BURR - BROWN®

OPA606

Wide-Bandwidth *Difet*® OPERATIONAL AMPLIFIER

FEATURES

- **WIDE BANDWIDTH: 13MHz typ**
- **HIGH SLEW RATE: 35V/μs typ**
- **LOW BIAS CURRENT: 10pA max at T_A = +25°C**
- **LOW OFFSET VOLTAGE: 500μV max**
- **LOW DISTORTION: 0.0035% typ at 10kHz**

APPLICATIONS

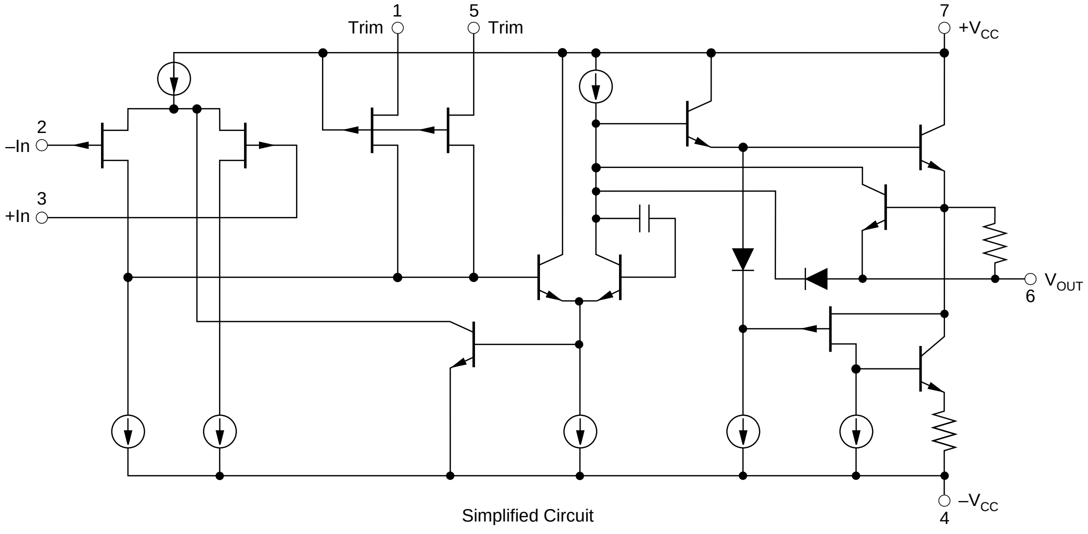
- **OPTOELECTRONICS**
- **DATA ACQUISITION**
- **TEST EQUIPMENT**
- **AUDIO AMPLIFIERS**

DESCRIPTION

The OPA606 is a wide-bandwidth monolithic dielectrically-isolated FET (***Difet***®) operational amplifier featuring a wider bandwidth and lower bias current than BIFET® LF156A amplifiers. Bias current is specified under warmed-up and operating conditions, as opposed to a junction temperature of +25°C.

Laser-trimmed thin-film resistors offer improved offset voltage and noise performance.

The OPA606 is internally compensated for unity-gain stability.



Simplified Circuit

Difet®; Burr-Brown Corp.

BIFET®; National Semiconductor Corp.

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PDS-598D

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SPECIFICATIONS

ELECTRICAL

At V_{CC} = ±15VDC and T_A = +25°C unless otherwise noted.

		OPA606KM			OPA606LM			OPA606KP			
PARAMETER	**CONDITIONS**	**MIN**	**TYP**	**MAX**	**MIN**	**TYP**	**MAX**	**MIN**	**TYP**	**MAX**	**UNITS**
FREQUENCY RESPONSE											
Gain Bandwidth	Small Signal	10	12.5		11	13		9	12		MHz
Full Power Response	20Vp-p, R_L = 2kΩ		515			550			470		kHz
Slew Rate	V_O = ±10V, R_L = 2kΩ	22	33		25	35		20	30		V/µs
Settling Time(1): 0.1%	Gain = –1, R_L = 2kΩ		1.0			1.0			1.0		µs
0.01%	10V Step		2.1			2.1			2.1		µs
Total Harmonic Distortion	G = +1, 20Vp-p R_L = 2kΩ f = 10kHz		0.0035			0.0035			0.0035		%
INPUT OFFSET VOLTAGE(2)											
Input Offset Voltage	V_{CM} = 0VDC		±180	±1.5mV		±100	±500		±300	±3mV	µV
Average Drift	T_A = T_{MIN} to T_{MAX}		±5			±3	±5		±10		µV/°C
Supply Rejection	V_{CC} = ±10V to ±18V	82	100		90	104		80	90		dB
			±10	±79		±6	±32		±32	±100	µV/V
BIAS CURRENT(2)											
Input Bias Current	V_{CM} = 0VDC		±7	±15		±5	±10		±8	±25	pA
OFFSET CURRENT(2)											
Input Offset Current	V_{CM} = 0VDC		±0.6	±10		±0.4	±5		±1	±15	pA
NOISE											
Voltage, f_O = 10Hz	100% tested (L)		37			30	40		37		$nV/\sqrt{Hz}$
100Hz	100% tested (L)		21			20	28		21		$nV/\sqrt{Hz}$
1kHz	100% tested (L)		14			13	16		14		$nV/\sqrt{Hz}$
10kHz	(3)		12			11	13		12		$nV/\sqrt{Hz}$
20kHz	(3)		11			10.5	13		11		$nV/\sqrt{Hz}$
f_B = 10Hz to 10kHz	(3)		1.3			1.2	1.5		1.3		µVrms
Current, f_O = 0.1Hz thru 20kHz	(3)		1.5			1.3	2		1.7		$fA/\sqrt{Hz}$
IMPEDANCE											
Differential			10^{13} || 1			10^{13} || 1			10^{13} || 1		Ω || pF
Common-Mode			10^{14} || 3			10^{14} || 3			10^{14} || 3		Ω || pF
VOLTAGE RANGE											
Common-Mode Input Range		±10.5	±11.5		±11	±11.6		±10.2	±11		V
Common-Mode Rejection	V_{IN} = ±10VDC	80	95		85	96		78	90		dB
OPEN-LOOP GAIN, DC											
Open-Loop Voltage Gain	R_L ≥ 2kΩ	95	115		100	118		90	110		dB
RATED OUTPUT											
Voltage Output	R_L = 2kΩ	±11	±12.2		±12	±12.6		±11	±12		V
Current Output	V_O = ±10VDC	±5	±10		±5	±10		±5	±10		mA
Output Resistance	DC, Open Loop		40			40			40		Ω
Load Capacitance Stability	Gain = +1		1000			1000			1000		pF
Short Circuit Current		10	20		10	20		10	20		mA
POWER SUPPLY											
Rated Voltage			±15			±15			±15		VDC
Voltage Range, Derated Performance		±5		±18	±5		±18	±5		±18	VDC
Current, Quiescent	I_O = 0mADC		6.5	9.5		6.2	9		6.5	10	mA
TEMPERATURE RANGE											
Specification	Ambient Temperature KM, KP, LM	0		+70	0		+70	0		+70	°C
Operating	Ambient Temperature	–55		+125	–55		+125	–40		+85	°C
θ_{JA}			200			200			155		°C/W

NOTES: (1) See settling time test circuit in Figure 2. (2) Offset voltage, offset current, and bias current are measured with the units fully warmed up. (3) Sample tested–this parameter is guaranteed on L grade only.

ELECTRICAL (FULL TEMPERATURE RANGE SPECIFICATIONS)

At V_{CC} = ±15VDC and T_A = T_{MIN} to T_{MAX} unless otherwise noted.

		OPA606KM			OPA606LM			OPA606KP			
PARAMETER	CONDITIONS	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	UNITS
TEMPERATURE RANGE											
Specification Range	Ambient Temp.	0		+70	0		+70	0		+70	°C
INPUT OFFSET VOLTAGE(1)											
Input Offset Voltage	V_{CM} = 0VDC		±400	±2mV		±335	±750		±750	±3.5mV	µV
Average Drift			±5			±3	±5		±10		µV/°C
Supply Rejection	V_{CC} = ±10V to ±18V	80	98		85	100		78	95		dB
			±13	±100		±10	±56		±18	±126	µV/V
BIAS CURRENT(1)											
Input Bias Current	V_{CM} = 0VDC		±158	±339		±113	±226		±181	±566	pA
OFFSET CURRENT(1)											
Input Offset Current	V_{CM} = 0VDC		±14	±226		±9	±113		±23	±339	pA
VOLTAGE RANGE											
Common-Mode Input Range		±10.4	±11.4		±10.9	±11.5		±10	±10.9		V
Common-Mode Rejection	V_{IN} = ±10VDC	78	92		82	95		75	88		dB
OPEN-LOOP GAIN, DC											
Open-Loop Voltage Gain	$R_L \geq 2k\Omega$	90	106		95	112		88	104		dB
RATED OUTPUT											
Voltage Output	$R_L = 2k\Omega$	±10.5	±12		±11.5	±12.4		±10.4	±11.8		V
Current Output	V_O = ±10VDC	±5	±10		±5	±10		±5	±10		mA
POWER SUPPLY											
Current, Quiescent	I_O = 0mADC		6.6	10		6.4	9.5		6.6	10.5	mA

NOTES: (1) Offset voltage, offset current, and bias current are measured with the units fully warmed up.

ABSOLUTE MAXIMUM RATINGS

Supply Voltage	±18VDC
Internal Power Dissipation (1)	500mW
Differential Input Voltage	±36VDC
Input Voltage Range	±18VDC
Storage Temperature Range	M = –65°C to +150°C P = –40°C to +85°C
Operating Temperature Range	M = –55°C to +125°C P = –40°C to +85°C
Lead Temperature (soldering, 10s)	+300°C
Output Short-Circuit Duration(3)	Continuous
Junction Temperature	+175°C

NOTES: (1) Packages must be derated based on θ_{JC} = 15°C/W or θ_{JA}. (2) For supply voltages less than ±18VDC, the absolute maximum input voltage is equal to the negative supply voltage. (3) Short circuit may be to power supply common only. Rating applies to +25°C ambient. Observe dissipation limit and T_J.

PACKAGE INFORMATION

MODEL	PACKAGE	PACKAGE DRAWING NUMBER(1)
OPA606KM	TO-99	001
OPA606LM	TO-99	001
OPA606KP	Plastic DIP	006

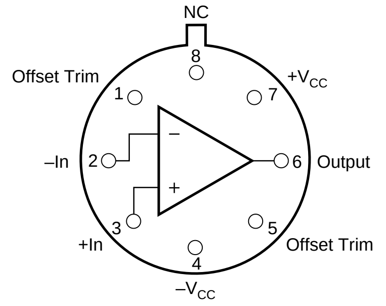
NOTE: (1) For detailed drawing and dimension table, please see end of data sheet, or Appendix D of Burr-Brown IC Data Book.

ORDERING INFORMATION

MODEL	PACKAGE	TEMPERATURE RANGE
OPA606KM	TO-99	0°C to 70°C
OPA606LM	TO-99	0°C to 70°C
OPA606KP	Plastic DIP	0°C to 70°C

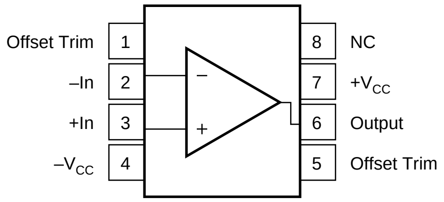
CONNECTION DIAGRAMS

Top View **TO-99**

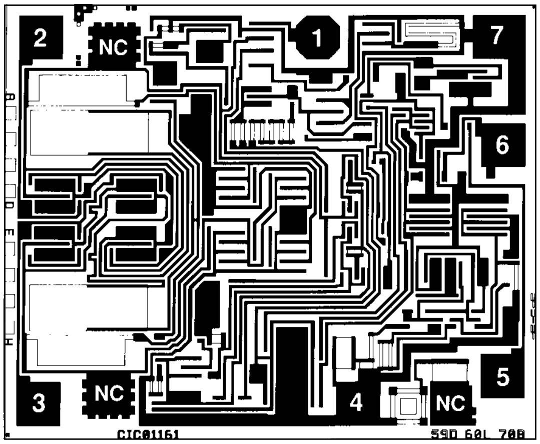


Case is connected to V_{CC}.

Top View **DIP**



DICE INFORMATION



OPA606 DIE TOPOGRAPHY

PAD	FUNCTION
1	Offset Trim
2	–In
3	+In
4	$-V_S$
5	Offset Trim
6	Output
7	$+V_S$
8	NC
NC	No Connection

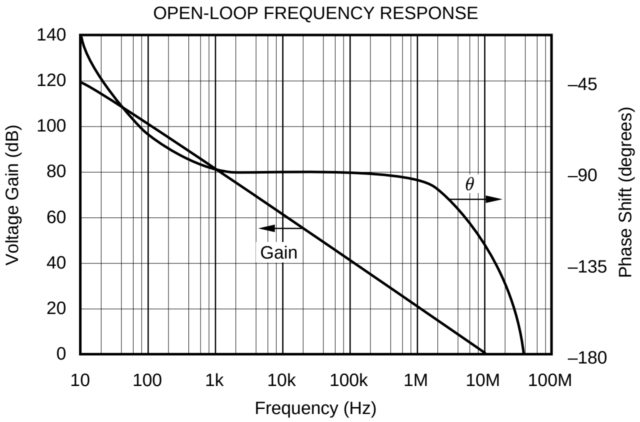
Substrate Bias: No Connection.

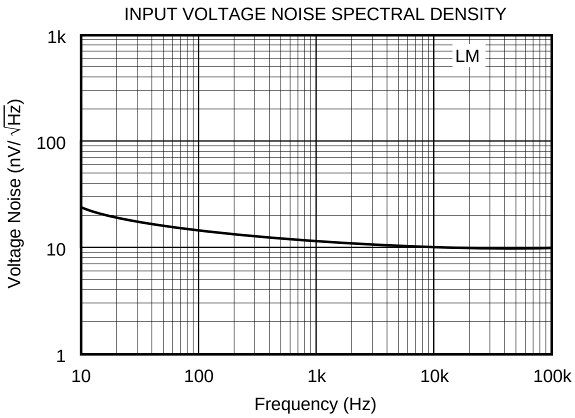
MECHANICAL INFORMATION

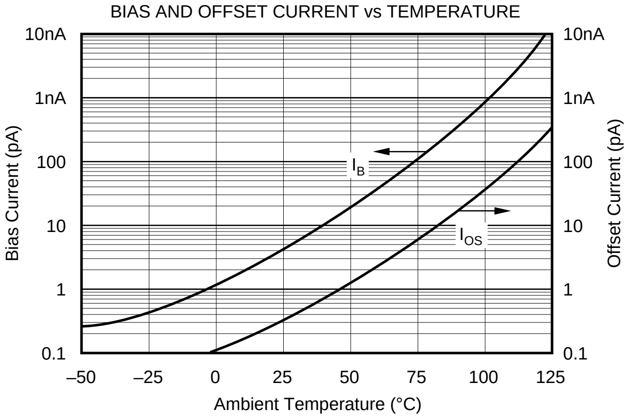
	MILS (0.001")	MILLIMETERS
Die Size	65 x 54 ±5	1.65 x 1.37 ±0.13
Die Thickness	20 ±3	0.51 ±0.08
Min. Pad Size	4 x 4	0.10 x 0.10
Backing		None
Transistor Count		43

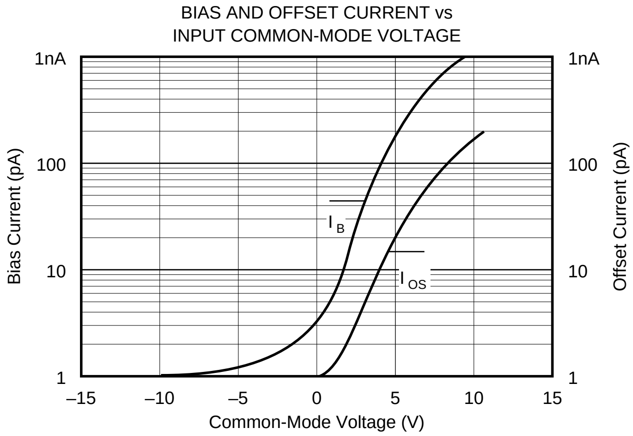
TYPICAL PERFORMANCE CURVES

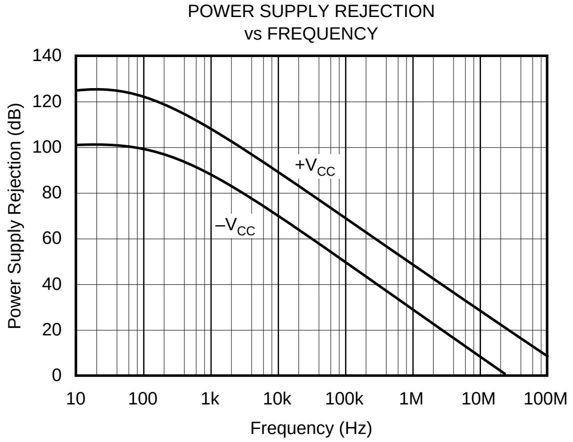
T_A = +25°C, V_{CC} = ±15VDC unless otherwise noted.

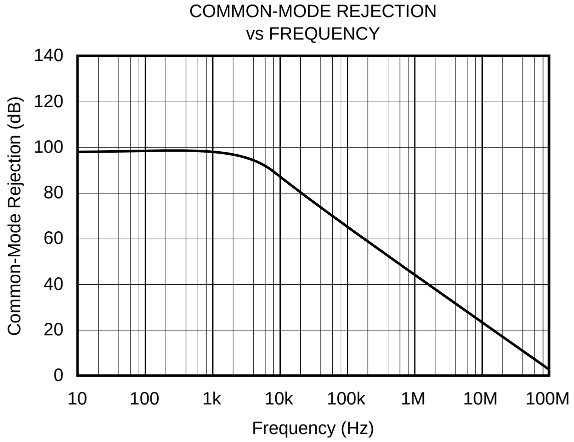








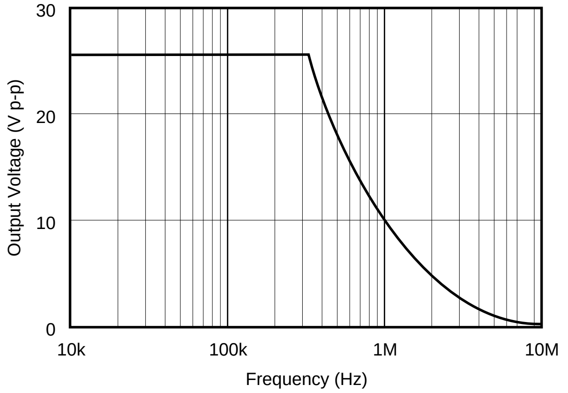




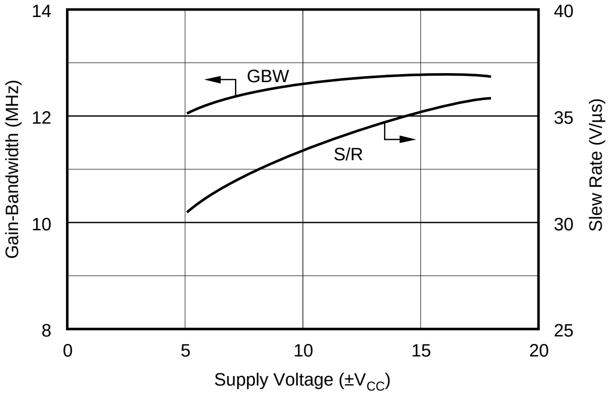
TYPICAL PERFORMANCE CURVES (CONT)

T_A = +25°C, V_{CC} = ±15V unless otherwise noted.

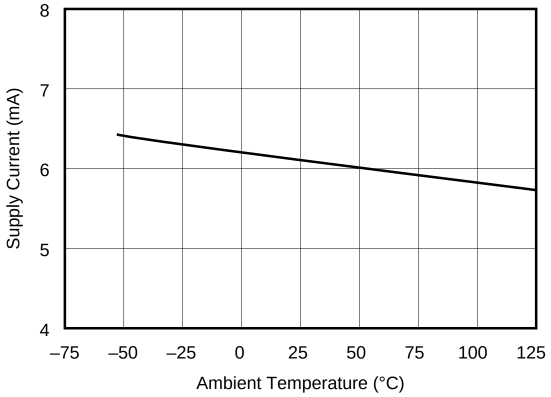
MAXIMUM UNDISTORTED OUTPUT VOLTAGE vs FREQUENCY



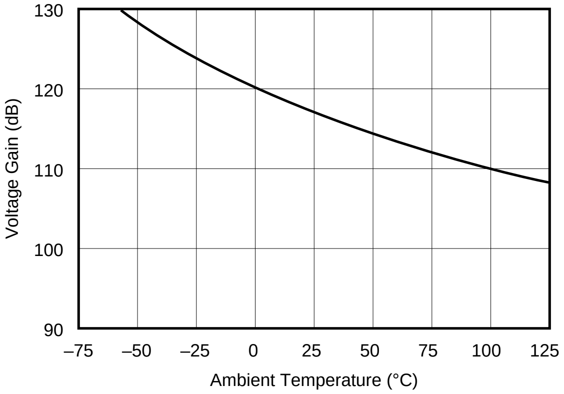
GAIN-BANDWIDTH AND SLEW RATE vs SUPPLY VOLTAGE



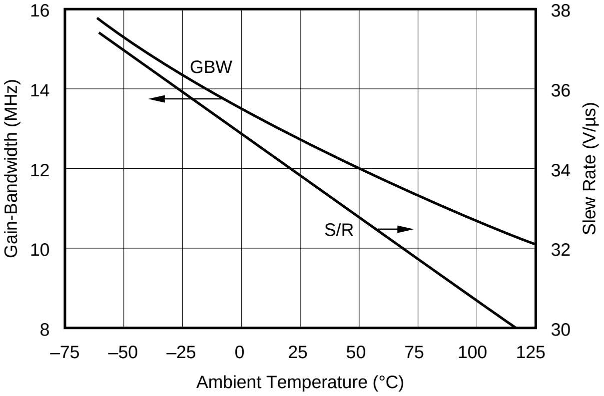
SUPPLY CURRENT vs TEMPERATURE



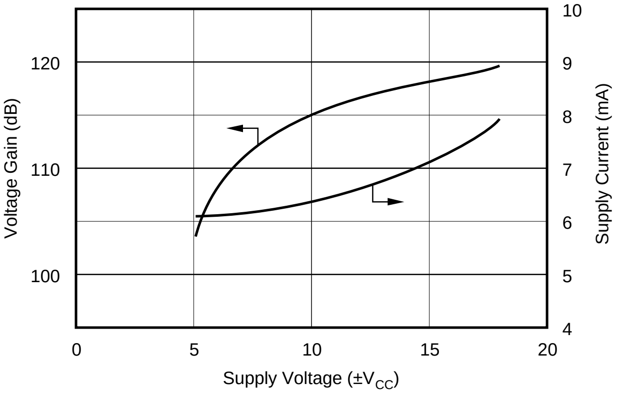
OPEN-LOOP GAIN vs TEMPERATURE



GAIN-BANDWIDTH AND SLEW RATE vs TEMPERATURE

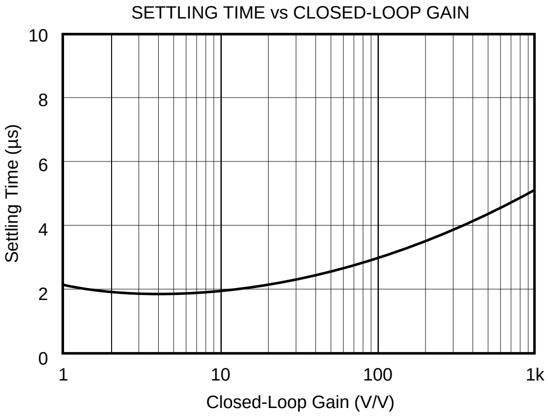


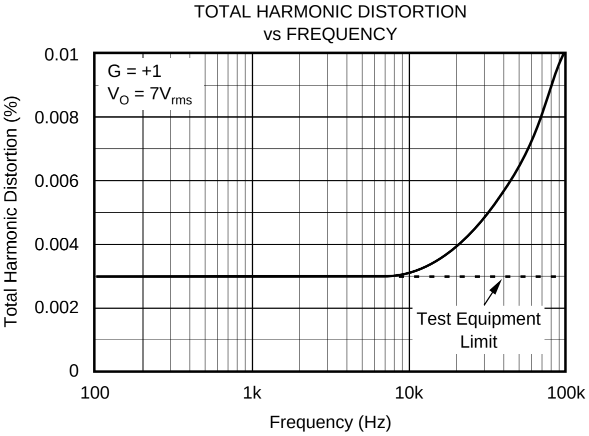
OPEN-LOOP GAIN AND SUPPLY CURRENT vs SUPPLY VOLTAGE

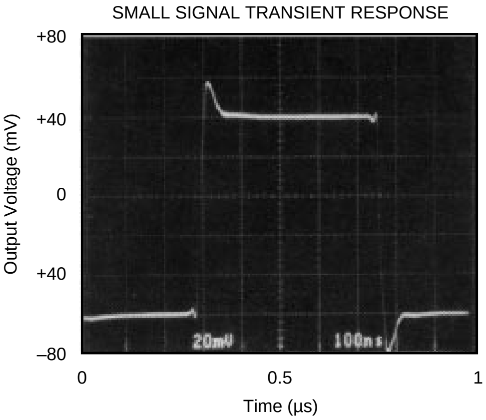


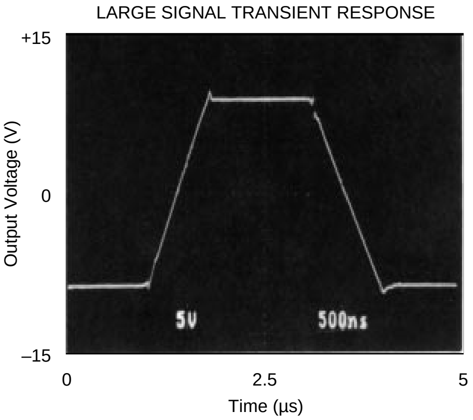
TYPICAL PERFORMANCE CURVES (CONT)

T_A = +25°C, V_{CC} = ±15V unless otherwise noted.


SETTLING TIME vs CLOSED-LOOP GAIN


TOTAL HARMONIC DISTORTION vs FREQUENCY

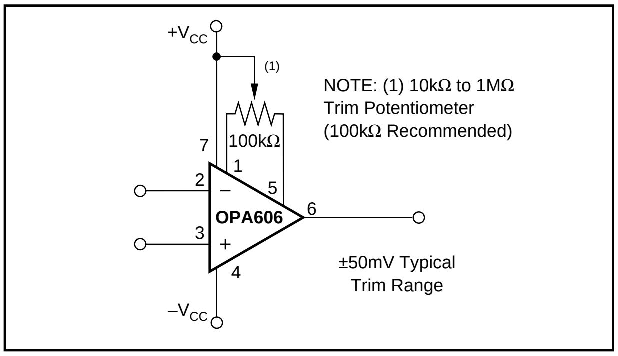

SMALL SIGNAL TRANSIENT RESPONSE


LARGE SIGNAL TRANSIENT RESPONSE

APPLICATIONS INFORMATION

OFFSET VOLTAGE ADJUSTMENT

The OPA606 offset voltage is laser-trimmed and will require no further trim for most applications. As with most amplifiers, externally trimming the remaining offset can change drift performance by about 0.5µV/°C for each millivolt of adjusted offset. Note that the trim (Figure 1) is similar to operational amplifiers such as LF156 and OP-16. The OPA606 can replace most other amplifiers by leaving the external null circuit unconnected.



NOTE: (1) 10kΩ to 1MΩ Trim Potentiometer (100kΩ Recommended)

±50mV Typical Trim Range

FIGURE 1. Offset Voltage Trim.

INPUT PROTECTION

Static damage can cause subtle changes in amplifier input characteristics without necessarily destroying the device. In precision operational amplifiers (both bipolar and FET types), this may cause a noticeable degradation of offset voltage and drift. Static protection is recommended when handling any precision IC operational amplifier.

If the input voltage exceeds the amplifier's negative supply voltage, input current limiting must be used to prevent damage.

CIRCUIT LAYOUT

Wideband amplifiers require good circuit layout techniques and adequate power supply bypassing. Short, direct connections and good high frequency bypass capacitors (ceramic or tantalum) will help avoid noise pickup or oscillation.

GUARDING AND SHIELDING

As in any situation where high impedances are involved, careful shielding is required to reduce "hum" pickup in input leads. If large feedback resistors are used, they should also be shielded along with the external input circuitry.

Leakage currents across printed circuit boards can easily exceed the bias current of the OPA606. To avoid leakage problems, it is recommended that the signal input lead of the OPA606 be wired to a Teflon® standoff. If the OPA606 is to be soldered directly into a printed circuit board, utmost care must be used in planning the board layout.

A "guard" pattern should completely surround the high impedance input leads and should be connected to a low impedance point which is at the signal input potential (see Figure 3).

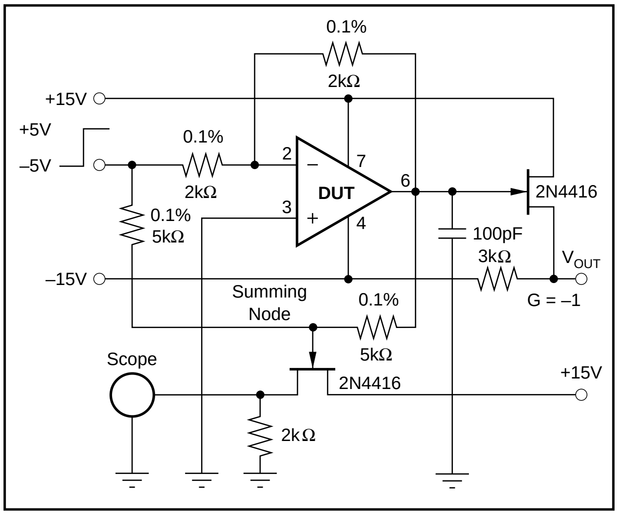


FIGURE 2. Settling Time Test Circuit.

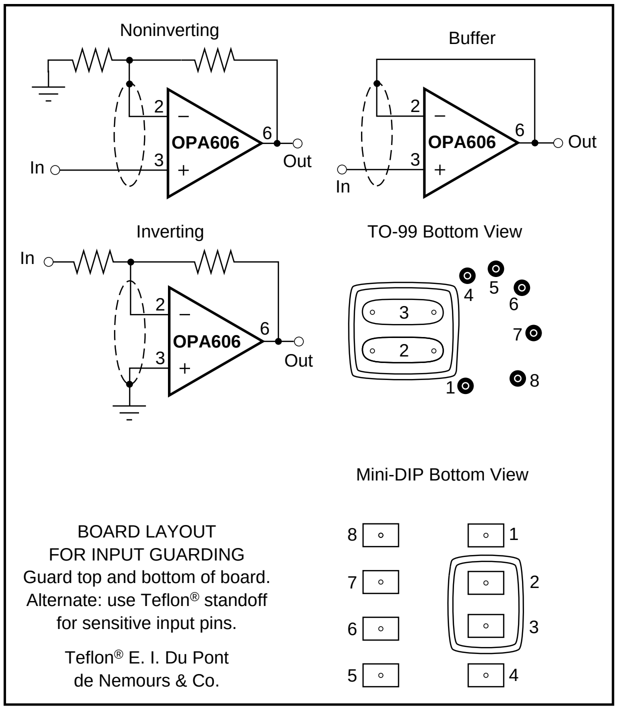


FIGURE 3. Connection of Input Guard.

APPLICATIONS CIRCUITS

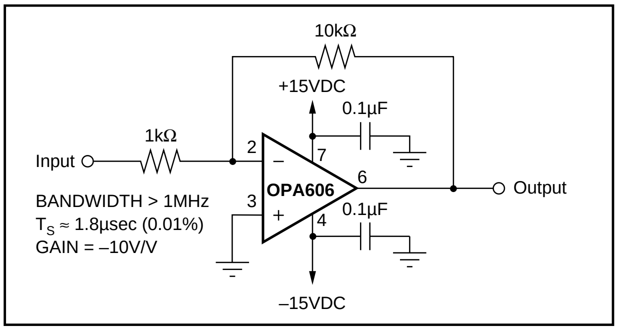


FIGURE 4. Inverting Amplifier.

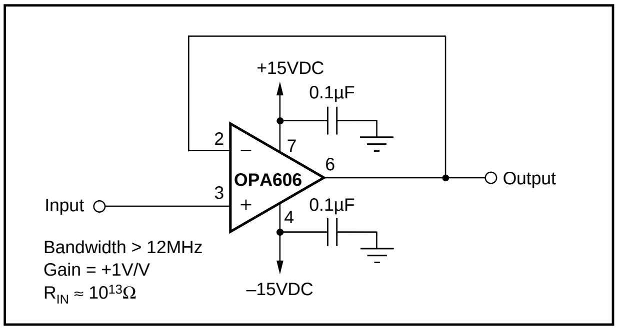


FIGURE 5. Noninverting Buffer.

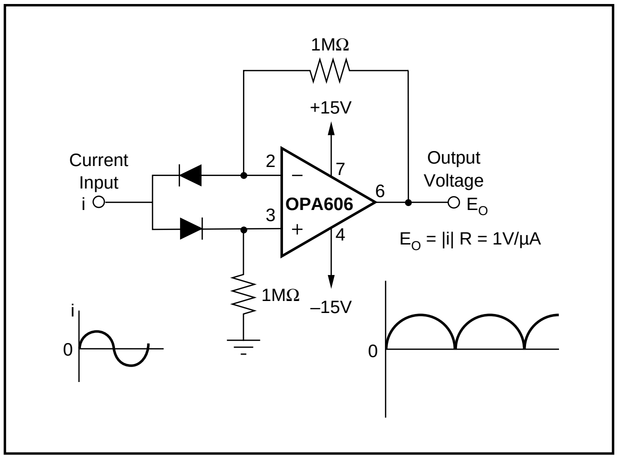
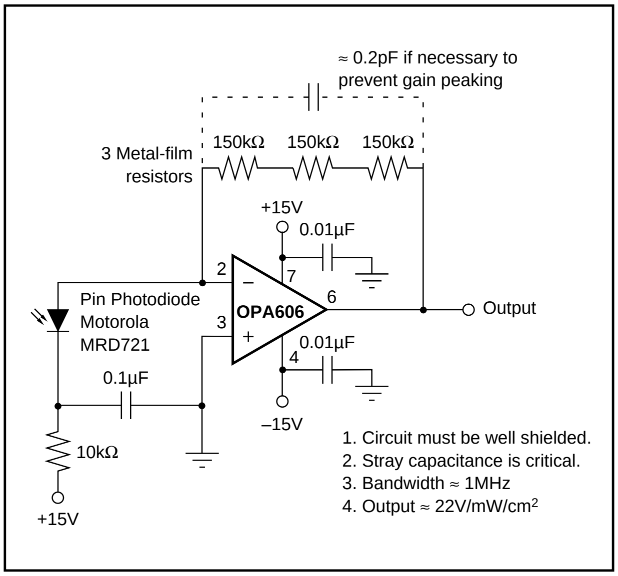
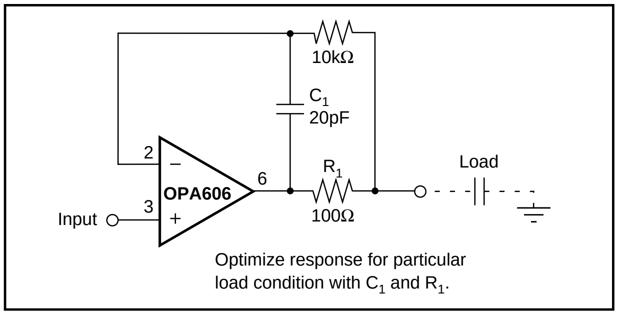


FIGURE 6. Absolute Value Current-to-Voltage Circuit.



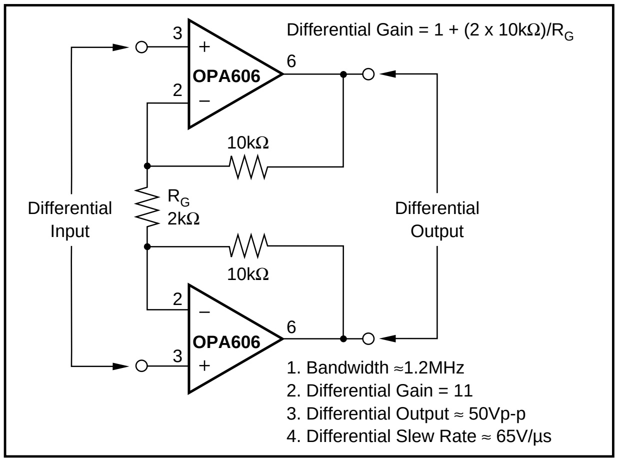
1. Circuit must be well shielded.
2. Stray capacitance is critical.
3. Bandwidth ≈ 1MHz
4. Output ≈ 22V/mW/cm^2

FIGURE 7. High-Speed Photodetector.



Optimize response for particular load condition with C_1 and R_1.

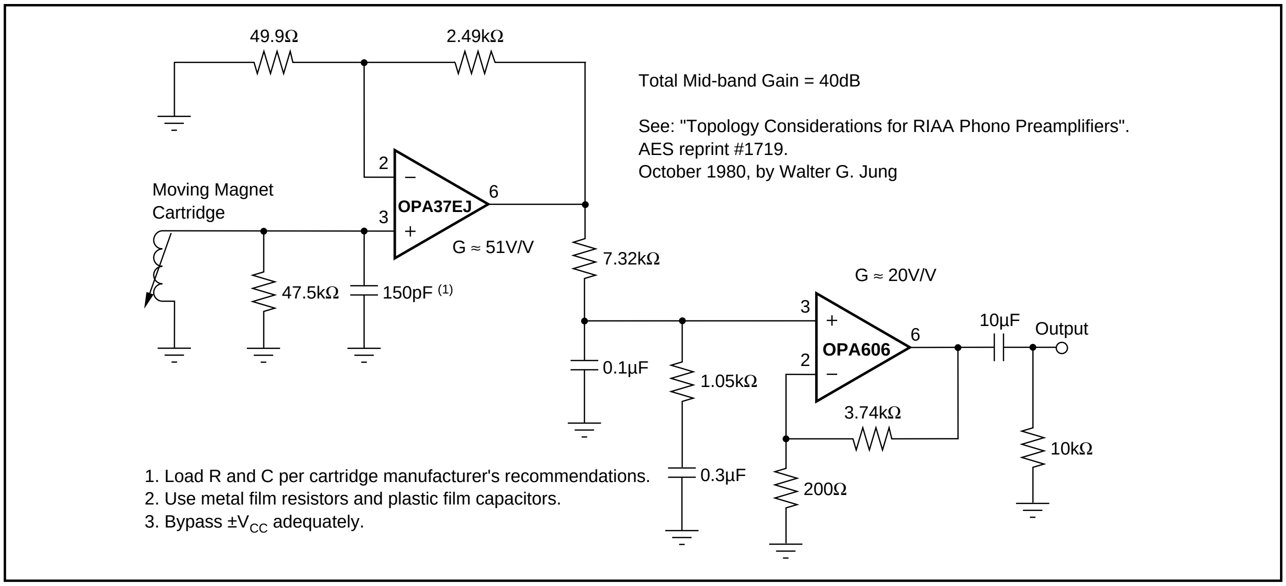
FIGURE 8. Isolating Load Capacitance from Buffer.



Differential Gain = 1 + (2 x 10kΩ)/R_G

1. Bandwidth ≈1.2MHz
2. Differential Gain = 11
3. Differential Output ≈ 50Vp-p
4. Differential Slew Rate ≈ 65V/µs

FIGURE 9. Differential Input/Differential Output Amplifier.



Total Mid-band Gain = 40dB

See: "Topology Considerations for RIAA Phono Preamplifiers".
AES reprint #1719.
October 1980, by Walter G. Jung

1. Load R and C per cartridge manufacturer's recommendations.
2. Use metal film resistors and plastic film capacitors.
3. Bypass ±V_{CC} adequately.

FIGURE 10. Low Noise/Low Distortion RIAA Preamplifier.

PACKAGE OPTION ADDENDUM

PACKAGING INFORMATION

Orderable Device	Status [1]	Package Type	Package Drawing	Pins	Package Qty	Eco Plan [2]	Lead/Ball Finish	MSL Peak Temp [3]
OPA606KM	OBSOLETE	TO-99	LMC	8		TBD	Call TI	Call TI
OPA606KP	ACTIVE	PDIP	P	8	50	TBD	Call TI	Level-NA-NA-NA
OPA606LM	OBSOLETE	TO-99	LMC	8		TBD	Call TI	Call TI

[1] The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

[2] Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS) or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

[3] MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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