



# High-Speed Voltage Follower/Buffer

## BUF-03

### FEATURES

- Very High Slew Rate ..... 220V/ $\mu$ s Min
- Wide Bandwidth ..... 63MHz
- Load Drive Current ..... 70mA Peak
- Easily Drives Large Capacitive Loads Without Oscillation
- High Input Resistance .....  $5 \times 10^{11}\Omega$
- Low Output Resistance .....  $2\Omega$
- Very Low Bias Current (Warmed-Up) ..... 400pA Max
- Low Offset Voltage ..... 6mV Max
- Unity Gain ..... 0.997V/V
- Excellent Gain Linearity ..... 0.015%
- Available in Die Form

in an open-loop circuit employing source followers and emitter followers, the BUF-03 utilizes a quasi-quad FET input structure to optimize both speed and D.C. input characteristics. On-chip zener-zap trimming is used to achieve low offset voltage while careful biasing throughout results in excellent gain linearity over the full input voltage range.

Applications for which the BUF-03 is well-suited include high-speed line drivers, isolation amplifiers for driving reactive loads, and high-speed sample-and-hold circuits.

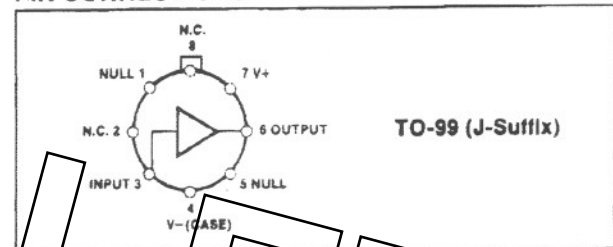
### ORDERING INFORMATION†

$T_A = 25^\circ\text{C}$ V <sub>OS</sub> MAX (mV)	PACKAGE TO-99 8-PIN	OPERATING TEMPERATURE RANGE
6	BUF03AJ*	MIL COM
6	BUF03EJ	MIL COM
15	BUF03BJ*	MIL COM
15	BUF03FJ	MIL COM

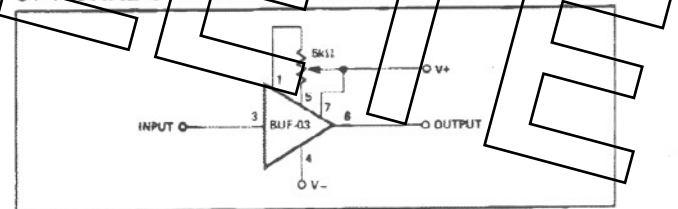
\* For devices processed in total compliance to MIL-STD-883, add/883 after part number. Consult factory for 883 data sheet.

† Burn-in is available on commercial and industrial temperature range parts in CerDIP, plastic DIP, and TO-can packages.

### PIN CONNECTIONS



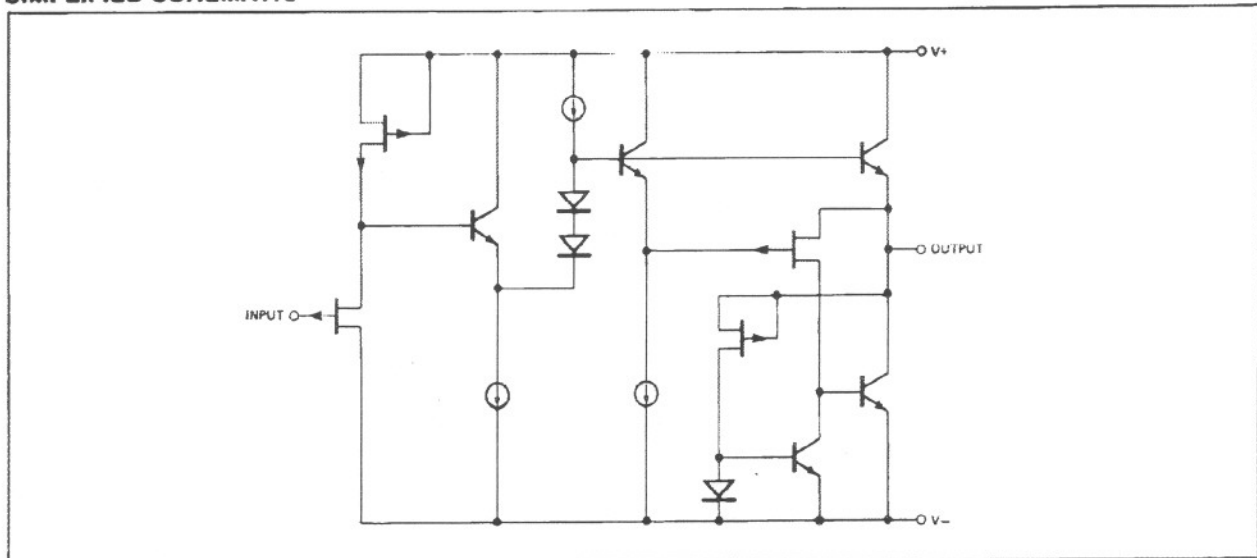
### OPTIONAL OFFSET NULLING CIRCUIT



### GENERAL DESCRIPTION

The BUF-03 is the first very high-speed monolithic voltage follower. Featuring performance previously unobtainable in a monolithic unit, it offers a combination of both exceptional speed and excellent input/output specifications. Implemented

### SIMPLIFIED SCHEMATIC



# BUF-03

## ABSOLUTE MAXIMUM RATINGS

Supply Voltage	±18V
Internal Power Dissipation ( $P_d$ )	
In Still Air Without Heat Sink (Note 1)	1.00W
Input Voltage (Note 2)	±18V
Continuous Output Current (Note 3)	70mA
Peak Output Current (Note 3)	100mA
Short Circuit Protection (Note 3)	Indefinite (Note 4)
Maximum Junction Temperature ( $T_j$ )	175°C
Storage Temperature Range	-65°C to +175°C
Operating Temperature Range (Note 5)	
	-55°C to +125°C
Lead Temperature (Soldering, 60 sec)	300°C

Dice Junction Temperature ( $T_j$ )	-65°C to +175°C
Thermal Resistance $\theta_{JA}$ (Note 1)	150°C/W
Thermal Resistance $\theta_{JC}$ (Note 1)	18°C/W

### NOTES:

- Based on MIL-STD-38510 published thermal resistance specification for 8 lead can-case outline C.
- When  $V_{CC} < \pm 18V$ , the maximum input voltage is equal to the supply voltage.
- The maximum  $P_d$  or  $T_j$  are not to be exceeded.
- At 80mA.
- When operating at  $T_A > +25^\circ C$ , heat sinking is required to insure  $T_{jMAX} = +175^\circ C$  specification is not exceeded using the equation  $T_{jMAX} = T_A + (P_d \times \theta_{JCMAX} + \theta_{SA})$  where  $\theta_{SA}$  = sink to ambient thermal resistance. PMI recommends using either the Thermalloy 2227 or 1101 or equivalent when operating up to  $T_A = +125^\circ C$ .

## ELECTRICAL CHARACTERISTICS at $V_S = \pm 15V$ , $R_S = 0\Omega$ , $T_A = T_j = 25^\circ C$ , unless otherwise noted. (Note 1)

PARAMETER	SYMBOL	CONDITIONS	BUF-03A/E			BUF-03B/F			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
<b>AC SPECIFICATIONS</b>									
Slew Rate	SR	$R_L \geq 2k\Omega$ , $C_L = 50pF$ , $T_A = T_j = 75^\circ C$	220	250	—	180	250	—	V/ $\mu s$
Power Bandwidth	PBW	$V_{IN} = 10V_{PP}$ , $R_L \geq 2k\Omega$	—	9	—	—	8	—	MHz
Bandwidth	BW	$\Delta V_{IN} = \pm 2V_{PP}$	—	63	—	—	50	—	MHz
Settling Time	$t_s$	To 0.1% $\pm 10V$ step	—	90	—	—	100	—	ns
Capacitive Load Capability	$C_{LOAD}$	No Oscillations	—	1	—	—	1	—	$\mu F$
Propagation Delay	$t_d$	Step Input	—	7	—	—	7	—	ns
Rise Time	$t_r$	$\Delta V = 0.5V$	—	7	—	—	7	—	ns
Wide Band Input Noise Voltage	$V_n$	DC to 50MHz	—	350	—	—	400	—	$\mu V_{RMS}$
Input Noise Voltage Density	$e_n$	$f = 10kHz$	—	50	—	—	60	—	nV/ $\sqrt{Hz}$
<b>DC SPECIFICATIONS</b>									
Input Offset Voltage	$V_{OS}$	$R_S \leq 20k\Omega$ (Note 2)	—	2	6	—	4	15	mV
Input Bias Current	$I_B$		—	150	400	—	180	700	pA
Input Resistance	$R_{IN}$		—	$5 \times 10^{11}$	—	—	$4 \times 10^{11}$	—	$\Omega$
Voltage Gain ( $V_{IN} = \pm 10V$ )	$A_{VO}$	$R_L \geq 10k\Omega$	0.9960	0.9975	—	0.9940	0.9970	—	V/V
		$R_L \geq 2k\Omega$	0.9945	0.9960	—	0.9930	0.9950	—	
		$R_L \geq 1k\Omega$	0.9925	0.9945	—	0.9905	0.9930	—	
Nonlinearity (Note 2)	NL	$V_{IN} = \pm 10V$ , $R_L \geq 2k\Omega$ $V_{IN} = \pm 7V$ , $R_L \geq 1k\Omega$ (Note 3)	—	0.015	0.023	—	0.017	0.03	%F.S.
Maximum Output Error	$OUT_{error}$	$V_{IN} = +10V, 0V, -10V$ $R_S = 0$ to $20k\Omega$ (Note 2) $R_L \geq 2k\Omega$ in all combinations	—	40	60	—	50	85	mV
Power Supply Rejection Ratio	PSRR	$V_S = \pm 6V$ to $\pm 18V$	—	0.10	0.71	—	0.15	1.42	mV/V
Supply Current	$I_{SV}$	No Load	—	19	25	—	19	25	mA
Peak Load Current	$I_{L(PK)}$		—	70	—	—	70	—	mA
Output Resistance	$R_O$		—	2	—	—	2	—	$\Omega$
Offset Voltage Nulling Range	$\Delta V_{OS}$	$R_P \geq 1k\Omega$	—	$\pm 80$	—	—	$\pm 80$	—	mV
Input Voltage Range (Reduced Accuracy)	IVR		—	$\pm 11.5$	—	—	$\pm 11.5$	—	V

### NOTES:

- Electrical parameters are pulse tested on automated test equipment. Total test time at each temperature is limited to less than one second maximum to keep  $T_j$  approximately equal to  $T_A$ .
- Parameters specified with  $R_S \leq 20k\Omega$  are tested at  $R_S = 0\Omega$ . Limits in test program are adjusted to take into account worst case voltage offset

induced by  $R_S = 20k\Omega$ , i.e.,  $I_B \max \times 20k\Omega$ .

- Nonlinearity is computed using linear regression techniques with data from five points (e.g., -10V, -5V, 0V, +5V, +10V for  $\pm 10V$  full-scale linearity; -7V, -3.5V, 0V, +3.5V, and +7V for  $\pm 7V$  full-scale linearity).

**BUF-03**

**ELECTRICAL CHARACTERISTICS** at  $V_S = \pm 15V$ ,  $-55^\circ C \leq T_A \leq +125^\circ C$ ,  $T_A = T_j$ , unless otherwise noted. (Note 1)

PARAMETER	SYMBOL	CONDITIONS	BUF-03A			BUF-03B			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Slew Rate	SR	$R_L \geq 2k\Omega$ , $C_L = 50pF$	—	220	—	—	220	—	V/ $\mu s$
Input Offset Voltage	$V_{OS}$	$R_S \leq 2k\Omega$	—	6	20	—	10	35	mV
Average Input Offset Voltage Drift	$TCV_{OS}$	$R_S \leq 2k\Omega$ , (Note 2)	—	50	100	—	90	170	$\mu V/^\circ C$
Input Bias Current	$I_B$	$T_A = +125^\circ C$	—	25	75	—	30	90	nA
Voltage Gain	$A_{VO}$	$R_L \geq 2k\Omega$ , $V_{IN} = \pm 10V$	0.9920	0.9955	—	0.9902	0.9942	—	V/V
Gain Drift with Temperature			—	5	—	—	8	—	ppm/ $^\circ C$
Power Supply Rejection Ratio	PSRR	$V_S = \pm 7V$ to $\pm 15V$	—	0.15	1.26	—	0.20	2.24	mV/V
Supply Current	$I_{SY}$	$T_A = +125^\circ C$	—	18	24	—	18	24	mA

**ELECTRICAL CHARACTERISTICS** at  $V_S = \pm 15V$ ,  $0^\circ C \leq T_A \leq +70^\circ C$ ,  $T_A = T_j$ , unless otherwise noted.

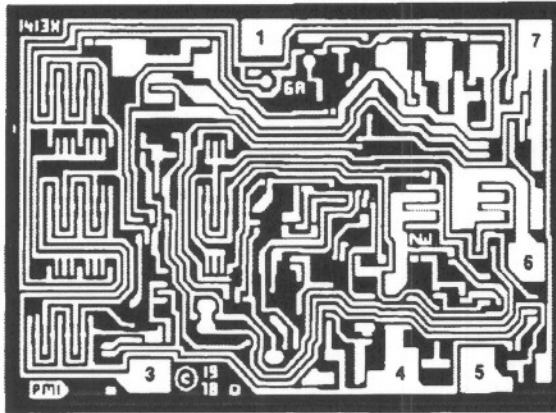
PARAMETER	SYMBOL	CONDITIONS	BUF-03E			BUF-03F			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
Slew Rate	SR	$R_L \geq 2k\Omega$	—	240	—	—	240	—	V/ $\mu s$
Input Offset Voltage	$V_{OS}$	$R_S \leq 2k\Omega$ , $C_L = 50pF$	—	4	14	—	7	28	mV
Average Input Offset Voltage Drift	$TCV_{OS}$	$R_S \leq 2k\Omega$ , (Note 2)	—	40	90	—	80	150	$\mu V/^\circ C$
Input Bias Current	$I_B$	$T_A = +70^\circ C$	—	1.5	5	—	1.8	8	nA
Voltage Gain ( $V_{IN} = \pm 10V$ )	$A_{VO}$	$R_L \geq 2k\Omega$	0.9935	0.9958	—	0.9918	0.9946	—	V/V
Gain Drift with Temperature			—	5	—	—	8	—	ppm/ $^\circ C$
Power Supply Rejection Ratio	PSRR	$V_S = \pm 7V$ to $\pm 15V$	—	0.12	1	—	0.16	1.78	mV/V
Supply Current	$I_{SY}$	$T_A = +70^\circ C$	—	19	25	—	19	25	mA

**NOTES:**

- In order to operate the device at an ambient temperature of  $+125^\circ C$ , more extensive heat sinking must be used to ensure that the chip temperature never exceeds the absolute maximum of  $+175^\circ C$ . The chip temperature of  $+165^\circ C$  is achieved by reducing the case-to-ambient thermal resistance to  $30^\circ C/W$  (e.g., Thermalloy 2227).
- Guaranteed by design.

# BUF-03

## DICE CHARACTERISTICS



- 1. NULL
- 3. INPUT
- 4. NEGATIVE SUPPLY
- 5. NULL
- 6. OUTPUT
- 7. POSITIVE SUPPLY

DIE SIZE 0.071 × 0.049 inch, 3479 sq. mils  
(1.80 × 1.24 mm, 2.23 sq. mm)

**WAFER TEST LIMITS** at  $V_S = \pm 15V$ ,  $T_J = 25^\circ C$ , unless otherwise noted.

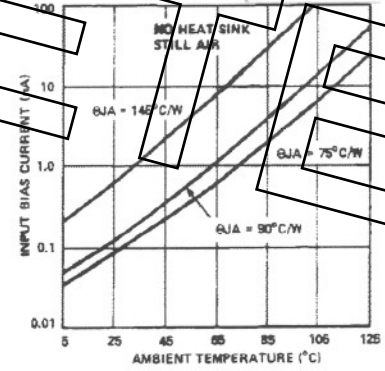
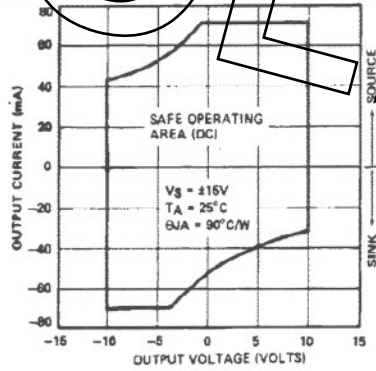
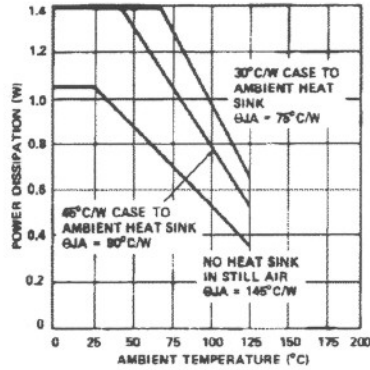
PARAMETER	SYMBOL	CONDITIONS	BUF-03N LIMIT	BUF-03G LIMIT	UNITS
Input Offset Voltage	$V_{OS}$	$R_S \geq 20k\Omega$	6	15	mV MAX
Voltage Gain	$A_{VO}$	$R_L \geq 10k\Omega$ , $V_{IN} = \pm 10V$	0.9960	0.9949	V/V MIN
Power Supply Rejection Ratio	PSRR	$V_S = \pm 8V$ to $\pm 18V$	0.71	1.42	mV/V MAX
Supply Current	$I_{SY}$	No Load	25	25	mA MAX

**NOTE:**

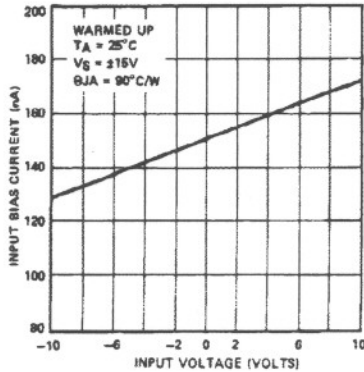
Electrical tests are performed at wafer probe to the limits shown. Due to variations in assembly methods and normal yield loss, yield after packaging is not guaranteed for standard product dice. Consult factory to negotiate specifications based on dice lot qualification through sample lot assembly and testing.

**TYPICAL ELECTRICAL CHARACTERISTICS** at  $V_S = \pm 15V$ ,  $T_J = 25^\circ C$ , unless otherwise noted.

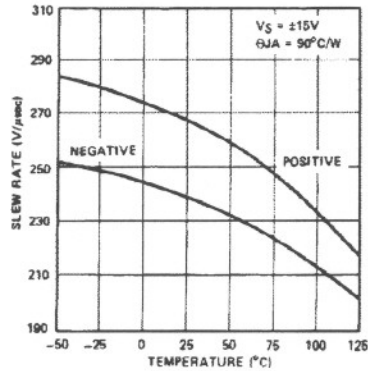
PARAMETER	SYMBOL	CONDITIONS	BUF-03N TYPICAL	BUF-03G TYPICAL	UNITS
Slew Rate	SR	$R_L \geq 2k\Omega$ , $C_L = 50pF$	220	180	V/ $\mu s$
Peak Load Current	$I_{L(PK)}$		70	70	mA
Input Bias Current	$I_B$		40	60	pA
Input Resistance	$R_{IN}$		$5 \times 10^{11}$	$5 \times 10^{11}$	$\Omega$
Output Resistance	$R_O$		2	2	$\Omega$
Offset Voltage Nulling Range	$\Delta V_{OS}$	$R_P \geq 1k\Omega$	$\pm 80$	$\pm 80$	mV
Input Voltage Range (Reduced Accuracy)	IVR		$\pm 11.5$	$\pm 11.5$	V
Power Bandwidth	PBW	$V_{IN} = 10V_{P-P}$ , $R_L \geq 2k\Omega$	9	8	MHz
Bandwidth	BW	$\Delta V_{IN} \leq 2V_{P-P}$	63	55	MHz
Settling Time	$t_S$	To 0.1%, $\pm 10V$ step	90	100	ns
Capacitive Load Capacity	$C_{LOAD}$	No Oscillations	1	1	$\mu F$
Propagation Delay	$t_d$	Step Input	7	7	ns
Rise Time	$t_r$	$\Delta V_{IN} = 0.5V$	7	7	ns
Wide Band Input Noise Voltage	$V_n$	DC to 50MHz	350	400	$\mu V_{RMS}$
Input Noise Voltage Density	$e_n$	$f = 10kHz$	50	60	nV/ $\sqrt{Hz}$



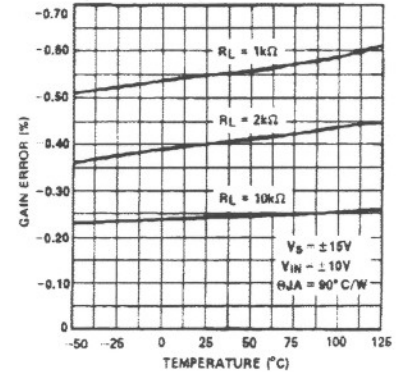
**INPUT BIAS CURRENT vs INPUT VOLTAGE**



**SLEW RATE vs TEMPERATURE**



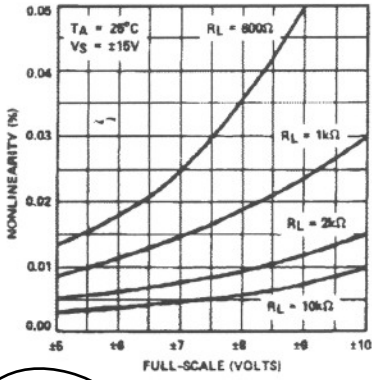
**GAIN ERROR vs TEMPERATURE**



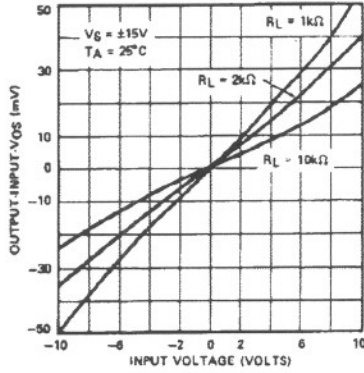
# BUF-03

## TYPICAL PERFORMANCE CHARACTERISTICS

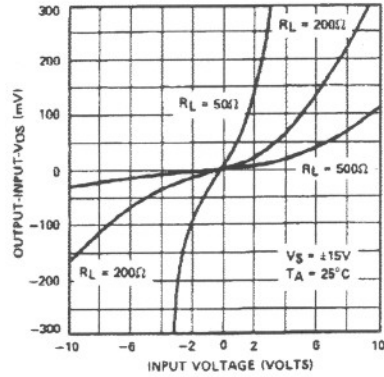
**NONLINEARITY vs FULL-SCALE VOLTAGE**



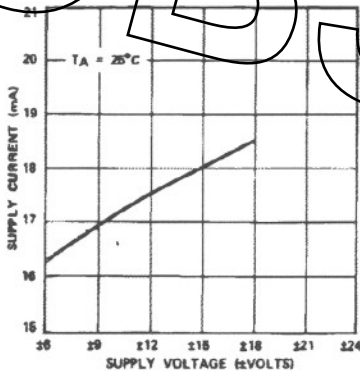
**GAIN ERROR vs INPUT VOLTAGE**



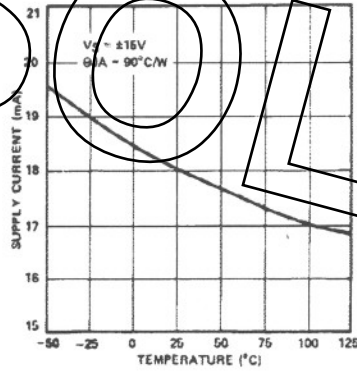
**GAIN ERROR vs INPUT VOLTAGE**



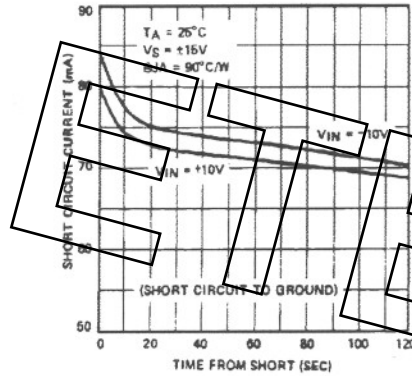
**SUPPLY CURRENT vs SUPPLY VOLTAGE**



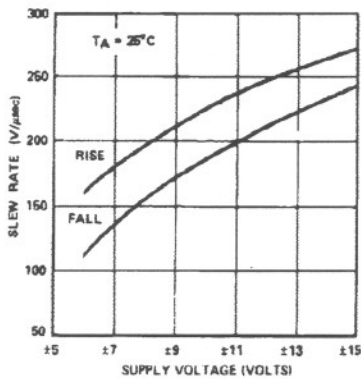
**SUPPLY CURRENT vs TEMPERATURE**



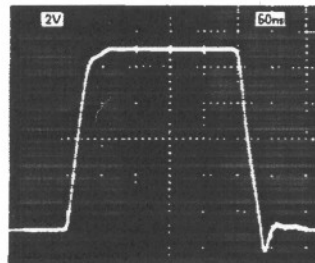
**OUTPUT SHORT-CIRCUIT CURRENT vs TIME**



**SLEW RATE vs SUPPLY VOLTAGE**



**SLEW RATE**



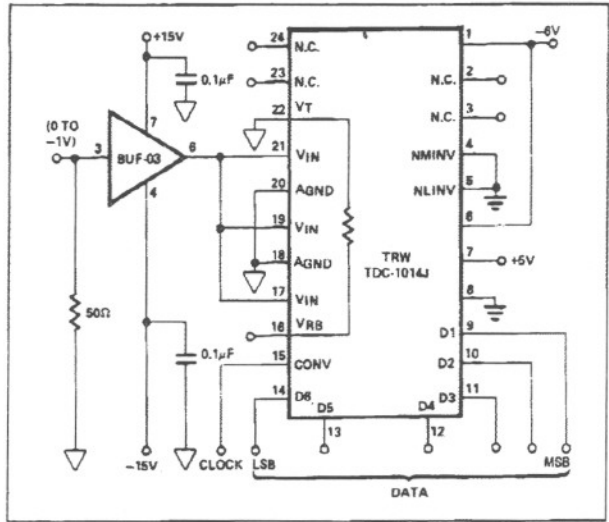
# BUF-03

## APPLICATIONS INFORMATION

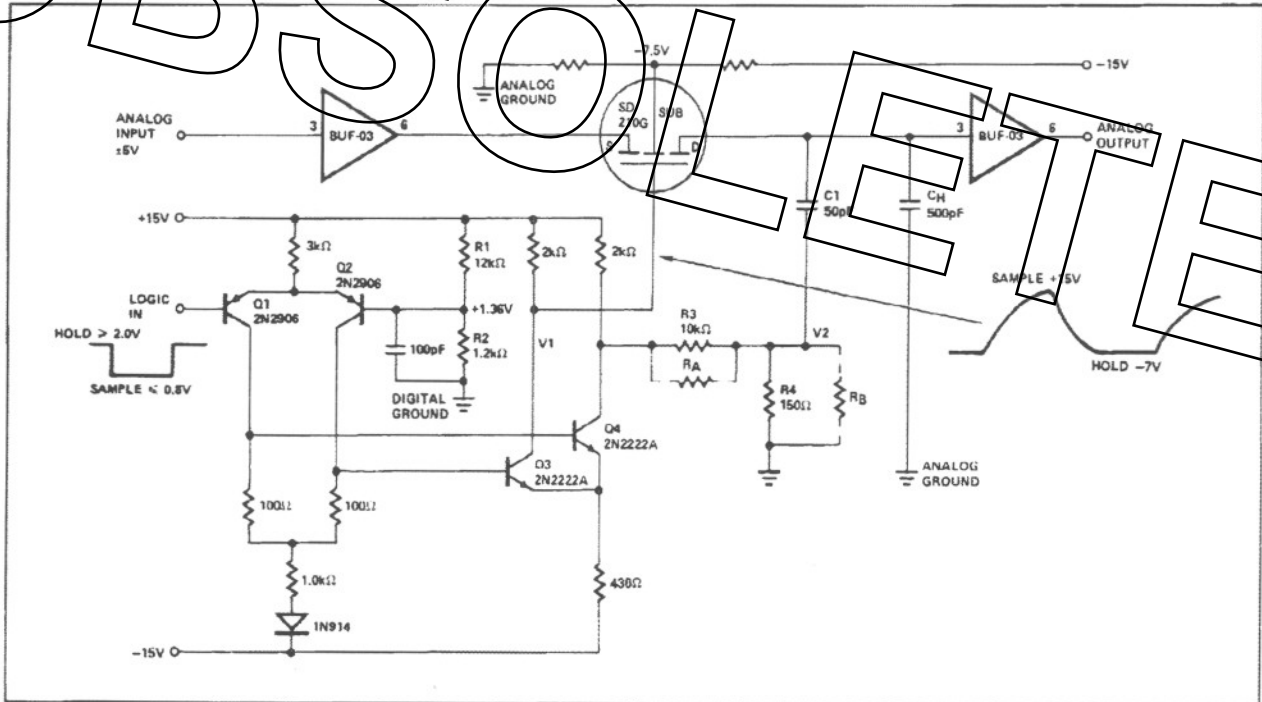
### OPERATING THE BUF-03 AT REDUCED POWER SUPPLIES

In most video applications the signal levels are significantly lower than the 20V peak-to-peak capability of the BUF-03. This suggests operating the BUF-03 at reduced power supplies; for example, at  $\pm 6V$  supplies  $\pm 2V$  signals can be handled. The obvious advantage of reduced supplies is the accompanying decrease in power dissipation: from a typical  $540mW (= 30V \times 18mA)$  to  $195mW (= 12V \times 16.2mA)$  at  $\pm 6V$ . At lower supply voltages heat sinking is no longer necessary. However, as shown on the slew rate vs supply voltage curve, slew rate does degrade at lower supplies. This occurs because of higher internal node capacitances at lower voltages and because of the slightly decreased operating current.

### HIGH-SPEED 6-BIT A/D BUFFER



### HIGH-SPEED SAMPLE/HOLD AMPLIFIER



OBSOLETE