µA776
Multi-Purpose Programmable Operational Amplifier

Linear Division Operational Amplifiers

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**
- **± 1.2 V To ± 18 V 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
Storage Temperature Range
Metal Can	−65°C to +175°C
Molded DIP	−65°C to +150°C

Operating Temperature Range
Extended (µA776M)	−55°C to +125°C
Commercial (µA776C)	0°C to +70°C

Lead Temperature
Metal Can (soldering, 60 s)	300°C
Molded DIP (soldering, 10 s)	265°C

Internal Power Dissipation[1, 2]
|	
8L-Metal Can	1.00 W
8L-Molded DIP	0.93 W
Supply Voltage	± 18 V
Differential Input Voltage	± 30 V
Input Voltage[3]	± 15 V
Voltage Between Offset Null and V−	± 0.5 V
Output Short Circuit Duration[4]	Indefinite
I_{SET} (Maximum Current at I_{SET})	500 µA
V_{SET} (Maximum Voltage to Ground at I_{SET})	(V+ −2.0 V) $\leqslant V_{SET} \leqslant$ V+

Notes
1. $T_{J\ Max} = 150°C$ for the Molded DIP, and 175°C for the Metal Can.
2. Ratings apply to ambient temperature at 25°C. Above this temperature, derate the 8L-Metal Can at 6.7 mW/°C, and the 8L-Molded DIP at 7.5 mW/°C.

Connection Diagram
8-Lead Metal Package
(Top View)
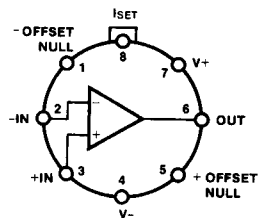
Lead 4 connected to case.

Order Information
Device Code	Package Code	Package Description
µA776HM	5W	Metal
µA776HC	5W	Metal

Connection Diagram
8-Lead DIP
(Top View)
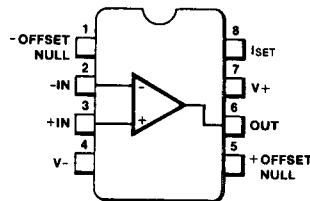
Order Information
Device Code	Package Code	Package Description
µA776TC	9T	Molded DIP

3. For supply voltages less than ± 15 V, the absolute maximum input voltage is equal to the supply voltage.
4. Short Circuit may be to ground or either supply. Rating applies to 125°C case temperature or 75°C ambient temperature for $I_{SET} \leqslant 30$ µA.

Equivalent Circuit

EQ00101F

μA776

μA776

Electrical Characteristics $T_A = 25°C$, $V_{CC} = \pm 15$ V, unless otherwise specified.

Symbol	Characteristic		Condition	I_{SET} = 1.5µA			I_{SET} = 15µA			Unit
				Min	Typ	Max	Min	Typ	Max	
V_{IO}	Input Offset Voltage		$R_S \leqslant 10$ kΩ		2.0	5.0		2.0	5.0	mV
$V_{IO\ adj}$	Input Offset Voltage Adjustment Range				9.0			18		mV
I_{IO}	Input Offset Current				0.7	3.0		2.0	15	nA
I_{IB}	Input Bias Current				2.0	7.5		15	50	nA
Z_I	Input Impedance				50			5.0		MΩ
I_{CC}	Supply Current				20	25		160	180	µA
P_c	Power Consumption					0.75			5.4	mW
I_{OS}	Output Short Circuit Current				3.0			12		mA
A_{VS}	Large Signal Voltage Gain		$V_O = \pm 10$ V, $R_L \geqslant 75$ kΩ	200	400					V/mV
			$V_O = \pm 10$ V, $R_L \geqslant 5.0$ kΩ				100	400		
V_{OP}	Output Voltage Swing		$R_L = 75$ kΩ	± 12	± 14					V
			$R_L = 5.0$ kΩ				± 10	± 13		
TR	Transient Response	Rise time	$V_I = 20$ mV, $R_L = 5.0$ kΩ, $C_L = 100$ pF, $A_V = 1.0$		1.6			0.35		µs
		Overshoot			0			10		%
SR	Slew Rate		$R_L = 5.0$ kΩ, $A_V = 1.0$		0.1			0.8		V/µs

The following specifications apply $-55°C \leqslant T_A \leqslant +125°C$

Symbol	Characteristic	Condition	Min	Typ	Max	Min	Typ	Max	Unit
V_{IO}	Input Offset Voltage	$R_S \leqslant 10$ kΩ			6.0			6.0	mV
I_{IO}	Input Offset Current	$T_A = +125°C$			5.0			15	nA
		$T_A = -55°C$			10			40	
I_{IB}	Input Bias Current	$T_A = +125°C$			7.5			50	nA
		$T_A = -55°C$			20			120	
I_{CC}	Supply Current				30			200	µA
P_c	Power Consumption				0.9			6.0	mW
CMR	Common Mode Rejection	$R_S \leqslant 10$ kΩ	70	90		70	90		dB
V_{IR}	Input Voltage Range		± 10			± 10			V
PSRR	Power Supply Rejection Ratio	$R_S \leqslant 10$ kΩ		25	150		25	150	µV/V
A_{VS}	Large Signal Voltage Gain	$V_O = \pm 10$ V, $R_L \geqslant 75$ kΩ	100			75			V/mV
V_{OP}	Output Voltage Swing	$R_L = 75$ kΩ	± 10			± 10			V

µA776
Electrical Characteristics $T_A = 25°C$, $V_{CC} = \pm 3.0$ V, unless otherwise specified.

Symbol	Characteristic		Condition	$I_{SET} = 1.5\mu A$			$I_{SET} = 15\mu A$			Unit
				Min	Typ	Max	Min	Typ	Max	
V_{IO}	Input Offset Voltage		$R_S \leqslant 10$ kΩ		2.0	5.0		2.0	5.0	mV
$V_{IO\ adj}$	Input Offset Voltage Adjustment Range				9.0			18		mV
I_{IO}	Input Offset Current				0.7	3.0		2.0	15	nA
I_{IB}	Input Bias Current				2.0	7.5		15	50	nA
Z_I	Input Impedance				50			5.0		MΩ
I_{CC}	Supply Current				13	20		130	160	μA
P_c	Power Consumption				78	120		780	960	μW
I_{OS}	Output Short Circuit Current				3.0			5.0		mA
A_{VS}	Large Signal Voltage Gain		$V_O = \pm 1.0$ V, $R_L \geqslant 75$ kΩ	50	200					V/mV
			$V_O = \pm 1.0$ V, $R_L \geqslant 5.0$ kΩ				50	200		
TR	Transient Response	Rise time	$V_I = 20$ mV, $R_L = 5.0$ kΩ, $C_L = 100$ pF, $A_V = 1.0$		3.0			0.6		μs
		Overshoot			0			5		%
SR	Slew Rate		$R_L = 5.0$ kΩ, $A_V = 1.0$		0.03			0.35		V/μs

The following specifications apply $-55°C \leqslant T_A \leqslant +125°C$

Symbol	Characteristic	Condition	Min	Typ	Max	Min	Typ	Max	Unit
V_{IO}	Input Offset Voltage	$R_S \leqslant 10$ kΩ			6.0			6.0	mV
I_{IO}	Input Offset Current	$T_A = +125°C$			5.0			15	nA
		$T_A = -55°C$			10			40	nA
I_{IB}	Input Bias Current	$T_A = +125°C$			7.5			50	nA
		$T_A = -55°C$			20			120	
I_{CC}	Supply Current				25			180	μA
P_c	Power Consumption				150			1080	μW
CMR	Common Mode Rejection	$R_S \leqslant 10$ kΩ	70	86		70	86		dB
V_{IR}	Input Voltage Range		± 1.0			± 1.0			V
PSRR	Power Supply Rejection Ratio	$R_S \leqslant 10$ kΩ		25	150		25	150	$\mu V/V$
A_{VS}	Large Signal Voltage Gain	$V_O = \pm 1.0$ V, $R_L \geqslant 75$ kΩ	25						V/mV
		$V_O = \pm 1.0$ V, $R_L \geqslant 5.0$ kΩ				25			
V_{OP}	Output Voltage Swing	$R_L = 75$ kΩ	± 2.0	± 2.4					V
		$R_L = 5.0$ kΩ				± 1.9	± 2.1		

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µA776C
Electrical Characteristics $T_A = 25°C$, $V_{CC} = \pm 15$ V, unless otherwise specified.

Symbol	Characteristic		Condition	$I_{SET} = 1.5\mu A$			$I_{SET} = 15\mu A$			Unit
				Min	Typ	Max	Min	Typ	Max	
V_{IO}	Input Offset Voltage		$R_S \leqslant 10$ kΩ		2.0	6.0		2.0	6.0	mV
$V_{IO\ adj}$	Input Offset Voltage Adjustment Range				9.0			18		mV
I_{IO}	Input Offset Current				0.7	6.0		2.0	25	nA
I_{IB}	Input Bias Current				2.0	10		15	50	nA
Z_I	Input Impedance				50			5.0		MΩ
I_{CC}	Supply Current				20	30		160	190	μA
P_c	Power Consumption					0.9			5.7	mW
I_{OS}	Output Short Circuit Current				3.0			12		mA
A_{VS}	Large Signal Voltage Gain		$V_O = \pm 10$ V, $R_L \geqslant 75$ kΩ	50	400					V/mV
			$V_O = \pm 10$ V, $R_L \geqslant 5.0$ kΩ				50	400		
V_{OP}	Output Voltage Swing		$R_L = 75$ kΩ	± 12	± 14					V
			$R_L = 5.0$ kΩ				± 10	± 13		
TR	Transient Response	Rise time	$V_I = 20$ mV, $R_L \geqslant 5.0$ kΩ, $C_L = 100$ pF, $A_V = 1.0$		1.6			0.35		μs
		Overshoot			0			10		%
SR	Slew Rate		$R_L = 5.0$ kΩ, $A_V = 1.0$		0.1			0.8		V/μs

The following specifications apply $0°C \leqslant T_A \leqslant +70°C$

Symbol	Characteristic	Condition	Min	Typ	Max	Min	Typ	Max	Unit
V_{IO}	Input Offset Voltage	$R_S \leqslant 10$ kΩ			7.5			7.5	mV
I_{IO}	Input Offset Current	$T_A = 70°C$			6.0			25	nA
		$T_A = 0°C$			10			40	
I_{IB}	Input Bias Current	$T_A = 70°C$			10			50	nA
		$T_A = 0°C$			20			100	
I_{CC}	Supply Current				35			200	μA
P_c	Power Consumption				1.05			6.0	mW
CMR	Common Mode Rejection	$R_S \leqslant 10$ kΩ	70	90		70	90		dB
V_{IR}	Input Voltage Range		± 10			± 10			V
PSRR	Power Supply Rejection Ratio	$R_S \leqslant 10$ kΩ		25	200		25	200	μV/V
A_{VS}	Large Signal Voltage Gain	$V_O = \pm 10$ V, $R_L \geqslant 75$ kΩ	50			50			V/mV
V_{OP}	Output Voltage Swing	$R_L = 75$ kΩ	± 10			± 10			V

μA776C
Electrical Characteristics $T_A = 25°C$, $V_{CC} = \pm 3.0$ V, unless otherwise specified.

Symbol	Characteristic		Condition	$I_{SET} = 1.5\mu A$			$I_{SET} = 15\mu A$			Unit
				Min	Typ	Max	Min	Typ	Max	
V_{IO}	Input Offset Voltage		$R_S \leqslant 10$ kΩ		2.0	6.0		2.0	6.0	mV
$V_{IO\ adj}$	Input Offset Voltage Adjustment Range				9.0			18		mV
I_{IO}	Input Offset Current				0.7	6.0		2.0	25	nA
I_{IB}	Input Bias Current				2.0	10		15	50	nA
Z_I	Input Impedance				50			5.0		MΩ
I_{CC}	Supply Current				13	20		130	170	μA
P_c	Power Consumption				78	120		780	1020	μW
I_{OS}	Output Short Circuit Current				3.0			5.0		mA
A_{VS}	Large Signal Voltage Gain		$V_O = \pm 1.0$ V, $R_L \geqslant 75$ kΩ	25	200					V/mV
			$V_O = \pm 1.0$ V, $R_L \geqslant 5.0$ kΩ				25	200		
TR	Transient Response	Rise time	$V_I = 20$ mV, $R_L \geqslant 5.0$ kΩ, $C_L = 100$ pF, $A_V = 1.0$		3.0			0.6		μs
		Overshoot			0			5		%
SR	Slew Rate		$R_L = 5.0$ kΩ, $A_V = 1.0$		0.03			0.35		V/μs

The following specifications apply $0°C \leqslant T_A \leqslant +70°C$

Symbol	Characteristic	Condition	Min	Typ	Max	Min	Typ	Max	Unit
V_{IO}	Input Offset Voltage	$R_S \leqslant 10$ kΩ			7.5			7.5	mV
I_{IO}	Input Offset Current	$T_A = 70°C$			6.0			25	nA
		$T_A = 0°C$			10			40	
I_{IB}	Input Bias Current	$T_A = 70°C$			10			50	nA
		$T_A = 0°C$			20			100	
I_{CC}	Supply Current				25			180	μA
P_c	Power Consumption				150			1080	μW
CMR	Common Mode Rejection	$R_S \leqslant 10$ kΩ	70	86		70	86		dB
V_{IR}	Input Voltage Range		± 1.0			± 1.0			V
PSRR	Power Supply Rejection Ratio	$R_S \leqslant 10$ kΩ		25	200		25	200	μV/V
A_{VS}	Large Signal Voltage Gain	$V_O = \pm 1.0$ V, $R_L \geqslant 75$ kΩ	25						V/mV
		$V_O = \pm 1.0$ V, $R_L \geqslant 5.0$ kΩ				25			
V_{OP}	Output Voltage Swing	$R_L = 75$ kΩ	± 2.0	± 2.4					V
		$R_L = 5.0$ kΩ				± 2.0	± 2.1		

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Typical Performance Curves for μA776 and μA776C

Input Bias Current vs Set Current
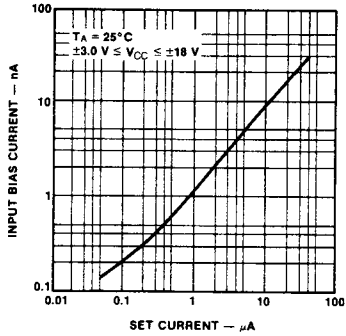
Input Bias Current vs Temperature
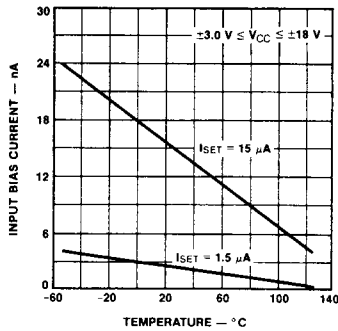
Input Offset Current vs Temperature
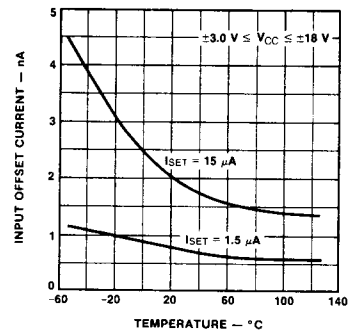
Change in Input Offset Voltage vs Set Current
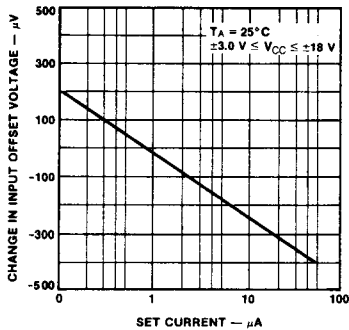
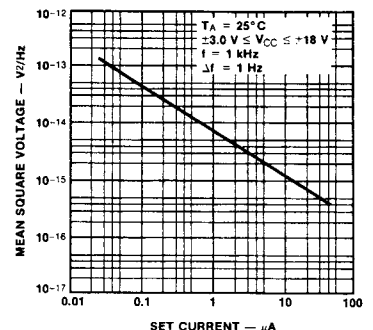### Change in Input Offset Voltage vs Temperature (Unnulled)
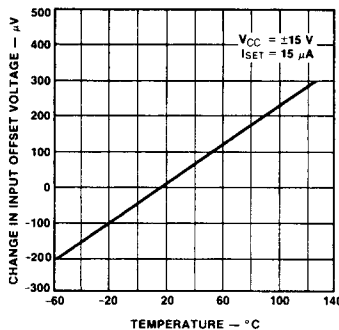
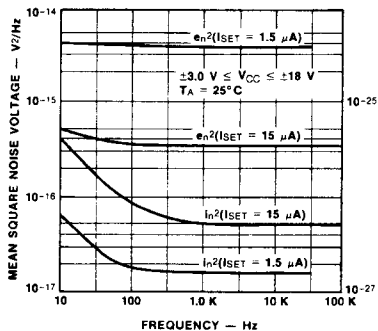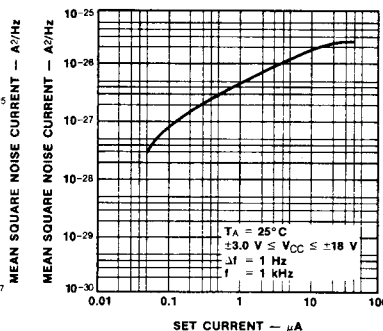### Input Noise Voltage vs Set Current

Input Noise Voltage and Current vs Frequency

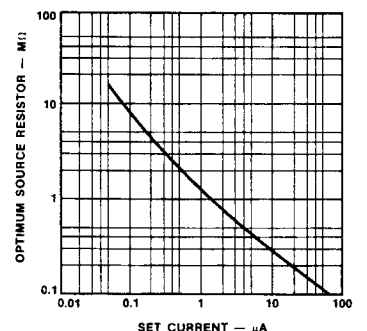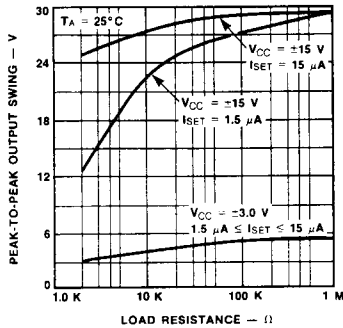### Input Noise Current vs Set Current
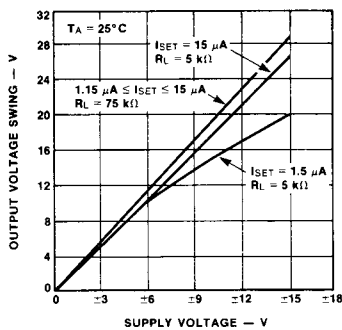
Optimum Source Resistor for Minimum Noise vs Set Current

Typical Performance Curves for μA776 and μA776C (Cont.)

Output Voltage Swing vs Load Resistance

PC04071F

Output Voltage Swing vs Supply Voltage

PC04080F

Gain Bandwidth Product vs Set Current
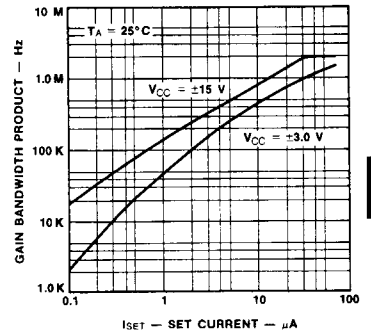
PC04091F

Voltage Gain vs Temperature
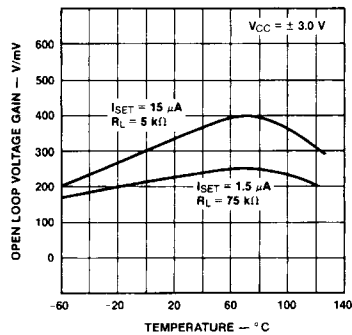
PC04101F

Voltage Gain vs Temperature
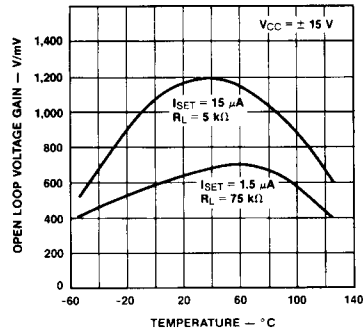
PC04111F

Power Supply Rejection Ratio vs Set Current
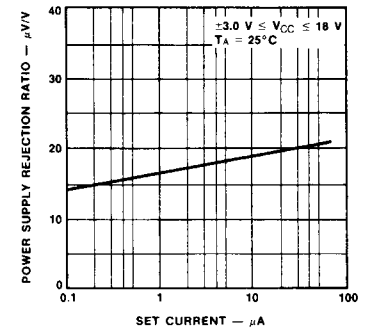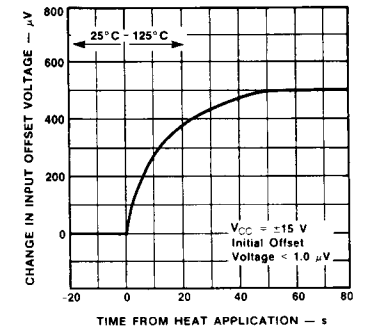

PC04121F

Supply Current vs Temperature
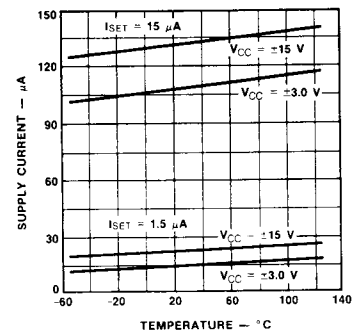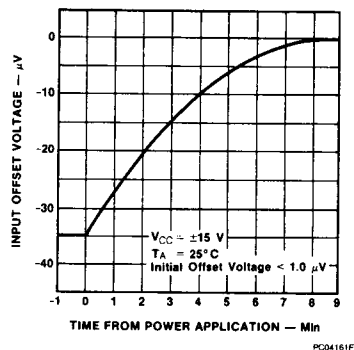

PC04130F

Standby Supply Current vs Set Current
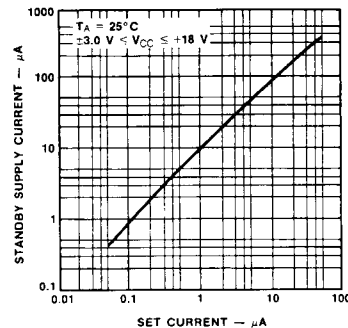
PC04141F

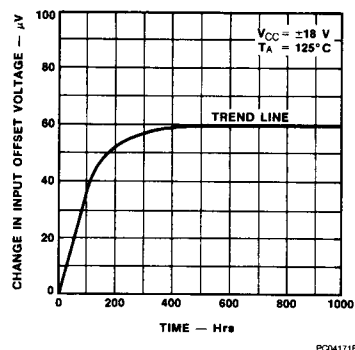### Thermal Response Of Input Offset Voltage To Step Change Of Case Temperature

PC04151F

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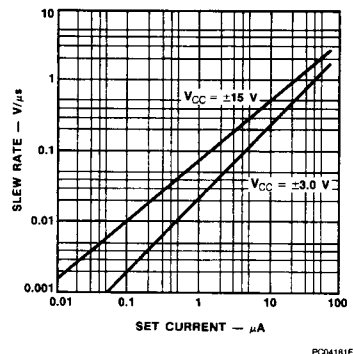
Typical Performance Curves for µA776 and µA776C (Cont.)

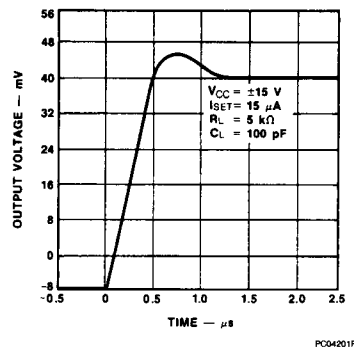### Stabilization Time Of Input Offset Voltage From Power On
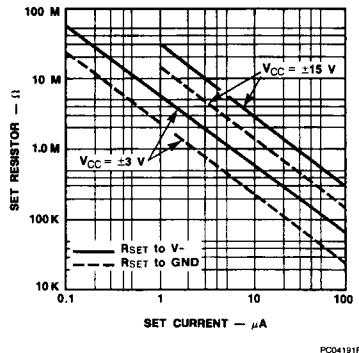

INPUT OFFSET VOLTAGE – µV

$V_{CC} = \pm 15$ V
$T_A = 25°C$
Initial Offset Voltage < 1.0 µV

TIME FROM POWER APPLICATION — Min

PC04161F

Input Offset Voltage Drift vs Time

CHANGE IN INPUT OFFSET VOLTAGE – µV

$V_{CC} = \pm 18$ V
$T_A = 125°C$

TREND LINE

TIME — Hrs

PC04171F

Slew Rate vs Set Current

SLEW RATE – V/µs

$V_{CC} = \pm 15$ V

$V_{CC} = \pm 3.0$ V

SET CURRENT — µA

PC04181F

Voltage Follower Transient Response (Unity Gain)

OUTPUT VOLTAGE – mV

$V_{CC} = \pm 15$ V
$I_{SET} = 15$ µA
$R_L = 5$ kΩ
$C_L = 100$ pF

TIME — µs

PC04201F

Set Current vs Set Resistor

SET RESISTOR – Ω

$V_{CC} = \pm 15$ V

$V_{CC} = \pm 3$ V

——— R_{SET} to V–
– – – R_{SET} to GND

SET CURRENT — µA

PC04191F

Quiescent Current Setting Resistor (I_{SET} to V⁻)

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

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

I_{SET} Equations

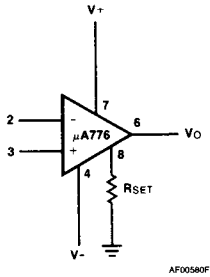$$I_{SET} = \frac{(V+)-0.7-(V-)}{R_{SET}}$$

where:
R_{SET} is connected to V –
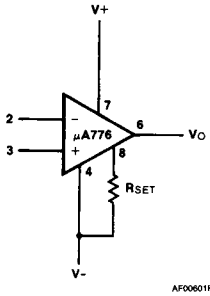
$$I_{SET} = \frac{(V+)-0.7}{R_{SET}}$$

where:
R_{SET} is connected to ground.

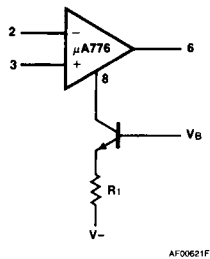## Biasing Circuits

Resistor Biasing

AF00580F

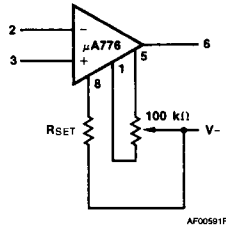R_{SET} Connected to Ground

AF00601F

R_{SET} Connected to V−
*Recommended for supply voltages less than ± 6 V.

Transistor Current Source Biasing

AF00621F

Voltage Offset Null Circuit

AF00591F

FET Current Source Biasing

AF00610F
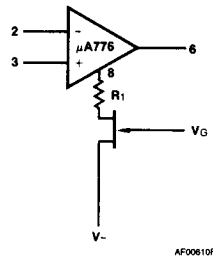
Transient Response Test Circuit

AF00631F