µA776

MULTI-PURPOSE PROGRAMMABLE OPERATIONAL AMPLIFIER

FAIRCHILD LINEAR INTEGRATED CIRCUITS

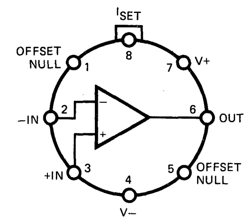
DESCRIPTION – The µA776 Programmable Operational Amplifier is constructed using the Fairchild Planar* epitaxial process. High input impedance, low supply currents, and low input noise over a wide range of operating supply voltages coupled with programmable electrical characteristics result in an extremely 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 (µA776)	–55°C to +125°C
Commercial (µA776C)	0°C to +70°C
Pin Temperature (Soldering, 60 s)	
Metal Can, DIP	300°C
Mini DIP	260°C
Output Short Circuit Duration (Note 3)	Indefinite

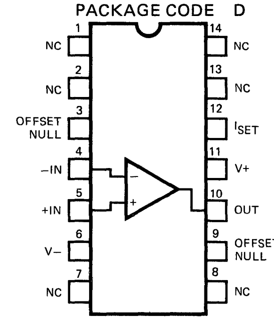
CONNECTION DIAGRAMS
8-PIN METAL CAN
(TOP VIEW)
PACKAGE OUTLINE 5S
PACKAGE CODE H



ORDER INFORMATION

TYPE	PART NO.
µA776	µA776HM
µA776C	µA776HC

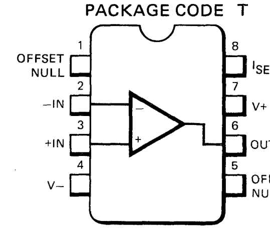
14-PIN DIP
(TOP VIEW)
PACKAGE OUTLINE 6A
PACKAGE CODE D



ORDER INFORMATION

TYPE	PART NO.
µA776	µA776DM
µA776	µA776DC

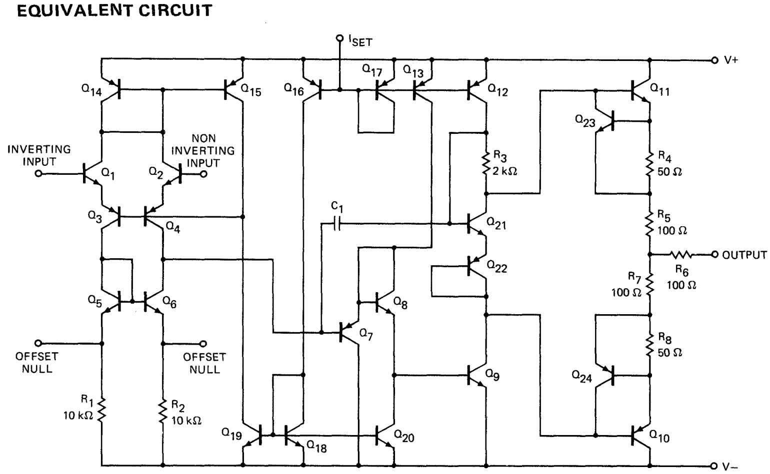
8-PIN MINI DIP
(TOP VIEW)
PACKAGE OUTLINE 9T
PACKAGE CODE T



ORDER INFORMATION

TYPE	PART NO.
µA776C	µA776TC

EQUIVALENT CIRCUIT



*Planar is a patented Fairchild process.

±15 V OPERATION FOR μA776

ELECTRICAL CHARACTERISTICS: T_A = 25°C, unless otherwise specified.

CHARACTERISTICS		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)	Rise Time	V_{IN} = 20mV, $R_L \geq 5k\Omega$, C_L = 100pF		1.6			0.35		μs
	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

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±3 V OPERATION FOR μA776

ELECTRICAL CHARACTERISTICS: T_A = 25°C, unless otherwise specified.

CHARACTERISTICS		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		$R_L \geq 75k\Omega$, $V_{OUT}=\pm1V$	50k	200k					V/V
		$R_L \geq 5k\Omega$, $V_{OUT}=\pm1V$				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)	Rise Time	V_{IN} = 20mV, $R_L \geq 5k\Omega$, $C_L \leq 100pF$		3.0			0.6		μs
	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		$R_L \geq 75k\Omega$, $V_{OUT}=\pm1V$	25k						V/V
		$R_L \geq 5k\Omega$, $V_{OUT}=\pm1V$				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 V OPERATION FOR μA776C

ELECTRICAL CHARACTERISTICS: T_A = 25°C, unless otherwise specified.

CHARACTERISTICS		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)	Rise Time	V_{IN} = 20mV, $R_L \geq 5k\Omega$, $C_L \leq 100pF$		1.6			0.35		μs
	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

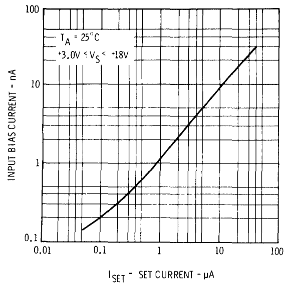
±3 V OPERATION FOR μA776C

ELECTRICAL CHARACTERISTICS: T_A = 25°C, unless otherwise specified.

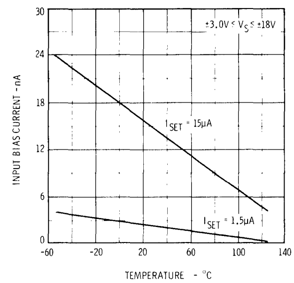
CHARACTERISTICS		CONDITIONS	I_{SET} = 1.5μA MIN	TYP	MAX	I_{SET} = 15μA MIN	TYP	MAX	UNITS
Input Offset Voltage		R_S≤10kΩ		2.0	6.0		2.0	6.0	mV
Input Offset Current				0.7	6.0		2.0	25	nA
Input Bias Current				2.0	10		15	50	nA
Input Resistance				50			5.0		MΩ
Input Capacitance				2.0			2.0		pF
Offset Voltage Adjustment Range				9.0			18		mV
Large Signal Voltage Gain		R_L≥75kΩ, V_{OUT}=±1V	25k	200k					V/V
		R_L≥5kΩ, 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)	Rise Time	V_{IN} = 20mV, R_L ≥ 5kΩ, C_L = 100pF		3.0			0.6		μs
	Overshoot			0			5		%
Slew Rate		R_L≥5kΩ		0.03			0.35		V/μs
The following specifications apply for 0°C≤T_A≤+70°C									
Input Offset Voltage		R_S≤10kΩ			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≤10kΩ	70	86		70	86		dB
Supply Voltage Rejection Ratio		R_S≤10kΩ		25	200		25	200	μV/V
Large Signal Voltage Gain		R_L≥75kΩ, V_{OUT}=±1V	25k						V/V
		R_L≥5kΩ, V_{OUT}=±1V				25k			V/V
Output Voltage Swing		R_L≥75kΩ	±2.0	±2.4					V
		R_L≥5kΩ				±2.0	±2.1		V
Supply Current					25			180	μA
Power Consumption					150			1080	μW

TYPICAL PERFORMANCE CURVES FOR μA776 AND μA776C

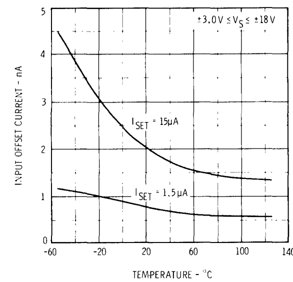
INPUT BIAS CURRENT AS A FUNCTION OF SET CURRENT



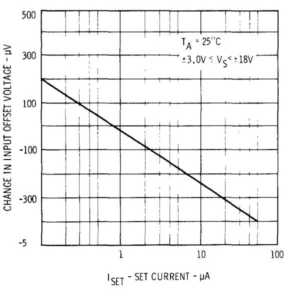
INPUT BIAS CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



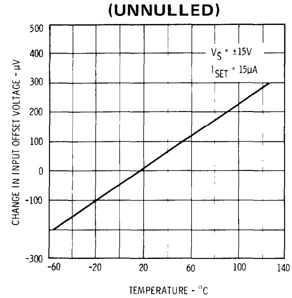
INPUT OFFSET CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



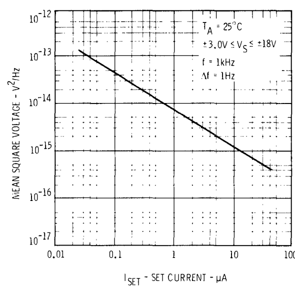
CHANGE IN INPUT OFFSET VOLTAGE AS A FUNCTION OF SET CURRENT



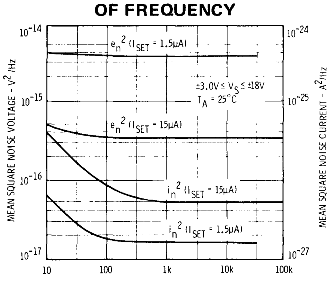
CHANGE IN INPUT OFFSET VOLTAGE AS A FUNCTION OF AMBIENT TEMPERATURE (UNNULLED)



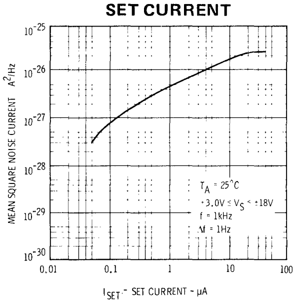
INPUT NOISE VOLTAGE AS A FUNCTION OF SET CURRENT



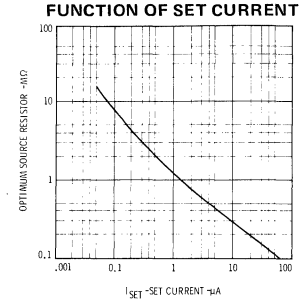
INPUT NOISE VOLTAGE AND CURRENT AS A FUNCTION OF FREQUENCY



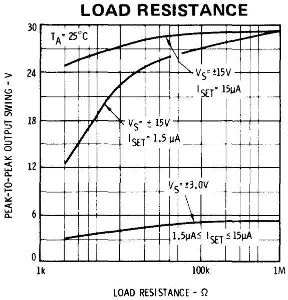
INPUT NOISE CURRENT AS A FUNCTION OF SET CURRENT



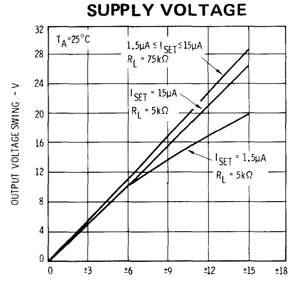
OPTIMUM SOURCE RESISTOR FOR MINIMUM NOISE AS A FUNCTION OF SET CURRENT



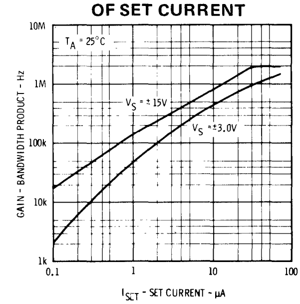
OUTPUT VOLTAGE SWING AS A FUNCTION OF LOAD RESISTANCE



OUTPUT VOLTAGE SWING AS A FUNCTION OF SUPPLY VOLTAGE

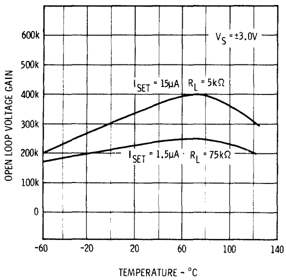


GAIN-BANDWIDTH PRODUCT AS A FUNCTION OF SET CURRENT

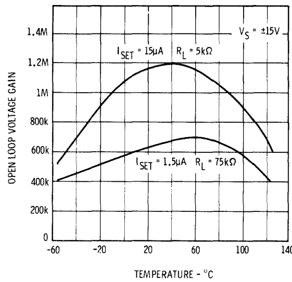


TYPICAL PERFORMANCE CURVES FOR μA776 AND μA776C

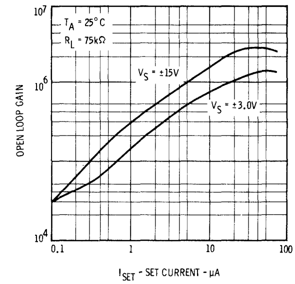
OPEN LOOP VOLTAGE GAIN AS A FUNCTION OF AMBIENT TEMPERATURE



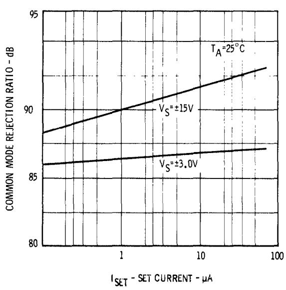
OPEN LOOP VOLTAGE GAIN AS A FUNCTION OF AMBIENT TEMPERATURE



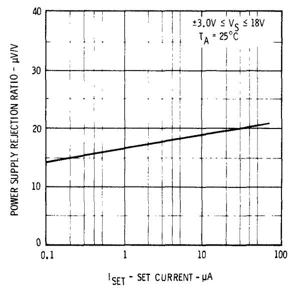
OPEN LOOP VOLTAGE GAIN AS A FUNCTION OF SET CURRENT



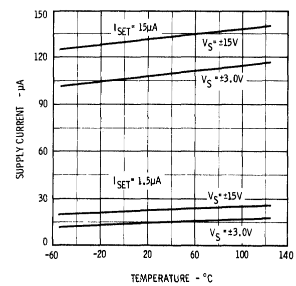
COMMON MODE REJECTION RATIO AS A FUNCTION OF SET CURRENT



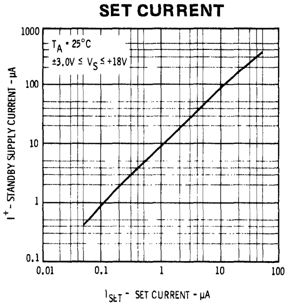
POWER SUPPLY REJECTION RATIO AS A FUNCTION OF SET CURRENT



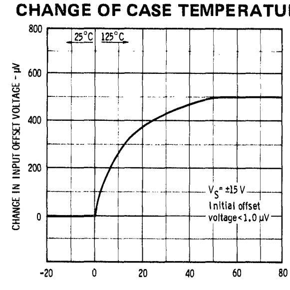
SUPPLY CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



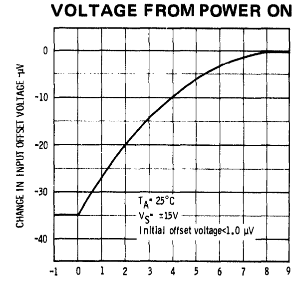
STANDBY SUPPLY CURRENT AS A FUNCTION OF SET CURRENT



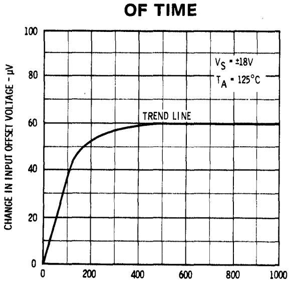
THERMAL RESPONSE OF INPUT OFFSET VOLTAGE TO STEP CHANGE OF CASE TEMPERATURE



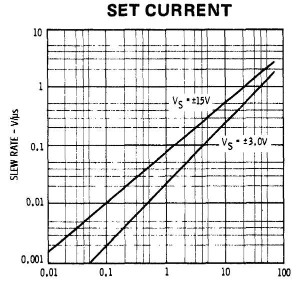
STABILIZATION TIME OF INPUT OFFSET VOLTAGE FROM POWER ON



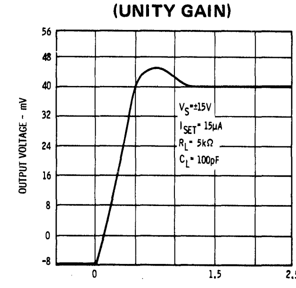
INPUT OFFSET VOLTAGE DRIFT AS A FUNCTION OF TIME



SLEW RATE AS A FUNCTION OF SET CURRENT

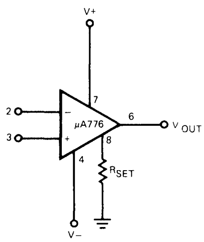


VOLTAGE FOLLOWER TRANSIENT RESPONSE (UNITY GAIN)

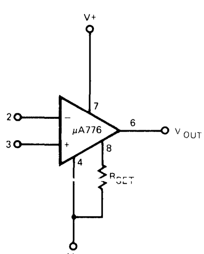


BIASING CIRCUITS

RESISTOR BIASING



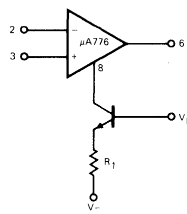
R_{SET} CONNECTED TO GROUND



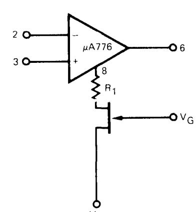
R_{SET} CONNECTED TO V^-

* Recommended for supply voltages less than ±6V.

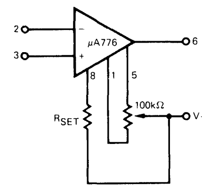
TRANSISTOR CURRENT SOURCE BIASING



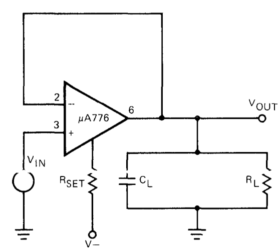
FET CURRENT SOURCE BIASING



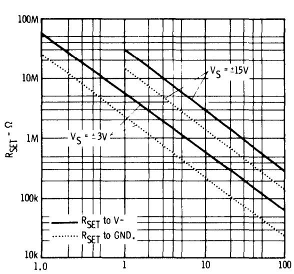
VOLTAGE OFFSET NULL CIRCUIT



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:

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

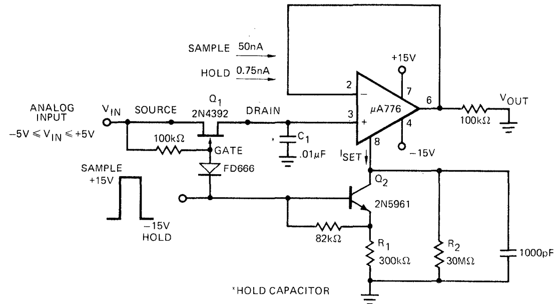
where R_{SET} is connected to V^-

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

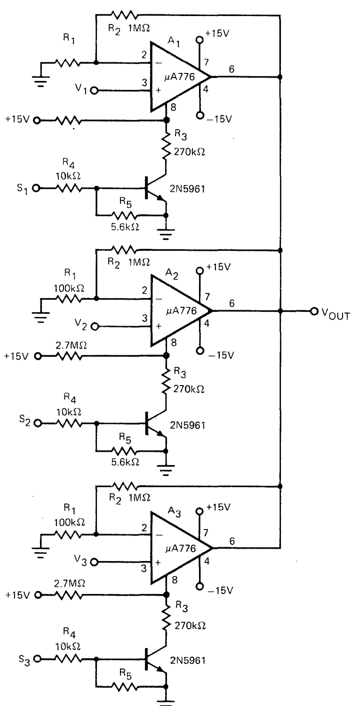
where R_{SET} is connected to ground.

TYPICAL APPLICATIONS

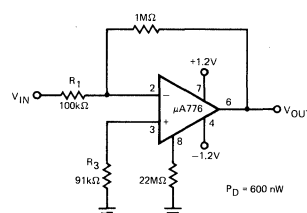
HIGH ACCURACY SAMPLE AND HOLD



MULTIPLEXING AND SIGNAL CONDITIONING WITHOUT FETs



NANO-WATT AMPLIFIER



HIGH INPUT IMPEDANCE AMPLIFIER