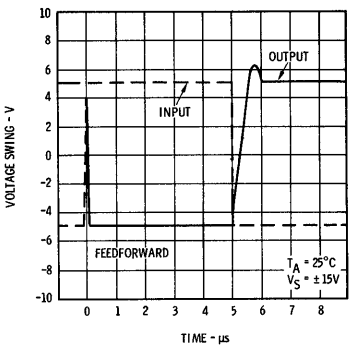
VOLTAGE FOLLOWER PULSE RESPONSE



VOLTAGE FOLLOWER PULSE RESPONSE



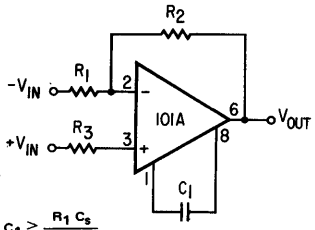
INVERTER PULSE RESPONSE



COMPENSATION CIRCUITS

(All pin numbers shown refer to 8 pin TO-5 package)

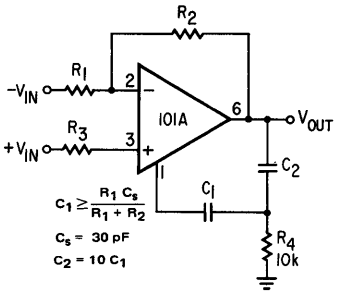
SINGLE POLE COMPENSATION



$C_1 \geq \frac{R_1 C_s}{R_1 + R_2}$

C_s = 30 pF

TWO POLE COMPENSATION

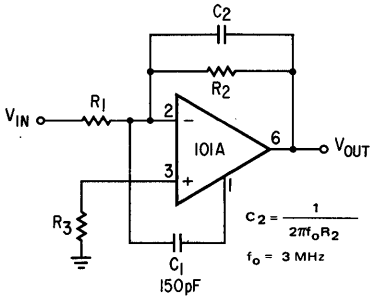


$C_1 \geq \frac{R_1 C_s}{R_1 + R_2}$

C_s = 30 pF

C_2 = 10 C_1

FEEDFORWARD COMPENSATION



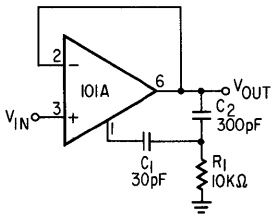
$C_2 = \frac{1}{2\pi f_o R_2}$

f_o = 3 MHz

TYPICAL APPLICATIONS

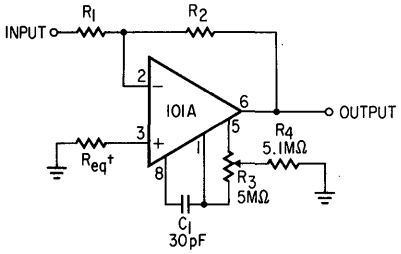
(All pin numbers shown refer to 8 pin TO-5 package)

FAST VOLTAGE FOLLOWER



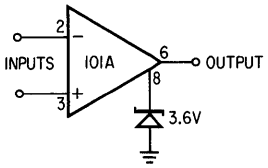
Power Bandwidth: 15 kHz
Slew Rate: 1V/μs

INVERTING AMPLIFIER –WITH BALANCING CIRCUIT

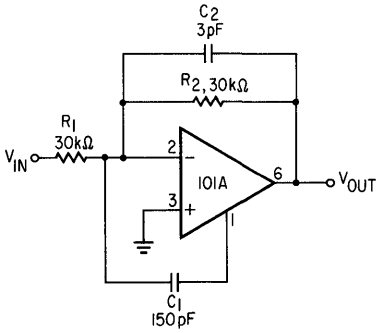


† May be zero or equal to parallel combination of R1 and R2 for minimum offset.

VOLTAGE COMPARATOR FOR DRIVING DTL OR TTL INTEGRATED CIRCUITS

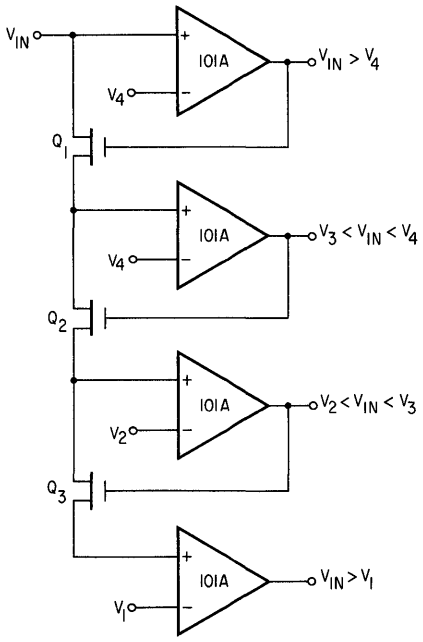


FAST SUMMING AMPLIFIER

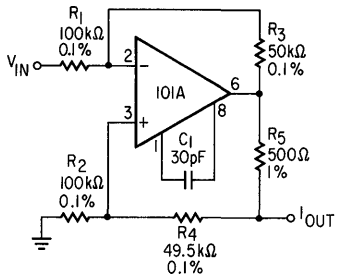


Power Bandwidth: 250 kHz
Small Signal Bandwidth: 3.5 MHz
Slew Rate: 10V/μs

MULTIPLE APERTURE WINDOW DISCRIMINATOR



BILATERAL CURRENT SOURCE



$$I_{OUT} = \frac{R_3 V_{IN}}{R_1 R_5}$$

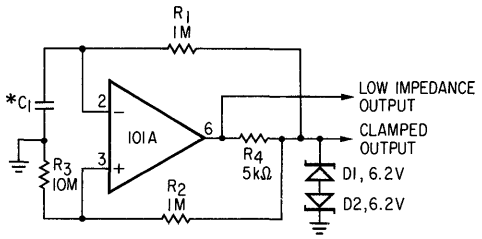
$R_3 = R_4 + R_5$

$R_1 = R_2$

TYPICAL APPLICATIONS (CON'D)

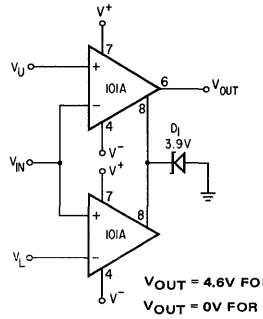
(All pin numbers shown refer to 8 pin TO-5 package)

LOW FREQUENCY SQUARE WAVE GENERATOR



* Adjust C_1 for frequency

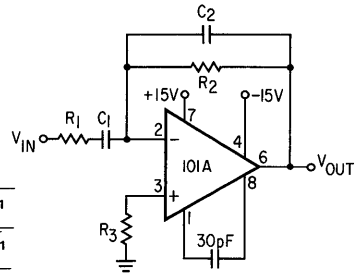
DOUBLE ENDED LIMIT DETECTOR



V_{OUT} = 4.6V FOR $V_L \leq V_{IN} \leq V_U$

V_{OUT} = 0V FOR $V_{IN} < V_L$ OR $V_{IN} < V_U$

PRACTICAL DIFFERENTIATOR

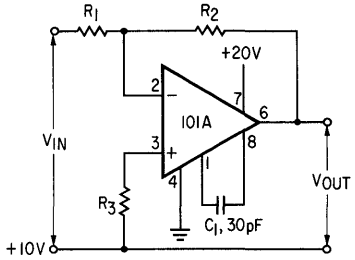


$f_c = \frac{1}{2\pi R_2 C_1}$

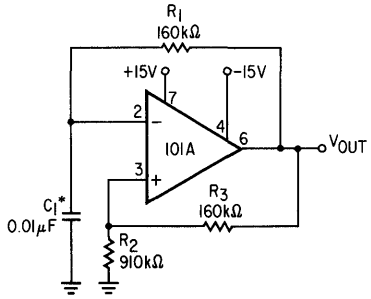
$f_h = \frac{1}{2\pi R_1 C_1} = \frac{1}{2\pi R_2 C_2}$

$f_c < f_h < f_{unity\ gain}$

CIRCUIT FOR OPERATING WITHOUT A NEGATIVE SUPPLY

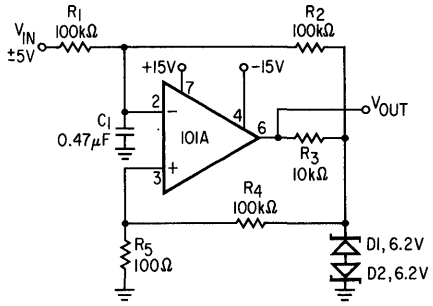


FREE-RUNNING MULTIVIBRATOR

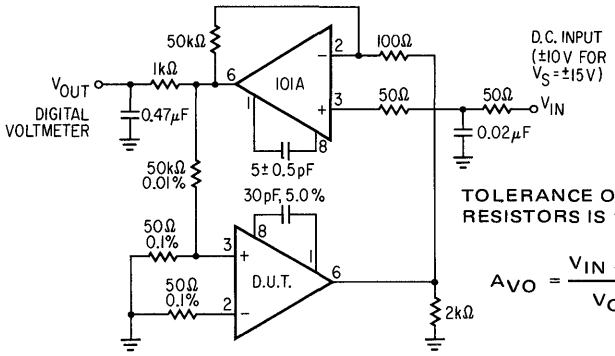


*Chosen for oscillation at 100 Hz

PULSE WIDTH MODULATOR



GAIN TEST CIRCUIT



TOLERANCE OF ALL UNMARKED RESISTORS IS 1%

$$A_{VO} = \frac{V_{IN} \times 10^3}{V_{OUT}} = \frac{10 \times 10^3}{V_{OUT}} \quad \text{FOR } \pm 10\text{V INPUT}$$