

**5 DEVICES COVER COMMERCIAL,
INDUSTRIAL, AND MILITARY
TEMPERATURE RANGES**

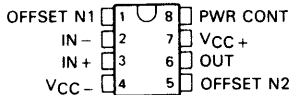
- Very Low, Adjustable ("Programmable") Power Consumption
- Adjustable Supply Current . . . 5 μ A to 200 μ A
- Very Low Input Bias and Offset Currents
- Wide Supply Range . . . ± 1.2 V to ± 18 V
- Wide Common-Mode and Differential Voltage Range
- Output Short-Circuit Protection
- High Input Impedance . . . JFET-Input Stage
- Unity-Gain Bandwidth . . . 1 MHz Typ (100 kHz at 25 μ W)
- High Slew Rate . . . 3.5 V/ μ s Typ
- Internal Frequency Compensation
- Latch-Up-Free Operation

description

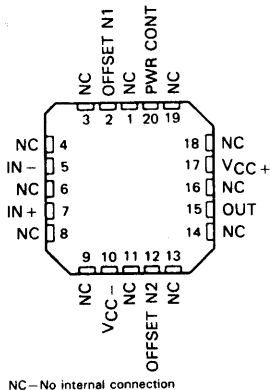
The TL066, TL066A, and TL066B are JFET-input operational amplifiers similar to the TL061 with the additional feature of being power-adjustable. They feature very low input offset and bias currents, high input impedance, wide bandwidth, and high slew rate. The power-control feature permits the amplifiers to be adjusted to require as little as 25 microwatts of power. This type of amplifier, which provides for changing several characteristics by varying one external element, is sometimes referred to as being "programmable." The JFET-input stage combined with the adjustable-low-power feature results in superior bandwidth and slew rate performance compared to low-power bipolar-input devices.

The TL066M is characterized for operation over the full military temperature range of -55°C to 125°C ; the TL066I is characterized for operation from -25°C to 85°C ; the TL066C, TL066AC, and TL066BC are characterized for operation from 0°C to 70°C .

**TL066M . . . JG PACKAGE
TL066I, TL066C, TL066AC, TL066BC . . . D, JG, OR P PACKAGE
(TOP VIEW)**

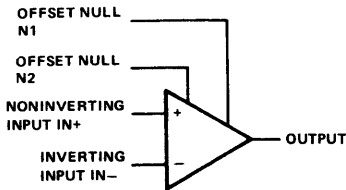


**TL066M . . . FH OR FK PACKAGE
(TOP VIEW)**



NC—No internal connection

symbol



3

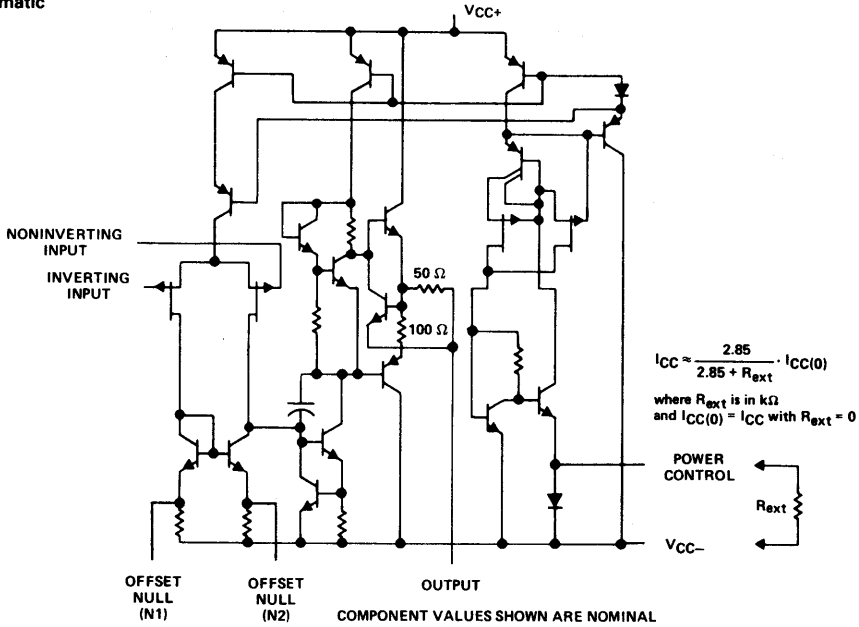
Operational Amplifiers

99071

TYPES TL066M, TL066I, TL066C, TL066AC, TL066BC

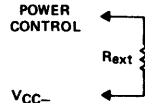
ADJUSTABLE LOW-POWER JFET-INPUT OPERATIONAL AMPLIFIERS

schematic



$$I_{CC} \approx \frac{2.85}{2.85 + R_{ext}} \cdot I_{CC(0)}$$

where R_{ext} is in $k\Omega$
and $I_{CC(0)} = I_{CC}$ with $R_{ext} = 0$



absolute maximum ratings over operating free-air temperature (unless otherwise noted)

	TL066M	TL066I	TL066C TL066AC TL066BC	UNIT
Supply voltage, V_{CC+} (see Note 1)	18	18	18	V
Supply voltage, V_{CC-} (see Note 1)	-18	-18	-18	V
Differential input voltage (see Note 2)	± 30	± 30	± 30	V
Input voltage (see Notes 1 and 3)	± 15	± 15	± 15	V
Voltage between power-control terminal and V_{CC-}	± 0.5	± 0.5	± 0.5	V
Duration of output short circuit (see Note 4)	unlimited	unlimited	unlimited	
Continuous total dissipation at (or below) 25°C free-air temperature (see Note 5)	680	680	680	mW
Operating free-air temperature range	-55 to 125	-25 to 85	0 to 70	°C
Storage temperature range	-65 to 150	-65 to 150	-65 to 150	°C
Lead temperature 1.6 mm (1/16 inch) from case for 60 seconds	FH, FK, or JG package	300	300	°C
Lead temperature 1.6 mm (1/16 inch) from case for 10 seconds	D or P package		260	°C

- NOTES: 1. All voltage values, except differential voltages, are with respect to the midpoint between V_{CC+} and V_{CC-} .
2. Differential voltages are at the noninverting input terminal with respect to the inverting input terminal.
3. The magnitude of the input voltage must never exceed the magnitude of the supply voltage or 15 volts, whichever is less.
4. The output may be shorted to ground or to either supply. Temperature and/or supply voltages must be limited to ensure that the dissipation rating is not exceeded.
5. For operation above 25°C free-air temperature, refer to Dissipation Derating Curves in Section 2. In the JG package, the TL066I, TL066C, TL066AC, and TL066BC chips are glass-mounted; the TL066M chips are alloy-mounted.

TYPES TL066M, TL066I, TL066C

ADJUSTABLE LOW-POWER JFET-INPUT OPERATIONAL AMPLIFIERS

electrical characteristics, $V_{CC} = \pm 15\text{ V}$

PARAMETER	TEST CONDITIONS†	TL066M			TL066I			TL066C			UNIT			
		MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX				
V_{IO} Input offset voltage	$V_O = 0$, $T_A = 25^\circ\text{C}$			3	6			3	6	3	15	mV		
	$V_O = 0$, $R_S = 50\ \Omega$, $T_A = \text{full range}$										20			
	$V_O = 0$, $R_S = 50\ \Omega$, $T_A = \text{full range}$			10				10					10	$\mu\text{V}/^\circ\text{C}$
α_{VIO} Temperature coefficient of input offset voltage	$V_O = 0$, $T_A = \text{full range}$			5	100			5	100			200	pA	
	$V_O = 0$, $T_A = \text{full range}$				20				10			5	nA	
I_{IO} Input offset current †	$V_O = 0$, $T_A = 25^\circ\text{C}$			30	200			30	200			30	400	pA
	$V_O = 0$, $T_A = \text{full range}$				50				20				10	nA
I_{IB} Input bias current †	$V_O = 0$, $T_A = 25^\circ\text{C}$			± 11.5				± 11.5				± 11		V
	$V_O = 0$, $T_A = \text{full range}$			± 10	± 13.5			± 10	± 13.5			± 10	± 13.5	V
V_{OM} Maximum peak output voltage swing	$T_A = 25^\circ\text{C}$, $R_L \geq 10\ \text{k}\Omega$			± 10	± 13.5			± 10	± 13.5			± 10	± 13.5	V
	$T_A = \text{full range}$, $R_L \geq 10\ \text{k}\Omega$			± 10	± 13.5			± 10	± 13.5			± 10	± 13.5	V
A _{VD} Large-signal differential voltage amplification	$R_L \geq 10\ \text{k}\Omega$, $T_A = 25^\circ\text{C}$			4	6			4	6			3	6	V/mV
	$R_L \geq 10\ \text{k}\Omega$, $V_O = \pm 10\ \text{V}$, $T_A = \text{full range}$			4				4				3		V/mV
B_1 Unity-gain bandwidth	$T_A = 25^\circ\text{C}$, $R_L = 10\ \text{k}\Omega$			1				1				1		MHz
	$T_A = 25^\circ\text{C}$			10	12			10	12			10	12	Ω
f_i Input resistance	$T_A = 25^\circ\text{C}$			220				220				220		Ω
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICR}\ \text{min}$, $V_O = 0$, $R_S = 50\ \Omega$, $T_A = 25^\circ\text{C}$			80	86			80	86			70	76	dB
	$V_{CC} = \pm 9\ \text{V}$ to $\pm 15\ \text{V}$, $V_O = 0$, $R_S = 50\ \Omega$, $T_A = 25^\circ\text{C}$			80	95			80	95			70	95	dB
P _D Total power dissipation	$V_O = 0$, $T_A = 25^\circ\text{C}$			6	7.5			6	7.5			6	7.5	mW
	$V_O = 0$, $T_A = 25^\circ\text{C}$			200	250			200	250			200	250	μA
I _{CC} Supply current	$V_O = 0$, $T_A = 25^\circ\text{C}$			200	250			200	250			200	250	μA
	$V_O = 0$, $T_A = 25^\circ\text{C}$			200	250			200	250			200	250	μA

† All characteristics are measured under open-loop conditions with zero common-mode input voltage unless otherwise specified. Full range of T_A is -55°C to 125°C for TL066M; -25°C to 85°C for TL066I; and 0°C to 70°C for TL066C. The electrical parameters are measured with the power-control terminal (pin 8) connected to V_{CC} .

‡ Input bias currents of a JFET-input operational amplifier are normal junction reverse currents, which are temperature-sensitive. Pulse techniques must be used that will maintain the junction temperature as close to the ambient temperature as is possible.



Operational Amplifiers

TYPES TL066AC, TL066BC

ADJUSTABLE LOW-POWER JFET-INPUT OPERATIONAL AMPLIFIERS

electrical characteristics, $V_{CC} = \pm 15 \text{ V}$

PARAMETER	TEST CONDITIONS†	TL066AC			TL066BC			UNIT
		MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO} Input offset voltage	$V_O = 0$, $R_S = 50 \Omega$, $T_A = 25^\circ\text{C}$		3	6		2	3	mV
	$V_O = 0$, $R_S = 50 \Omega$, $T_A = \text{full range}$			7.5			5	
α_{VIO} Temperature coefficient of input offset voltage	$V_O = 0$, $R_S = 50 \Omega$, $T_A = \text{full range}$		10			10		$\mu\text{V}/^\circ\text{C}$
I_{IO} Input offset current‡	$V_O = 0$, $T_A = 25^\circ\text{C}$		5	100		5	100	pA
	$V_O = 0$, $T_A = \text{full range}$			3			3	nA
I_{IB} Input bias current‡	$V_O = 0$, $T_A = 25^\circ\text{C}$		30	200		30	200	pA
	$V_O = 0$, $T_A = \text{full range}$			7			7	nA
V_{ICR} Common-mode input voltage range	$T_A = 25^\circ\text{C}$		± 11.5			± 11.5		V
V_{OM} Maximum peak output voltage swing	$T_A = 25^\circ\text{C}$, $R_L \geq 10 \text{ k}\Omega$		± 10	± 13.5		± 10	± 13.5	V
	$T_A = \text{full range}$, $R_L \geq 10 \text{ k}\Omega$		± 10	± 13.5		± 10	± 13.5	
AVD Large-signal differential voltage amplification	$R_L \geq 10 \text{ k}\Omega$, $V_O = \pm 10 \text{ V}$, $T_A = 25^\circ\text{C}$		4	6		4	6	V/mV
	$R_L \geq 10 \text{ k}\Omega$, $V_O = \pm 10 \text{ V}$, $T_A = \text{full range}$		4			4		
B_1 Unity-gain bandwidth	$T_A = 25^\circ\text{C}$, $R_L = 10 \text{ k}\Omega$		1			1		MHz
r_i Input resistance	$T_A = 25^\circ\text{C}$		10^{12}			10^{12}		Ω
r_o Output resistance	$T_A = 25^\circ\text{C}$, $f = 1 \text{ kHz}$		220			220		Ω
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICR \text{ min}}$, $V_O = 0$, $R_S = 50 \Omega$, $T_A = 25^\circ\text{C}$		80	86		80	86	dB
k_{SVR} Supply voltage rejection ratio ($\Delta V_{CC} \pm / \Delta V_{IO}$)	$V_{CC} = \pm 9 \text{ V to } \pm 15 \text{ V}$, $V_O = 0$, $R_S = 50 \Omega$, $T_A = 25^\circ\text{C}$		80	95		80	95	dB
P_D Total power dissipation	No load, $V_O = 0$, $T_A = 25^\circ\text{C}$		6	7.5		6	7.5	mW
I_{CC} Supply current	No load, $V_O = 0$, $T_A = 25^\circ\text{C}$		200	250		200	250	μA

†All characteristics are measured under open-loop conditions with zero common-mode input voltage unless otherwise specified. Full range of $T_A = -55^\circ\text{C}$ to 125°C for TL066M; -25°C to 85°C for TL066I; and 0°C to 70°C for TL066C, TL066AC, and TL066BC. The electrical parameters are measured with the power-control terminal (pin 8) connected to V_{CC-} .

‡Input bias currents of a FET-input operational amplifier are normal junction reverse currents, which are temperature-sensitive. Pulse techniques must be used that will maintain the junction temperature as close to the ambient temperature as is possible.

TYPES TL066M, TL066I, TL066C, TL066AC, TL066BC ADJUSTABLE LOW-POWER JFET-INPUT OPERATIONAL AMPLIFIERS

operating characteristics, $V_{CC\pm} = \pm 15\text{ V}$, $T_A = 25^\circ\text{C}$, $R_{ext} = 0$

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
SR	Slew rate at unity gain	$V_I = 10\text{ V}$, $C_L = 100\text{ pF}$,	$R_L = 10\text{ k}\Omega$, See Figure 1	2	3.5		$\text{V}/\mu\text{s}$
t_r	Rise time	$V_I = 20\text{ mV}$,	$R_L = 10\text{ k}\Omega$		0.2		μs
	Overshoot factor	$C_L = 100\text{ pF}$,	See Figure 1		10%		
V_n	Equivalent input noise voltage	$R_S = 100\ \Omega$,	$f = 1\text{ kHz}$		42		$\text{nV}/\sqrt{\text{Hz}}$

PARAMETER MEASUREMENT INFORMATION

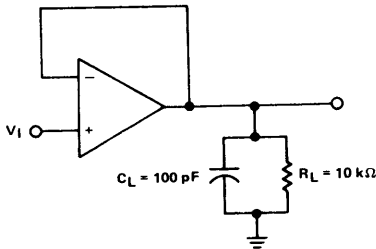


FIGURE 1—UNITY-GAIN AMPLIFIER

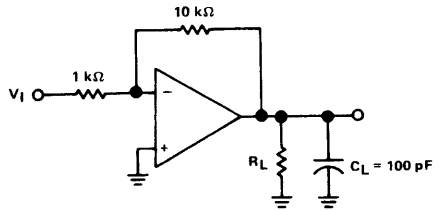


FIGURE 2—GAIN-OF-10 INVERTING AMPLIFIER

INPUT OFFSET VOLTAGE NULL CIRCUIT

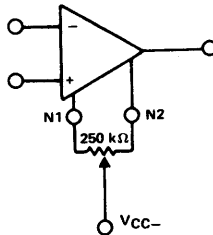


FIGURE 3

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Operational Amplifiers

TYPES TL066M, TL066I, TL066C, TL066AC, TL066BC

ADJUSTABLE LOW-POWER JFET-INPUT OPERATIONAL AMPLIFIERS

TYPICAL CHARACTERISTICS†

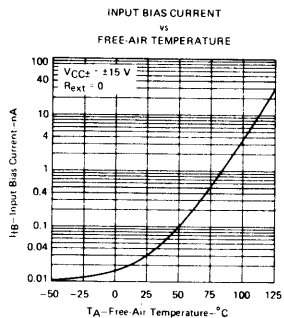


FIGURE 4

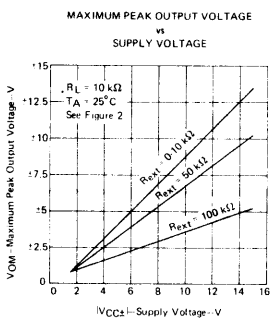


FIGURE 5

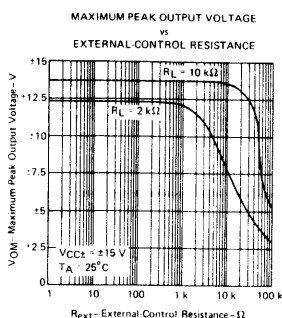


FIGURE 6

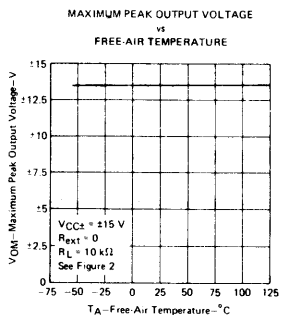


FIGURE 7

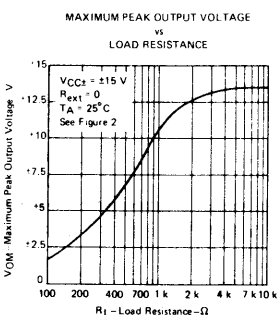


FIGURE 8

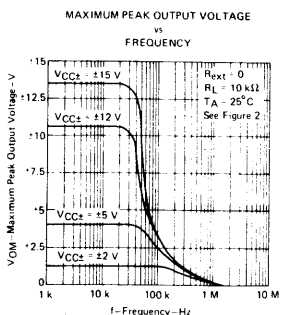


FIGURE 9

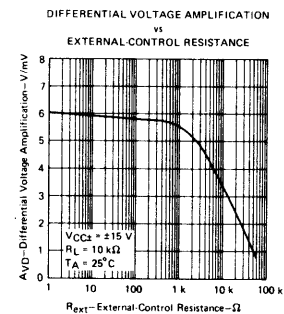


FIGURE 10

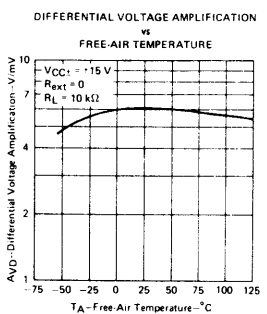


FIGURE 11

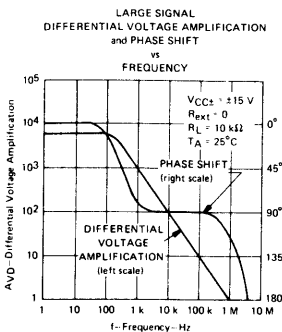


FIGURE 12

†Data at high and low temperatures are applicable only within the rated free-air temperature ranges of the various devices.

TYPES TL066M, TL066I, TL066C, TL066AC, TL066BC ADJUSTABLE LOW-POWER JFET-INPUT OPERATIONAL AMPLIFIERS

TYPICAL CHARACTERISTICS†

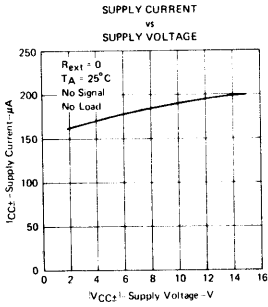


FIGURE 13

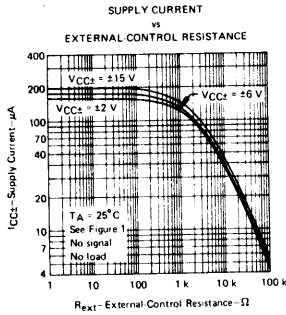


FIGURE 14

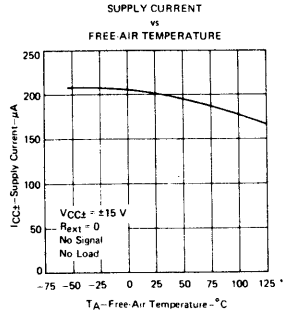


FIGURE 15

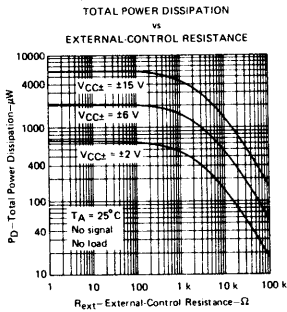


FIGURE 16

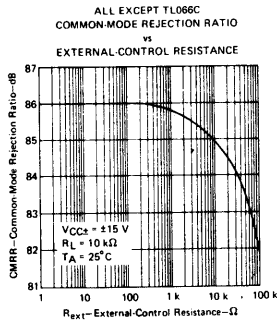


FIGURE 17

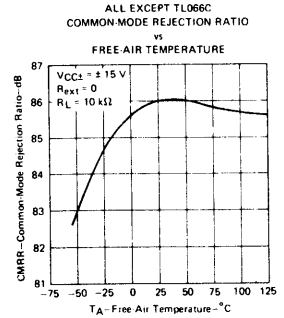


FIGURE 18

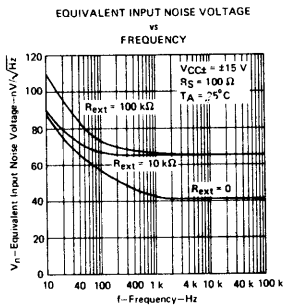


FIGURE 19

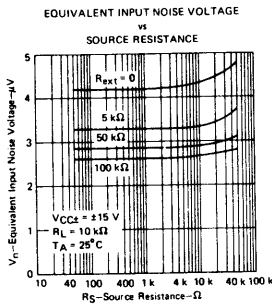


FIGURE 20

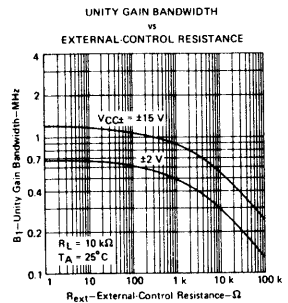


FIGURE 21

†Data at high and low temperatures are applicable only within the rated free-air temperature ranges of the various devices.

3
Operational Amplifiers

TYPES TL066M, TL066I, TL066C, TL066AC, TL066BC ADJUSTABLE LOW-POWER JFET-INPUT OPERATIONAL AMPLIFIERS

TYPICAL CHARACTERISTICS†

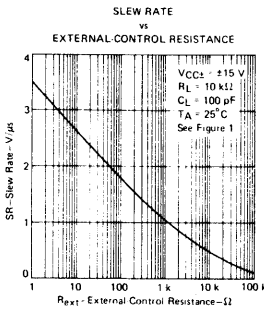


FIGURE 22

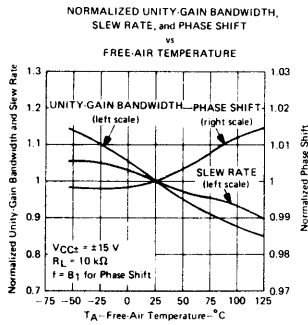


FIGURE 23

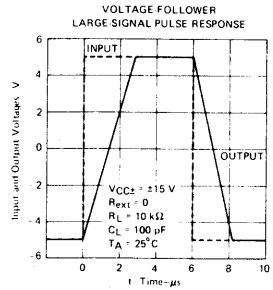


FIGURE 24

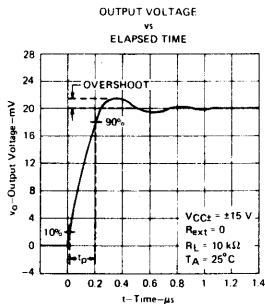


FIGURE 25

†Data at high and low temperatures are applicable only within the rated free-air temperature ranges of the various devices.

TYPICAL APPLICATION DATA

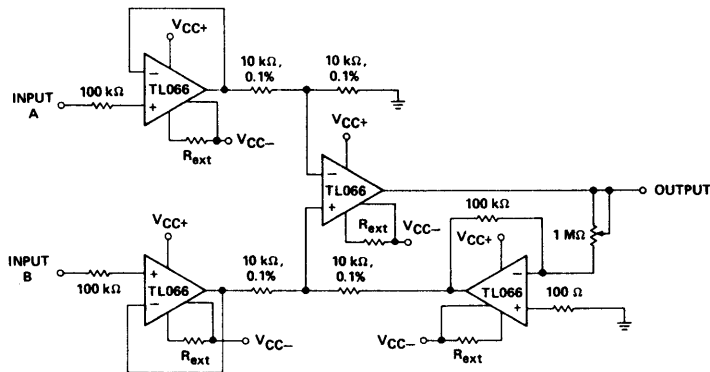


FIGURE 26—INSTRUMENTATION AMPLIFIER

TYPES TL066M, TL066I, TL066C, TL066AC, TL066BC
ADJUSTABLE LOW-POWER JFET-INPUT OPERATIONAL AMPLIFIERS

TYPICAL APPLICATION DATA

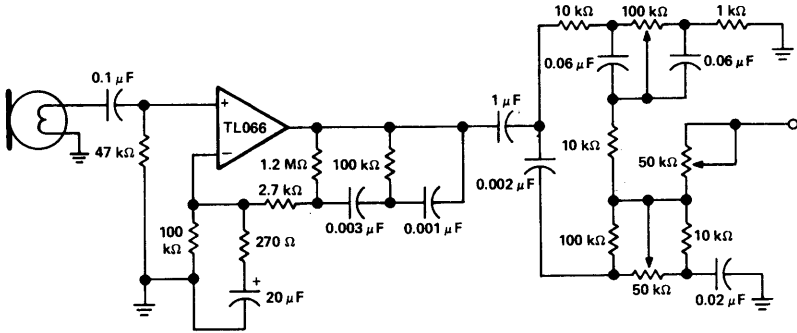


FIGURE 27—MICROPHONE PREAMPLIFIER WITH TONE CONTROL

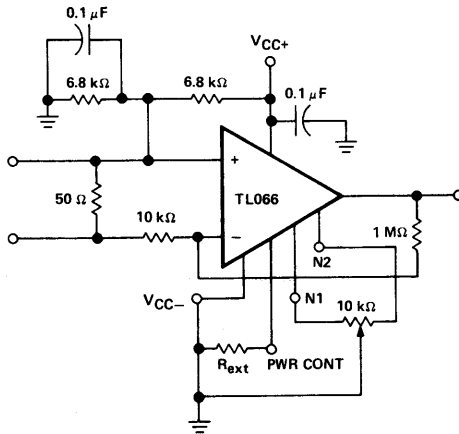


FIGURE 28—AC AMPLIFIER

3
Operational Amplifiers

TYPES TL066M, TL066I, TL066C, TL066AC, TL066BC
ADJUSTABLE LOW-POWER JFET-INPUT OPERATIONAL AMPLIFIERS

TYPICAL APPLICATION DATA

IC PREAMPLIFIER RESPONSE CHARACTERISTICS

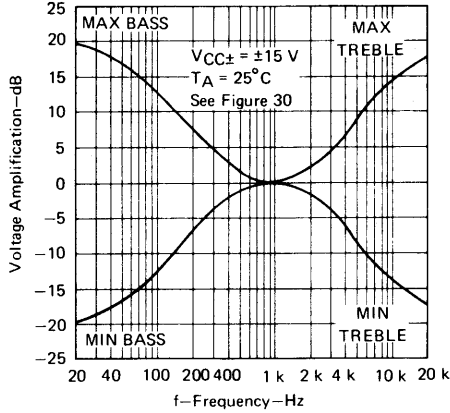


FIGURE 29

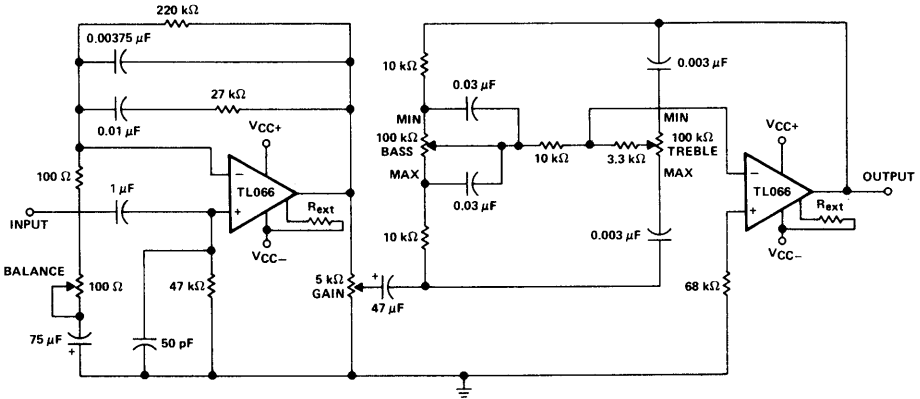


FIGURE 30—IC PREAMPLIFIER