μA714

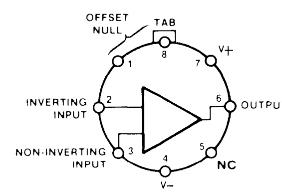
PRECISION OPERATIONAL AMPLIFIER

FAIRCHILD LINEAR INTEGRATED CIRCUITS

DESCRIPTION – The μA714 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.

- **LOW OFFSET VOLTAGE . . . 75 μV for μA714**
- **LOW OFFSET VOLTAGE DRIFT . . . 1.3 μV/°C for μA714**
- **LOW BIAS CURRENT . . . ±3.0 nA for μA714**
- **LOW INPUT NOISE CURRENT . . . 0.17 pA/√Hz @1.0 kHz max**
- **HIGH OPEN LOOP GAIN . . . 500,000 typically**
- **LOW INPUT OFFSET CURRENT . . . 2.8 nA max for μA714**
- **HIGH COMMON MODE REJECTION . . . 110 dB min for μA714**
- **WIDE POWER SUPPLY RANGE . . . ±3.0 TO ±22 V**

CONNECTION DIAGRAM
8-PIN METAL CAN
(TOP VIEW)
PACKAGE OUTLINE 5S
PACKAGE CODE H



ABSOLUTE MAXIMUM RATINGS

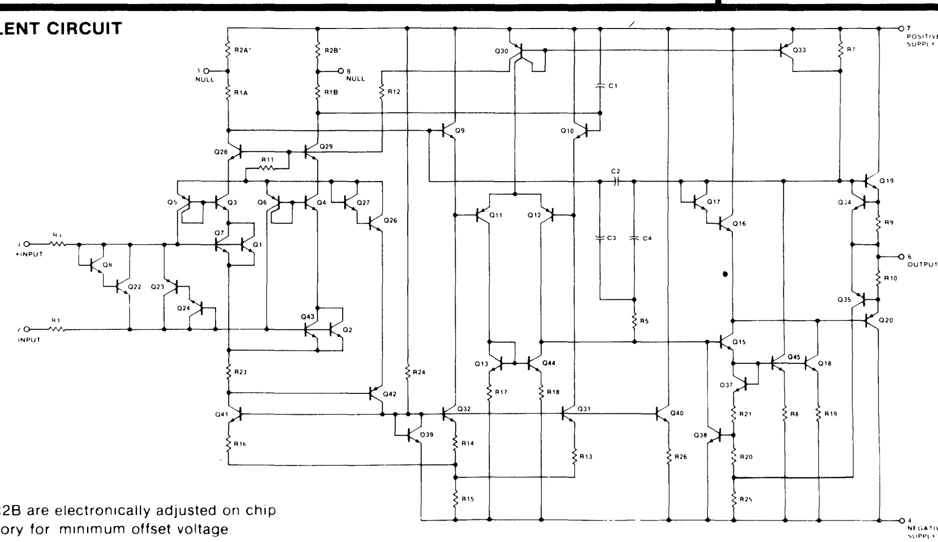
Notes on following pages

	μA714 μA714E, μA714C	μA714L
Supply Voltage	±22 V	±18 V
Internal Power Dissipation (Note 1)		
Metal Can	500 mW	500 mW
Differential Input Voltage	±30 V	±30 V
Input Voltage (Note 2)	±22 V	±18 V
Storage Temperature Range		
Metal Can	−65°C to +150°C	−65°C to +150°C
Operating Temperature Range		
Military	−55°C to +125°C	
Commercial	0°C to +70°C	0°C to +70°C
Pin Temperature		
Metal Can (Soldering, 60 s)	300°C	300°C

ORDER INFORMATION

TYPE	PART NO.
714	μA714HM
714E	μA714EHC
714C	μA714HC
714L	μA714LHC

EQUIVALENT CIRCUIT



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

ELECTRICAL CHARACTERISTICS μA714

These specifications apply for V_S = ±15 V, T_A = 25°C.

CHARACTERISTICS	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Input Offset Voltage	Note 3, R_S = 50 Ω, V_{CM} = 0.0V		30	75	μV
Long Term Input Offset Voltage Stability	Note 4, R_S = 50 Ω, V_{CM} = 0.0V		0.2	1.0	μV/mo.
Input Offset Current	V_{CM} = 0.0 V		0.4	2.8	nA
Input Bias Current	V_{CM} = 0.0 V		±1.0	±3.0	nA
Input Noise Voltage	0.1 Hz to 10 Hz (Note 5)		0.35	0.6	μV_{p-p}
Input Noise Voltage Density	f_O = 10 Hz (Note 5)		10.3	18.0	nV/√Hz
	f_O = 100 Hz (Note 5)		10.0	13.0	
	f_O = 1000 Hz (Note 5)		9.6	11.0	
Input Noise Current	0.1 Hz to 10 Hz (Note 5)		14	30	pA p-p
Input Noise Current Density	f_O = 10 Hz (Note 5)		0.32	0.80	pA/√Hz
	f_O = 100 Hz (Note 5)		0.14	0.23	
	f_O = 1000 Hz (Note 5)		0.12	0.17	
Input Resistance – Differential Mode		20	60		MΩ
Input Resistance – Common Mode			200		GΩ
Input Voltage Range		±13.0	±14.0		V
Common Mode Rejection Ratio	V_{CM} = ±13 V, R_S = 50 Ω	110	126		dB
Power Supply Rejection Ratio	V_S = ±3.0 V to ±18 V, R_S = 50 Ω	100	110		dB
Large Signal Voltage Gain	R_L ≥ 2.0 kΩ, V_O = −10 V to +10 V	200	500		V/mV
	R_L ≥ 500 Ω, V_O = −0.5 V to +0.5 V, V_S = ±3.0 V	150	500		
Maximum Output Voltage Swing	R_L ≥ 10 kΩ	±12.5	±13.0		V
	R_L ≥ 2.0 kΩ	±12.0	±12.8		
	R_L ≥ 1.0 kΩ	±10.5	±12.0		
Slewing Rate	R_L ≥ 2.0 kΩ		0.17		V/μs
Closed Loop Bandwidth	A_{VCL} = +1.0		0.6		MHz
Open Loop Output Resistance	V_O = 0 V, I_O = 0 A		60		Ω
Power Consumption	V_O = 0 V		75	120	mW
	V_S = ±3.0 V, V_O = 0 V		4.0	6.0	
Offset Adjustment Range	R_P = 20 kΩ		±4.0		mV
The following specifications apply for V_S = ±15 V, −55°C ≤ T_A ≤ +125°C.					
Input Offset Voltage	Note 3, R_S = 50 Ω, V_{CM} = 0.0V		60	200	μV
Average Input Offset Voltage Drift					μV/°C
Without External Trim	R_S = 50 Ω, V_{CM} = 0.0 V		0.3	1.3	
With External Trim	Note 5, R_P = 20 kΩ, R_S = 50 Ω		0.3	1.3	
Input Offset Current	V_{CM} = 0.0 V		1.2	5.6	nA
Average Input Offset Current Drift	V_{CM} = 0.0 V		8.0	50	pA/°C
Input Bias Current	V_{CM} = 0.0 V		±2.0	±6.0	nA
Average Input Bias Current Drift	V_{CM} = 0.0 V		13	50	pA/°C
Input Voltage Range		±13.0	±13.5		V
Common Mode Rejection Ratio	V_{CM} = ±13 V, R_S = 50 Ω	106	123		dB
Power Supply Rejection Ratio	V_S = ±3.0 V to ±18 V, R_S = 50 Ω	94	106		dB
Large Signal Voltage Gain	R_L ≥ 2.0 kΩ, V_O = −10 V to +10 V	150	400		V/mV
Maximum Output Voltage Swing	R_L ≥ 2.0 kΩ	±12.0	±12.6		V

NOTES:
1. Ratings applies to ambient temperature to 70°C. Above T_A = 70°C derate linearly 6.3 mW/°C.
2. For supply voltage less than ±22 volts, the absolute maximum input voltage is equal to the supply voltage.
3. Input offset voltage measurements are performed by automated test equipment approximately 0.5 seconds after application of power.
4. Long term input offset voltage stability refers to the averaged trend of V_{OS} versus time over extended periods after the first 30 days of operation. Parameter is not 100% tested. 90% of the units meet this specification.
5. Parameter is not 100% tested; 90% of the units meet this specification.

ELECTRICAL CHARACTERISTICS μA714E

These specifications apply for $V_S = \pm 15$ V, $T_A = 25°C$.

CHARACTERISTICS	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Input Offset Voltage	Note 3, $R_S = 50\ \Omega$, $V_{CM} = 0.0$ V		30	75	μV
Long Term Input Offset Voltage Stability	Note 4, $R_S = 50\ \Omega$, $V_{CM} = 0.0$ V		0.3	1.5	μV/mo.
Input Offset Current	$V_{CM} = 0.0$ V		0.5	3.8	nA
Input Bias Current	$V_{CM} = 0.0$ V		±1.2	±4.0	nA
Input Noise Voltage	0.1 Hz to 10 Hz (Note 5)		0.35	0.6	μV_{p-p}
Input Noise Voltage Density	$f_O = 10$ Hz (Note 5) $f_O = 100$ Hz (Note 5) $f_O = 1000$ Hz (Note 5)		10.3 10.0 9.6	18.0 13.0 11.0	$nV/\sqrt{Hz}$
Input Noise Current	0.1 Hz to 10 Hz (Note 5)		14	30	pA p-p
Input Noise Current Density	$f_O = 10$ Hz (Note 5) $f_O = 100$ Hz (Note 5) $f_O = 1000$ Hz (Note 5)		0.32 0.14 0.12	0.80 0.23 0.17	$pA/\sqrt{Hz}$
Input Resistance – Differential Mode		15	50		MΩ
Input Resistance – Common Mode			160		GΩ
Input Voltage Range		±13.0	±14.0		V
Common Mode Rejection Ratio	$V_{CM} = \pm 13$ V, $R_S = 50\ \Omega$	106	123		dB
Power Supply Rejection Ratio	$V_S = \pm 3.0$ V to ±18 V, $R_S = 50\ \Omega$	94	107		dB
Large Signal Voltage Gain	$R_L \geq 2.0$ kΩ, $V_O = -10$ V to +10 V $R_L \geq 500\ \Omega$, $V_O = -0.5$ V to +0.5 V $V_S = \pm 3.0$ V	200 150	500 500		V/mV
Maximum Output Voltage Swing	$R_L \geq 10$ kΩ $R_L \geq 2.0$ kΩ $R_L \geq 1.0$ kΩ	±12.5 ±12.0 ±10.5	±13.0 ±12.8 ±12.0		V
Slewing Rate	$R_L \geq 2.0$ kΩ		0.17		V/μs
Closed Loop Bandwidth	$A_{VCL} = +1.0$		0.6		MHz
Open Loop Output Resistance	$V_O = 0.0$ V, $I_O = 0.0$ A		60		Ω
Power Consumption	$V_O = 0.0$ V $V_S = \pm 3.0$ V, $V_O = 0.0$ V		75 4.0	120 6.0	mW
Offset Adjustment Range	$R_P = 20$ kΩ		±4.0		mV
The following specifications apply for $V_S = \pm 15$ V, $0°C \leq T_A \leq +70°C$.					
Input Offset Voltage	Note 3, $R_S = 50\ \Omega$, $V_{CM} = 0.0$ V		45	130	μV
Average Input Offset Voltage Drift Without External Trim With External Trim	 $R_S = 50\ \Omega$, $V_{CM} = 0.0$ V Note 5, $R_P = 20$ kΩ, $R_S = 50\ \Omega$		 0.3 0.3	 1.3 1.3	μV/°C
Input Offset Current	$V_{CM} = 0.0$ V		0.9	5.3	nA
Average Input Offset Current Drift	$V_{CM} = 0.0$ V		8.0	35	pA/°C
Input Bias Current	$V_{CM} = 0.0$ V		±1.5	±5.5	nA
Average Input Bias Current Drift	$V_{CM} = 0.0$ V		13	35	pA/°C
Input Voltage Range		±13.0	±13.5		V
Common Mode Rejection Ratio	$V_{CM} = \pm 13$ V, $R_S = 50\ \Omega$	103	123		dB
Power Supply Rejection Ratio	$V_S = \pm 3.0$ V to ±18 V, $R_S = 50\ \Omega$	90	104		dB
Large Signal Voltage Gain	$R_L \geq 2.0$ kΩ, $V_O = -10$ V to +10 V	180	450		V/mV
Maximum Output Voltage Swing	$R_L \geq 2.0$ kΩ	±12.0	±12.6		V

NOTES:
1. Ratings applies to ambient temperature to 70°C. Above $T_A = 70°C$ derate linearly 6.3 mW/°C.
2. For supply voltage less than ±22 volts, the absolute maximum input voltage is equal to the supply voltage.
3. Input offset voltage measurements are performed by automated test equipment approximately 0.5 seconds after application of power.
4. Long term input offset voltage stability refers to the averaged trend of V_{OS} versus time over extended periods after the first 30 days of operation. Parameter is not 100% tested. 90% of the units meet this specification.
5. Parameter is not 100% tested; 90% of the units meet this specification.

ELECTRICAL CHARACTERISTICS μA714C

These specifications apply for $V_S = \pm15$ V, $T_A = 25°C$.

CHARACTERISTICS	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Input Offset Voltage	Note 3, $R_S = 50\ \Omega$, $V_{CM} = 0.0V$		60	150	μV
Long Term Input Offset Voltage Stability	Note 4, $R_S = 50\ \Omega$, $V_{CM} = 0.0V$		0.4	2.0	μV/mo.
Input Offset Current	$V_{CM} = 0.0$ V		0.8	6.0	nA
Input Bias Current	$V_{CM} = 0.0$ V		±1.8	±7.0	nA
Input Noise Voltage	0.1 Hz to 10 Hz (Note 5)		0.38	0.65	μV_{p-p}
Input Noise Voltage Density	$f_O = 10$ Hz (Note 5)		10.5	20.0	nV/√Hz
	$f_O = 100$ Hz (Note 5)		10.2	13.5	
	$f_O = 1000$ Hz (Note 5)		9.8	11.5	
Input Noise Current	0.1 Hz to 10 Hz (Note 5)		15	35	pA p-p
Input Noise Current Density	$f_O = 10$ Hz (Note 5)		0.35	0.90	pA/√Hz
	$f_O = 100$ Hz (Note 5)		0.15	0.27	
	$f_O = 1000$ Hz (Note 5)		0.13	0.18	
Input Resistance – Differential Mode		8.0	33		MΩ
Input Resistance – Common Mode			120		GΩ
Input Voltage Range		±13.0	±14.0		V
Common Mode Rejection Ratio	$V_{CM} = \pm13$, $R_S = 50\ \Omega$	100	120		dB
Power Supply Rejection Ratio	$V_S = \pm3.0$ V to ±18 V, $R_S = 50\ \Omega$	90	104		dB
Large Signal Voltage Gain	$R_L \geq 2.0\ k\Omega$, $V_O = -10$ V to +10 V	120	400		V/mV
	$R_L \geq 500\ \Omega$, $V_O = -0.5$ V to +0.5 V, $V_S = \pm3.0$ V	100	400		
Maximum Output Voltage Swing	$R_L \geq 10\ k\Omega$	±12.0	±13.0		V
	$R_L \geq 2.0\ k\Omega$	±11.5	±12.8		
	$R_L \geq 1.0\ k\Omega$		±12.0		
Slewing Rate	$R_L \geq 2.0\ k\Omega$		0.17		V/μs
Closed Loop Bandwidth	$A_{VCL} = +1.0$		0.6		MHz
Open Loop Output Resistance	$V_O = 0$ V, $I_O = 0$ A		60		Ω
Power Consumption	$V_O = 0.0$ V		80	150	mW
	$V_S = \pm3.0$ V, $V_O = 0.0$ V		4.0	8.0	
Offset Adjustment Range	$R_P = 20\ k\Omega$		±4.0		mV
The following specifications apply for $V_S = \pm15$ V, $0°C \leq T_A \leq +70°C$.					
Input Offset Voltage	Note 3, $R_S = 50\ \Omega$, $V_{CM} = 0.0V$		85	250	μV
Average Input Offset Voltage Drift					
Without External Trim	Note 5, $R_S = 50\ \Omega$, $V_{CM} = 0.0$ V		0.5	1.8	μV/°C
With External Trim	Note 5, $R_P = 20\ k\Omega$, $R_S = 50\Omega$		0.4	1.6	
Input Offset Current	$V_{CM} = 0.0$ V		1.6	8.0	nA
Average Input Offset Current Drift	Note 5, $V_{CM} = 0.0$ V		12	50	pA/°C
Input Bias Current	$V_{CM} = 0.0$ V		±2.2	±9.0	nA
Average Input Bias Current Drift	Note 5, $V_{CM} = 0.0$ V		18	50	pA/°C
Input Voltage Range		±13.0	±13.5		V
Common Mode Rejection Ratio	$V_{CM} = \pm13$ V, $R_S = 50\ \Omega$	97	120		dB
Power Supply Rejection Ratio	$V_S = \pm3.0$ V to ±18 V, $R_S = 50\ \Omega$	86	100		dB
Large Signal Voltage Gain	$R_L \geq 2.0\ k\Omega$, $V_O = -10$ V to +10 V	100	400		V/mV
Maximum Output Voltage Swing	$R_L \geq 2.0\ k\Omega$	±11.0	±12.6		V

NOTES:
1. Ratings applies to ambient temperature to 70°C. Above $T_A = 70°C$ derate linearly 6.3 mW/°C.
2. For supply voltage less than ±22 volts, the absolute maximum input voltage is equal to the supply voltage.
3. Input offset voltage measurements are performed by automated test equipment approximately 0.5 seconds after application of power.
4. Long term input offset voltage stability refers to the averaged trend of V_{OS} versus time over extended periods after the first 30 days of operation. Parameter is not 100% tested. 90% of the units meet this specification.
5. Parameter is not 100% tested; 90% of the units meet this specification.

ELECTRICAL CHARACTERISTICS μA714L

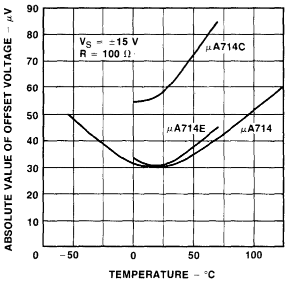
These specifications apply for $V_S = \pm 15$ V, $T_A = 25°C$.

CHARACTERISTICS	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Input Offset Voltage	Note 3, $R_S = 50\ \Omega$, $V_{CM} = 0.0V$		100	250	μV
Long Term Input Offset Voltage Stability	Note 4, $R_S = 50\ \Omega$, $V_{CM} = 0.0V$		0.5	3.0	μV/mo.
Input Offset Current	$V_{CM} = 0.0$ V		5.0	20	nA
Input Bias Current	$V_{CM} = 0.0$ V		6.0	±30	nA
Input Noise Voltage Density	$f_O = 10$ Hz (Note 5)		10.5		
	$f_O = 100$ Hz (Note 5)		10.2		
	$f_O = 1000$ Hz (Note 5)		9.8		
Input Noise Current	0.1 Hz to 10 Hz (Note 5)		15		pA p-p
Input Noise Current Density	$f_O = 10$ Hz (Note 5)		0.35		
	$f_O = 100$ Hz (Note 5)		0.15		
	$f_O = 1000$ Hz (Note 5)		0.13		
Input Resistance – Differential Mode		8.0	33		MΩ
Input Resistance – Common Mode			120		GΩ
Input Voltage Range		±13.0	±14.0		V
Common Mode Rejection Ratio	$V_{CM} = \pm 13$ V, $R_S = 50\ \Omega$	100	120		dB
Power Supply Rejection Ratio	$V_S = \pm 3.0$ V to ± 18 V, $R_S = 50\ \Omega$	90	104		dB
Large Signal Voltage Gain	$R_L \geq 2.0\ k\Omega$, $V_O = -10$ V to $+10$ V	100	300		V/mV
	$R_L \geq 500\ \Omega$, $V_O = -0.5$ V to $+0.5$ V, $V_S = \pm 3.0$ V	50	150		V/mV
Maximum Output Voltage Swing	$R_L \geq 10\ k\Omega$	±12.0	±13.0		V
	$R_L \geq 2.0\ k\Omega$	±11.0	±12.8		V
	$R_L \geq 1.0\ k\Omega$		±12.0		V
Slewing Rate	$R_L \geq 2.0\ k\Omega$		0.17		V/μs
Closed Loop Bandwidth	$A_{VCL} = +1.0$		0.6		MHz
Open Loop Output Resistance	$V_O = 0.0$ V, $I_O = 0$ A		60		Ω
Power Consumption	$V_O = 0.0$ V		100	180	mW
	$V_S = \pm 3.0$ V, $V_O = 0.0$ V		5.0	12	mW
Offset Adjustment Range	$R_P = 20\ k\Omega$		±4.0		mV
The following specifications apply for $V_S = \pm 15$ V, $0°C \leq T_A \leq +70°C$.					
Input Offset Voltage	Note 3, $R_S = 50\ \Omega$, $V_{CM} = 0.0V$			400	μV
Average Input Offset Voltage Drift Without External Trim	Note 5, $R_S = 50\ \Omega$, $V_{CM} = 0.0$ V		1.0	3.0	μV/°C
Input Offset Current	$V_{CM} = 0.0$ V		8.0	40	nA
Average Input Offset Current Drift	Note 5, $V_{CM} = 0.0$ V		20	100	pA/°C
Input Bias Current	$V_{CM} = 0.0$ V		±15	±60	nA
Average Input Bias Current Drift	Note 5, $V_{CM} = 0.0$ V		35	150	pA/°C
Input Voltage Range		±13.0	±13.5		V
Common Mode Rejection Ratio	$V_{CM} = \pm 13$ V, $R_S = 50\ \Omega$	94	120		dB
Power Supply Rejection Ratio	$V_S = \pm 3.0$ V to ± 18 V, $R_S = 50\ \Omega$	83	100		dB
Large Signal Voltage Gain	$R_L \geq 2.0\ k\Omega$, $V_O = -10$ V to $+10$ V	80	400		V/mV
Maximum Output Voltage Swing	$R_L \geq 2.0\ k\Omega$	±10.0	±12.6		V

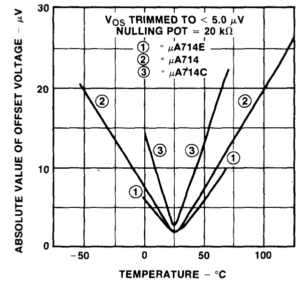
NOTES:
1. Ratings applies to ambient temperature to 70°C. Above $T_A = 70°C$ derate linearly 6.3 mW/°C.
2. For supply voltage less than ±22 volts, the absolute maximum input voltage is equal to the supply voltage.
3. Input offset voltage measurements are performed by automated test equipment approximately 0.5 seconds after application of power.
4. Long term input offset voltage stability refers to the averaged trend of V_{OS} versus time over extended periods after the first 30 days of operation. Parameter is not 100% tested. 90% of the units meet this specification.
5. Parameter is not 100% tested; 90% of the units meet this specification.

TYPICAL PERFORMANCE CURVES

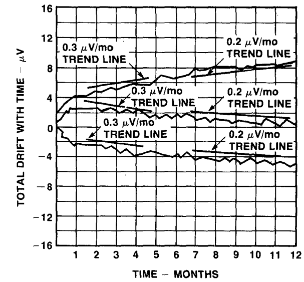
UNTRIMMED OFFSET VOLTAGE VERSUS TEMPERATURE



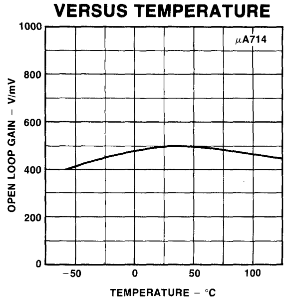
TRIMMED OFFSET VOLTAGE VERSUS TEMPERATURE



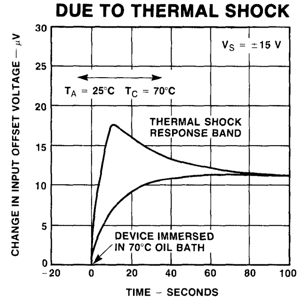
OFFSET VOLTAGE STABILITY VERSUS TIME



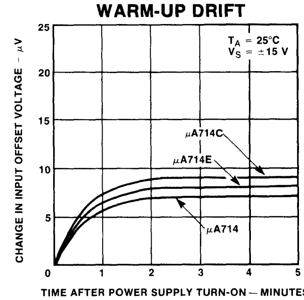
OPEN LOOP GAIN VERSUS TEMPERATURE



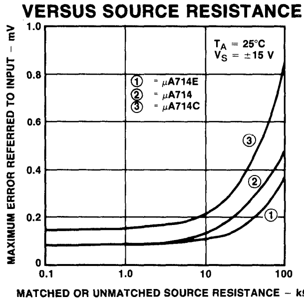
OFFSET VOLTAGE CHANGE DUE TO THERMAL SHOCK



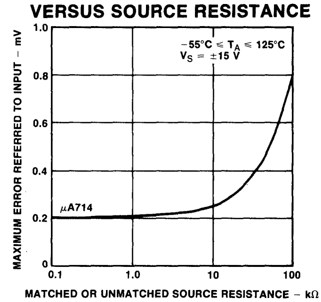
WARM-UP DRIFT



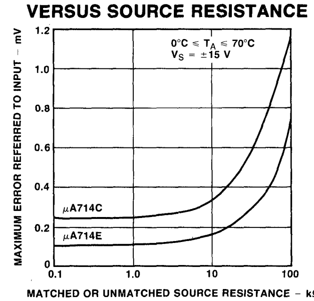
MAXIMUM ERROR VERSUS SOURCE RESISTANCE



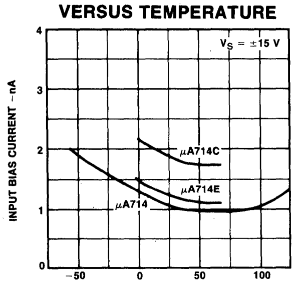
MAXIMUM ERROR VERSUS SOURCE RESISTANCE



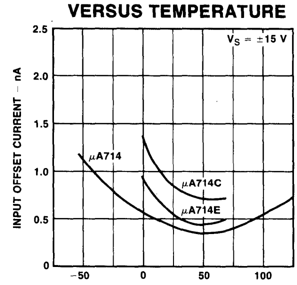
MAXIMUM ERROR VERSUS SOURCE RESISTANCE



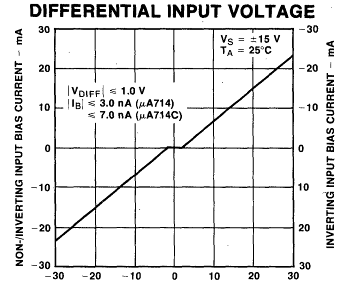
INPUT BIAS CURRENT VERSUS TEMPERATURE



INPUT OFFSET CURRENT VERSUS TEMPERATURE



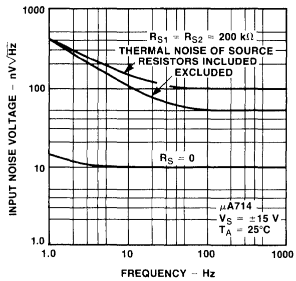
INPUT BIAS CURRENT VERSUS DIFFERENTIAL INPUT VOLTAGE



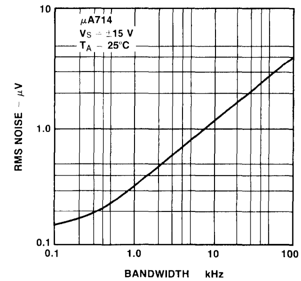
5

TYPICAL PERFORMANCE CURVES

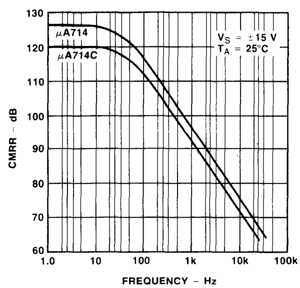
INPUT SPOT NOISE VOLTAGE VERSUS FREQUENCY



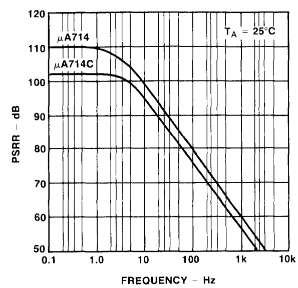
INPUT WIDEBAND NOISE VERSUS BANDWIDTH (0.1 Hz TO FREQUENCY INDICATED)



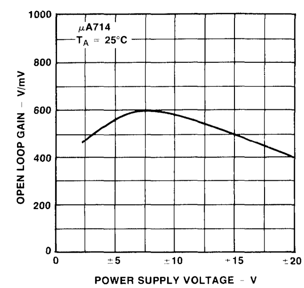
CMRR VERSUS FREQUENCY



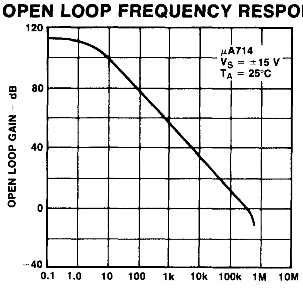
PSRR VERSUS FREQUENCY



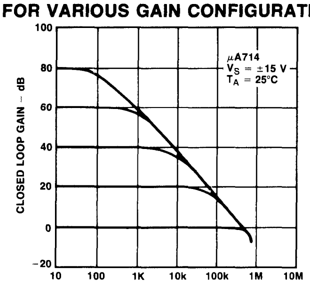
OPEN LOOP GAIN VERSUS POWER SUPPLY VOLTAGE



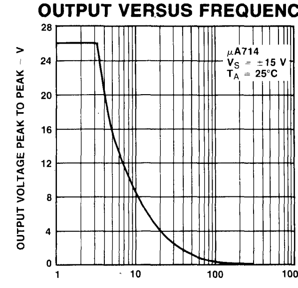
OPEN LOOP FREQUENCY RESPONSE



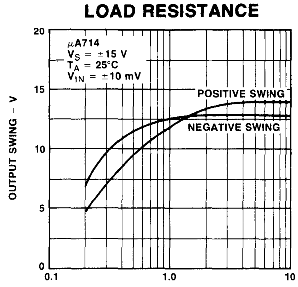
CLOSED LOOP RESPONSE FOR VARIOUS GAIN CONFIGURATIONS



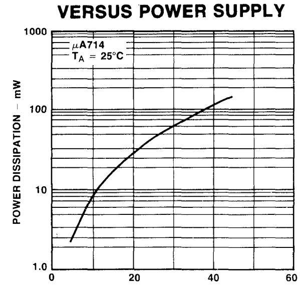
MAXIMUM UNDISTORTED OUTPUT VERSUS FREQUENCY



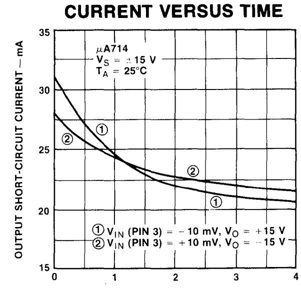
OUTPUT VOLTAGE VERSUS LOAD RESISTANCE



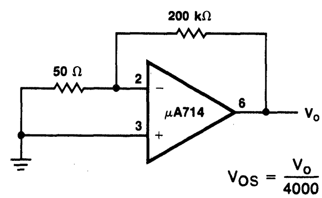
POWER CONSUMPTION VERSUS POWER SUPPLY



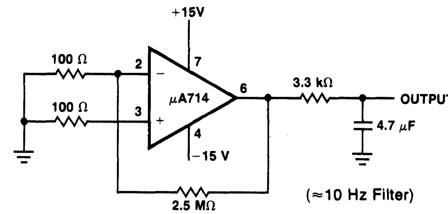
OUTPUT SHORT CIRCUIT CURRENT VERSUS TIME



TYPICAL APPLICATIONS

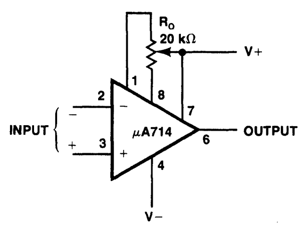


OFFSET VOLTAGE TEST CIRCUIT

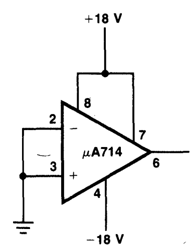


$$\text{Input Referred Noise} = \frac{V_O}{25{,}000} = \frac{5\ \text{mV/cm}}{25{,}000} = 200\ \text{nV/cm}$$

LOW FREQUENCY NOISE TEST CIRCUIT



OPTIONAL OFFSET NULLING CIRCUIT



BURN-IN CIRCUIT