FAIRCHILD
A Schlumberger Company

# 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**

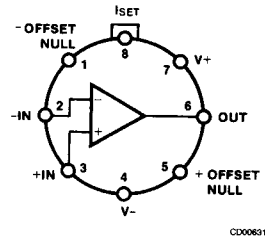
## Absolute Maximum Ratings

| | |
|---|---|
| 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) ≤ $V_{SET}$ ≤ 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.
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 $I_{SET}$ ≤ 30 μA.

## Connection Diagram
## 8-Lead Metal Package
## (Top View)



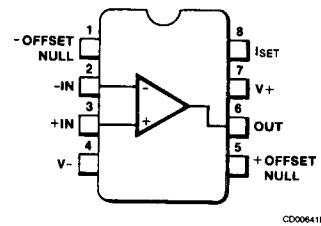

CD00631F

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)

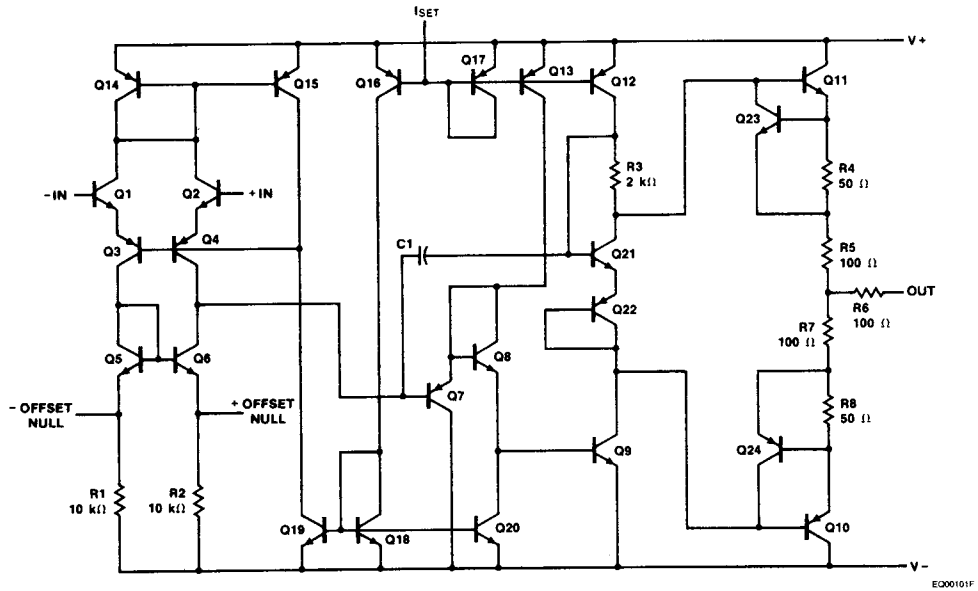



CD00641F

## Order Information

| Device Code | Package Code | Package Description |
|---|---|---|
| μA776TC | 9T | Molded DIP |

## Equivalent Circuit



## μA776

**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 | | $R_S \leq 10$ 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, $R_L \geq 75$ kΩ | 200 | 400 | | | | | V/mV |
| | | | $V_O = \pm 10$ V, $R_L \geq 5.0$ 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 $-55°C \leq T_A \leq +125°C$

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $V_{IO}$ | Input Offset Voltage | $R_S \leq 10$ 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 | $R_S \leq 10$ kΩ | 70 | 90 | | 70 | 90 | | dB |
| $V_{IR}$ | Input Voltage Range | | ±10 | | | ±10 | | | V |
| PSRR | Power Supply Rejection Ratio | $R_S \leq 10$ kΩ | | 25 | 150 | | 25 | 150 | μV/V |
| $A_{VS}$ | Large Signal Voltage Gain | $V_O = \pm 10$ V, $R_L \geq 75$ 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 | $I_{SET} = 1.5\mu A$ Min | Typ | Max | $I_{SET} = 15\mu A$ Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| $V_{IO}$ | Input Offset Voltage | | $R_S \leq 10$ 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, $R_L \geq 75$ kΩ | 50 | 200 | | | | | V/mV |
| | | | $V_O = \pm 1.0$ V, $R_L \geq 5.0$ 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 $-55°C \leq T_A \leq +125°C$ | | | | | | | | | | |
| $V_{IO}$ | Input Offset Voltage | | $R_S \leq 10$ 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 | | $R_S \leq 10$ kΩ | 70 | 86 | | 70 | 86 | | dB |
| $V_{IR}$ | Input Voltage Range | | | ±1.0 | | | ±1.0 | | | V |
| PSRR | Power Supply Rejection Ratio | | $R_S \leq 10$ kΩ | | 25 | 150 | | 25 | 150 | μV/V |
| $A_{VS}$ | Large Signal Voltage Gain | | $V_O = \pm 1.0$ V, $R_L \geq 75$ kΩ | 25 | | | | | | V/mV |
| | | | $V_O = \pm 1.0$ V, $R_L \geq 5.0$ 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 | | |

## μA776C

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

| Symbol | Characteristic | | Condition | $I_{SET} = 1.5\mu A$ Min | Typ | Max | $I_{SET} = 15\mu A$ Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| $V_{IO}$ | Input Offset Voltage | | $R_S \leq 10$ 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, $R_L \geq 75$ kΩ | 50 | 400 | | | | | V/mV |
| | | | $V_O = \pm 10$ V, $R_L \geq 5.0$ 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, $R_L \geq 5.0$ 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 $0°C \leq T_A \leq +70°C$

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $V_{IO}$ | Input Offset Voltage | $R_S \leq 10$ 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 | $R_S \leq 10$ kΩ | 70 | 90 | | 70 | 90 | | dB |
| $V_{IR}$ | Input Voltage Range | | ±10 | | | ±10 | | | V |
| PSRR | Power Supply Rejection Ratio | $R_S \leq 10$ kΩ | | 25 | 200 | | 25 | 200 | μV/V |
| $A_{VS}$ | Large Signal Voltage Gain | $V_O = \pm 10$ V, $R_L \geq 75$ 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.

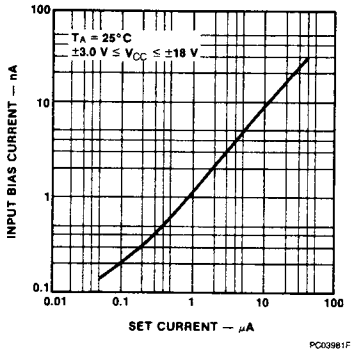
| Symbol | Characteristic | | Condition | $I_{SET} = 1.5\mu A$ Min | Typ | Max | $I_{SET} = 15\mu A$ Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| $V_{IO}$ | Input Offset Voltage | | $R_S \leq 10$ kΩ | | 2.0 | 6.0 | | 2.0 | 6.0 | mV |
| $V_{IO\ adj}$ | Input Offset Voltage 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, $R_L \geq 75$ kΩ | 25 | 200 | | | | | V/mV |
| | | | $V_O = \pm 1.0$ V, $R_L \geq 5.0$ kΩ | | | | 25 | 200 | | |
| TR | Transient Response | Rise time | $V_I = 20$ mV, $R_L \geq 5.0$ 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 $0°C \leq T_A \leq +70°C$

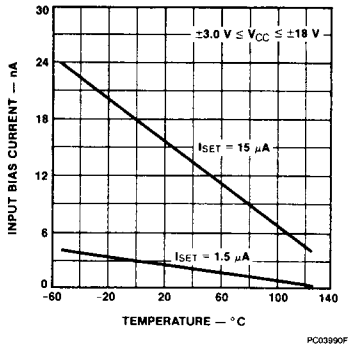
| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $V_{IO}$ | Input Offset Voltage | $R_S \leq 10$ kΩ | | | 7.5 | | | 7.5 | mV |
| $I_{IO}$ | Input Offset Current | $T_A = 70°C$ | | | 6.0 | | | 25 | nA |
| | | $T_A = 0°C$ | | | 10 | | | 40 | |
| $I_{IB}$ | Input Bias Current | $T_A = 70°C$ | | | 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 | $R_S \leq 10$ kΩ | 70 | 86 | | 70 | 86 | | dB |
| $V_{IR}$ | Input Voltage Range | | ±1.0 | | | ±1.0 | | | V |
| PSRR | Power Supply Rejection Ratio | $R_S \leq 10$ kΩ | | 25 | 200 | | 25 | 200 | μV/V |
| $A_{VS}$ | Large Signal Voltage Gain | $V_O = \pm 1.0$ V, $R_L \geq 75$ kΩ | 25 | | | | | | V/mV |
| | | $V_O = \pm 1.0$ V, $R_L \geq 5.0$ 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 | | |

## Typical Performance Curves for μA776 and μA776C

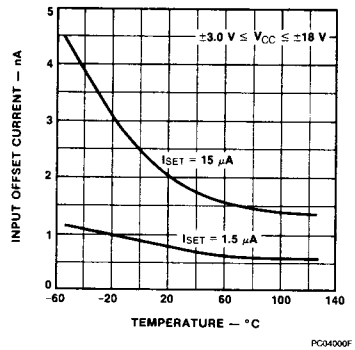
### Input Bias Current vs Set Current



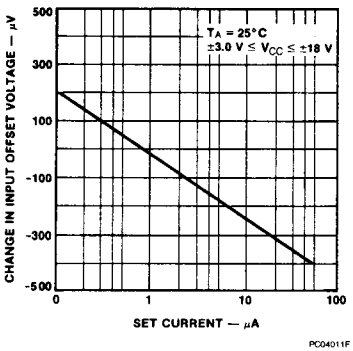

### Input Bias Current vs Temperature



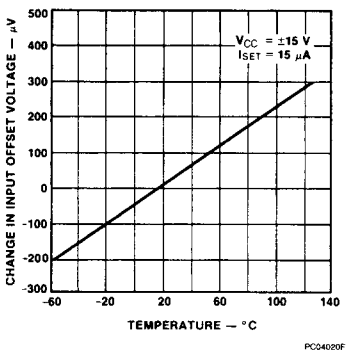

### Input Offset Current vs Temperature



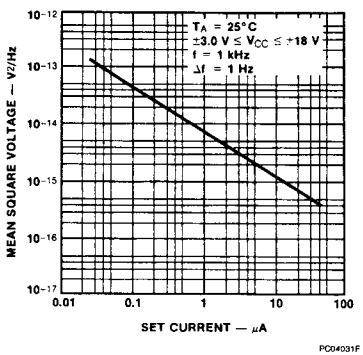

### Change in Input Offset Voltage vs Set Current



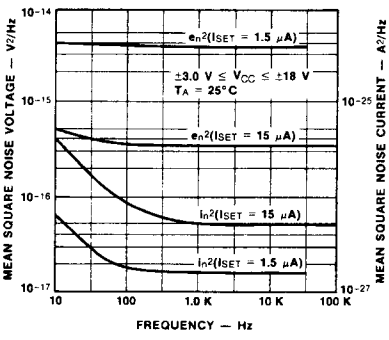

### Change in Input Offset Voltage vs Temperature (Unnulled)



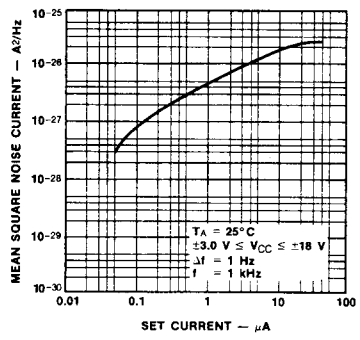

### Input Noise Voltage vs Set Current



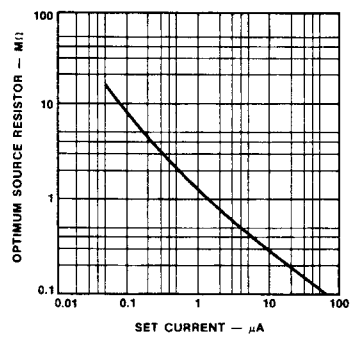

### Input Noise Voltage and Current vs Frequency




### Input Noise Current vs Set Current

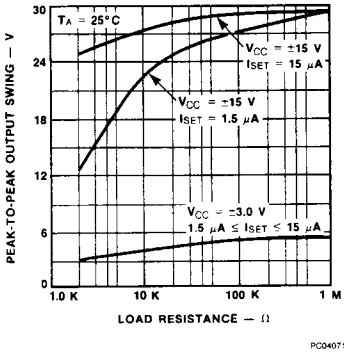



### Optimum Source Resistor for Minimum Noise vs Set Current

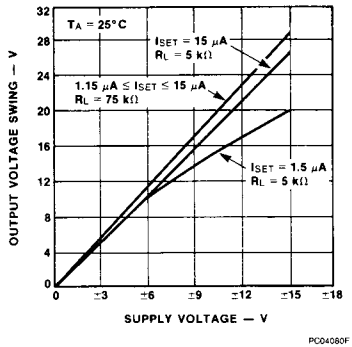


## Typical Performance Curves for μA776 and μA776C (Cont.)

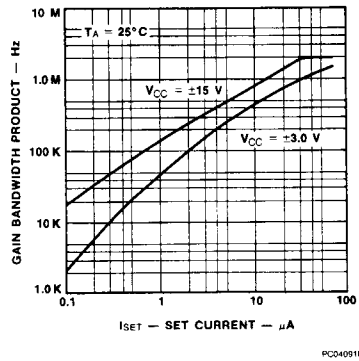
### Output Voltage Swing vs Load Resistance



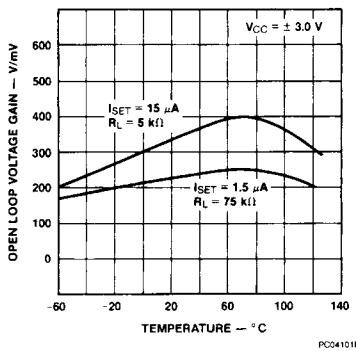

### Output Voltage Swing vs Supply Voltage



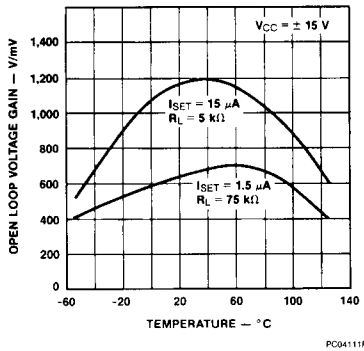

### Gain Bandwidth Product vs Set Current



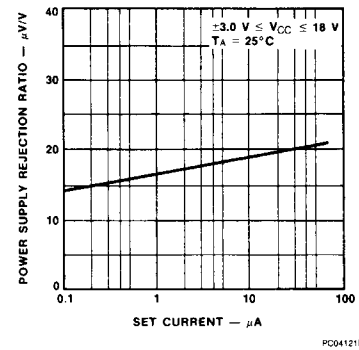

### Voltage Gain vs Temperature



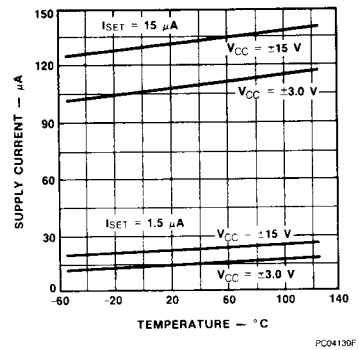

### Voltage Gain vs Temperature



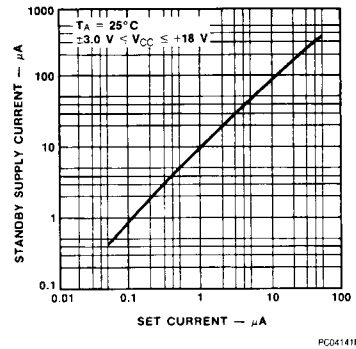

### Power Supply Rejection Ratio vs Set Current



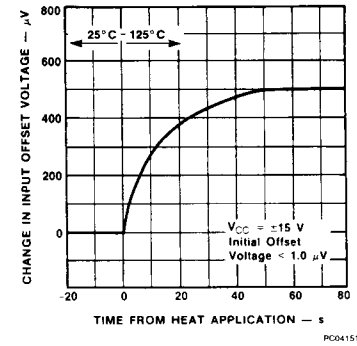

### Supply Current vs Temperature




### Standby Supply Current vs Set Current

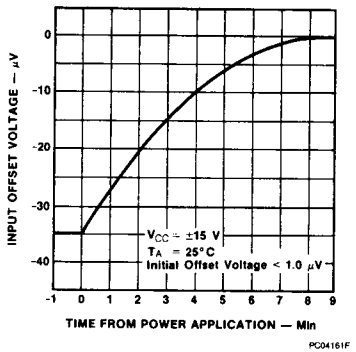



### Thermal Response Of Input Offset Voltage To Step Change Of Case Temperature

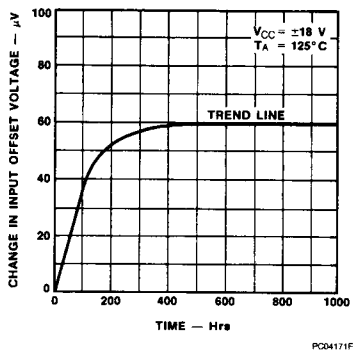


## Typical Performance Curves for μA776 and μA776C (Cont.)

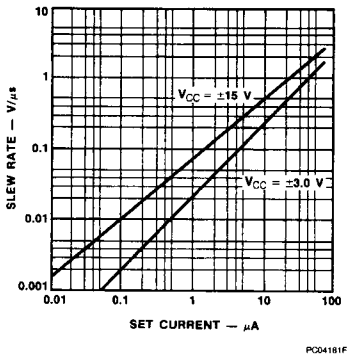
### Stabilization Time Of Input Offset Voltage From Power On



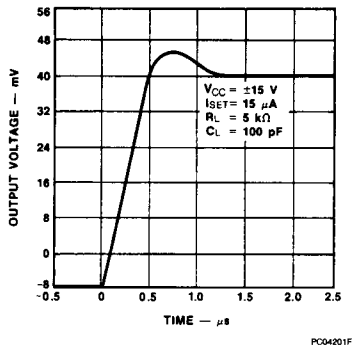

### Input Offset Voltage Drift vs Time



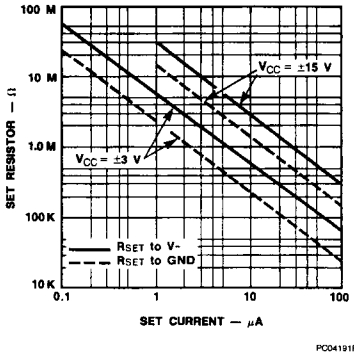

### Slew Rate vs Set Current




### Voltage Follower Transient Response (Unity Gain)




### Set Current vs Set Resistor




### Quiescent Current Setting Resistor ($I_{SET}$ to $V^-$)

| | $I_{SET}$ | |
|---|---|---|
| $V_S$ | 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

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

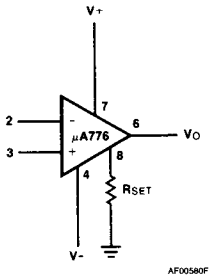
where:
$R_{SET}$ is connected to V−

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

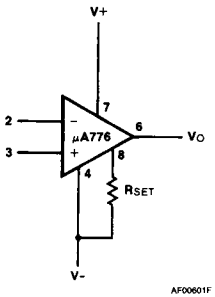
where:
$R_{SET}$ is connected to ground.

## Biasing Circuits

### Resistor Biasing

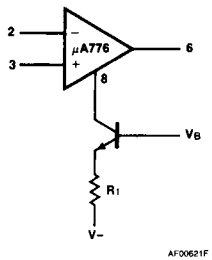



$R_{SET}$ Connected to Ground

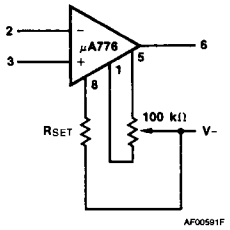



$R_{SET}$ Connected to V–
*Recommended for supply voltages less than ±6 V.

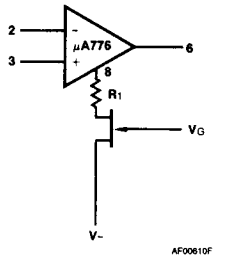
### Transistor Current Source Biasing




### Voltage Offset Null Circuit




### FET Current Source Biasing




### Transient Response Test Circuit