HARRIS SEMICONDUCTOR

HA-5142, HA-5144

Dual/Quad, 400kHz, Ultra-Low Power Operational Amplifiers

November 1996

Features

- **Low Supply Current. 45µA/Amp**
- **Wide Supply Voltage Range Single . . . . 3V to 30V or Dual . . . . ±1.5V to ±15V**
- **High Slew Rate. 1.5V/µs**
- **High Gain 100kV/V**
- **Unity Gain Stable**
- **Available in Duals and Quads**

Applications

- **Portable Instruments**
- **Meter Amplifiers**
- **Telephone Headsets**
- **Microphone Amplifiers**
- **Instrumentation**
- **For Further Design Ideas See Application Note 544**

Description

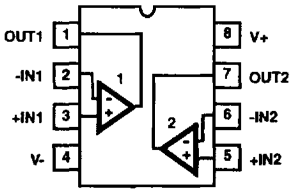
The HA-5142/44 ultra-low power operational amplifiers provide AC and DC performance characteristics similar to or better than most general purpose amplifiers while only drawing 1/30 of the supply current of most general purpose amplifiers. In applications which require low power dissipation and good AC electrical characteristics, this family offers the industry's best speed/power ratio.

The HA-5142/44 provides accurate signal processing by virtue of their low input offset voltage (2mV), low input bias current (45nA), high open loop gain (100kV/V) and low noise (20nV/$\sqrt{Hz}$), for low power operational amplifiers. These characteristics coupled with a 1.5V/µs slew rate and a 400kHz bandwidth make the HA-5142/44 ideal for use in low power instrumentation, audio amplifier and active filter designs. The wide range of supply voltages (3V to 30V) also allow these amplifiers to be very useful in low voltage battery powered equipment. These parts are also tested and guaranteed at both ±15V and single ended +5V supplies.

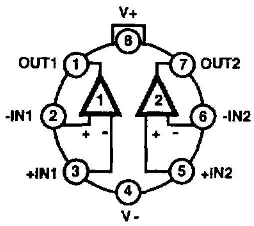
These amplifiers are available with industry standard pinouts which allow the HA-5142/5144s to be interchangeable with most other operational amplifiers. For military grade product refer to the 5142, 5144/883 data sheet.

Pinouts (See Ordering Information on Next Page)

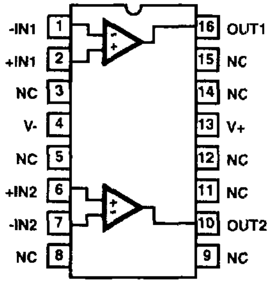
HA-5142 (PDIP, CERDIP)
TOP VIEW



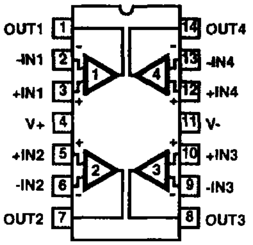
HA-5142 (METAL CAN)
TOP VIEW



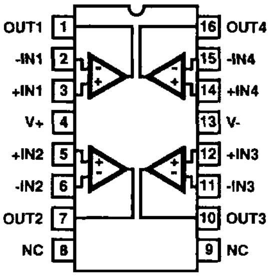
HA-5142 (SOIC)
TOP VIEW



HA-5144 (PDIP, CERDIP)
TOP VIEW



HA-5144 (SOIC)
TOP VIEW



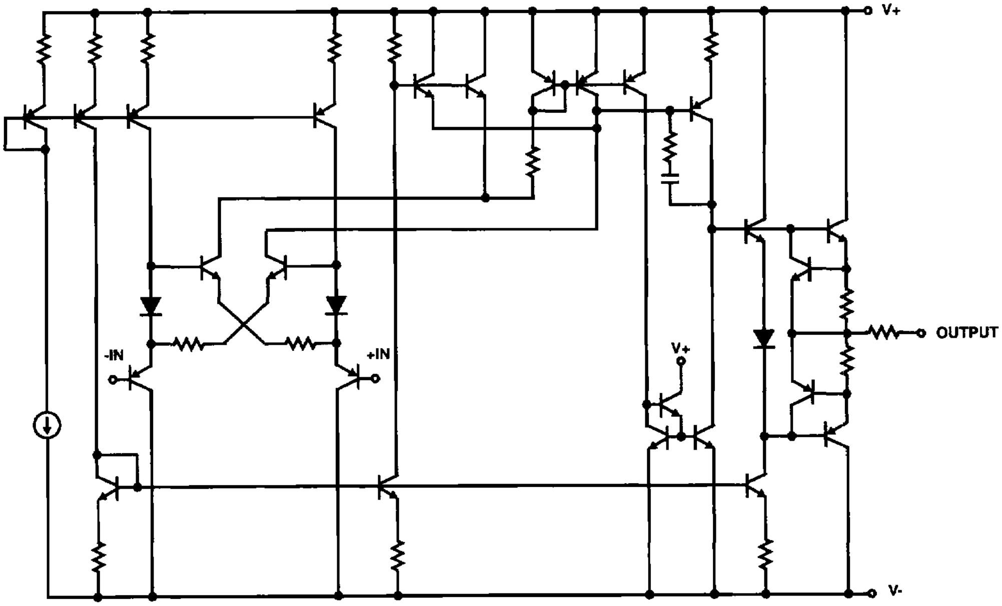
CAUTION: These devices are sensitive to electrostatic discharge. Users should follow proper IC Handling Procedures.

File Number **2909.2**

Ordering Information

PART NUMBER	TEMP. RANGE (^{o}C)	PACKAGE	PKG. NO.
HA2-5142-2	-55 to 125	8 Pin Metal Can	T8.C
HA2-5142-5	0 to 75	8 Pin Metal Can	T8.C
HA3-5142-5	0 to 75	8 Ld PDIP	E8.3
HA7-5142-2	-55 to 125	8 Ld CERDIP	F8.3A
HA7-5142-5	0 to 75	8 Ld CERDIP	F8.3A
HA9P5142-9	-40 to 85	16 Ld SOIC	M16.3
HA1-5144-2	-55 to 125	14 Ld CERDIP	F14.3
HA1-5144-5	0 to 75	14 Ld CERDIP	F14.3
HA3-5144-5	0 to 75	14 Ld PDIP	E14.3
HA9P5144-5	0 to 75	16 Ld SOIC	M16.3
HA9P5144-9	-40 to 85	16 Ld SOIC	M16.3

Schematic Diagram



Absolute Maximum Ratings

Supply Voltage Between V+ and V- Terminals 35V
Differential Input Voltage. 7V
Output Current . . . . Short Circuit Protected

Operating Conditions

Temperature Range
HA-5142/44-5 . . . . 0^oC to 75^oC
HA-5142/44-2 . . . . -55^oC to 125^oC
HA-5142/44-9 . . . . -40^oC to 85^oC

Thermal Information

Thermal Resistance (Typical, Note 1)	θ_{JA} ($^oC/W$)	θ_{JC} ($^oC/W$)
14 Lead CERDIP Package	75	20
8 Pin Metal Can Package	155	67
14 Lead PDIP Package	100	N/A
8 Lead PDIP Package	120	N/A
8 Lead CERDIP Package	135	50
16 Lead SOIC Package (HA-5142)	110	N/A
16 Lead SOIC Package (HA-5144)	100	N/A

Maximum Junction Temperature (Hermetic Packages) . . . . 175^oC
Maximum Junction Temperature (Plastic Packages) . . . . 150^oC
Maximum Storage Temperature Range . . . . -65^oC to 150^oC
Maximum Lead Temperature (Soldering 10s) . . . . 300^oC
(SOIC - Lead Tips Only)

CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

NOTE:

1. θ_{JA} is measured with the component mounted on an evaluation PC board in free air.

Electrical Specifications $R_S = 100\Omega$, $C_L \leq 10pF$, Unless Otherwise Specified

PARAMETER	TEST CONDITIONS	TEMP. (^oC)	-2, -5, -9 V+ = +5V, V- = 0V MIN	TYP	MAX	-2, -5, -9 V+ = +15V, V- = -15V MIN	TYP	MAX	UNITS
INPUT CHARACTERISTICS									
Offset Voltage	Note 11	25	-	2	6	-	2	6	mV
		Full	-	-	8	-	-	8	mV
Average Offset Voltage Drift		Full	-	3	-	-	3	-	μV/^oC
Bias Current	Note 11	25	-	45	100	-	45	100	nA
		Full	-	-	125	-	-	125	nA
Offset Current	Note 11	25	-	0.3	10	-	0.3	10	nA
		Full	-	-	20	-	-	20	nA
Common Mode Range		Full	0 to 3	-	-	±10	-	-	V
Differential Input Resistance		25	-	0.6	-	-	0.6	-	MΩ
Input Noise Voltage	f = 1kHz	25	-	20	-	-	20	-	nV/√Hz
Input Noise Current	f = 1kHz	25	-	0.25	-	-	0.25	-	pA/√Hz
TRANSFER CHARACTERISTICS									
Large Signal Voltage Gain	Notes 2, 4	25	20	100	-	20	100	-	kV/V
		Full -2, -5	15	-	-	15	-	-	kV/V
		Full -9	12	-	-	12	-	-	kV/V
Common Mode Rejection Ratio	Note 7	Full -2, -5	77	105	-	77	105	-	cB
		Full -9	70	105	-	70	105	-	dB

Electrical Specifications $R_S = 100\Omega$, $C_L \leq 10pF$, Unless Otherwise Specified **(Continued)**

PARAMETER	TEST CONDITIONS	TEMP. (°C)	-2, -5, -9 V+ = +5V, V- = 0V MIN	TYP	MAX	-2, -5, -9 V+ = +15V, V- = -15V MIN	TYP	MAX	UNITS
Bandwidth	Notes 2, 3	25	-	0.4	-	-	0.4	-	MHz
OUTPUT CHARACTERISTICS									
Output Voltage Swing	Notes 2, 10	25	1.0 to 3.8	0.7 to 4.2	-	±10	±13	-	V
		Full	1.2 to 3.5	0.9 to 4.0	-	±10	±13	-	V
Full Power Bandwidth	Notes 2, 4, 8	25	-	240	-	-	24	-	kHz
TRANSIENT RESPONSE (Notes 2, 3)									
Rise Time		25	-	600	-	-	600	-	ns
Slew Rate	Note 6	25	0.8	1.5	-	0.8	1.5	-	V/µs
Settling Time	Note 5	25	-	10	-	-	10	-	µs
POWER SUPPLY CHARACTERISTICS									
Supply Current		25	-	45	80	-	100	150	µA/Amp
		Full	-	-	100	-	-	200	µA/Amp
Power Supply Rejection Ratio	Note 9	Full -2, -5	77	105	-	77	105	-	dB
		Full -9	70	105	-	70	105	-	dB

NOTES:

2. $R_L = 50k\Omega$.
3. $C_L = 50pF$.
4. $V_O = 1.4$ to 2.5V for $V_{SUPPLY} = +5, 0V$; $V_O = \pm 10V$ for $V_{SUPPLY} = \pm 15V$.
5. Settling Time is specified to 0.1% of final value for a 3V output step and $A_V = -1$ for $V_{SUPPLY} = +5V, 0V$. Output step = 10V for $V_{SUPPLY} = \pm 15V$.
6. Maximum input slew rate = 10V/µs.
7. $V_{CM} = 0$ to 3V for $V_{SUPPLY} = +5, 0V$; $V_{CM} = \pm 10V$ for $V_{SUPPLY} = \pm 15V$.
8. Full Power Bandwidth is guaranteed by equation: $FPBW = \frac{\text{Slew Rate}}{2\pi V_{PEAK}}$.
9. $\Delta V_S = +10V$ for $V_{SUPPLY} = +5, 0V$; $\Delta V_S = \pm 5V$ for $V_{SUPPLY} = \pm 15V$.
10. For $V_{SUPPLY} = +5, 0V$ terminate R_L at +2.5V. Typical output current is ±3mA.
11. $V_O = 1.4V$ for $V_{SUPPLY} = +5V, 0V$.

Test Circuits and Waveforms

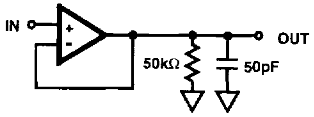
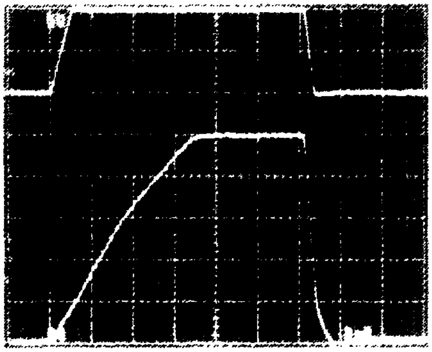


FIGURE 1. SLEW RATE AND TRANSIENT RESPONSE TEST CIRCUIT

INPUT

OUTPUT



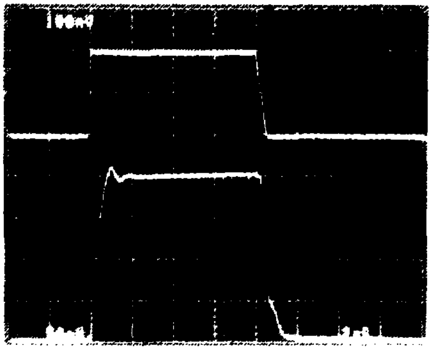
$+V_{SUPPLY} = +15V$, $-V_{SUPPLY} = -15V$

Vertical Scale: Input = 5V/Div.; Output = 2V/Div.
Horizontal Scale: 2µs/Div.

LARGE SIGNAL RESPONSE

INPUT

OUTPUT



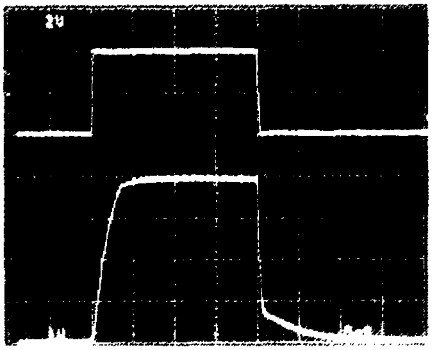
$+V_{SUPPLY} = +15V$, $-V_{SUPPLY} = -15V$

Vertical Scale: Input = 100mV/Div.; Output = 50mV/Div.
Horizontal Scale: 2µs/Div.

SMALL SIGNAL RESPONSE

INPUT

OUTPUT



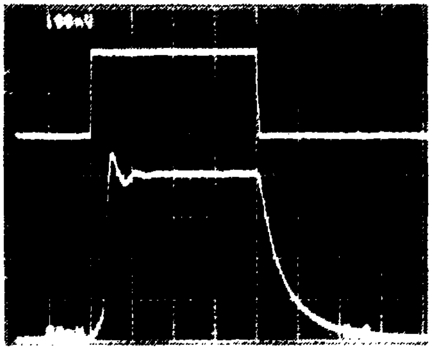
$+V_{SUPPLY} = +5V$, $-V_{SUPPLY} = 0V$

Vertical Scale: Input = 2V/Div.; Output = 1V/Div.
Horizontal Scale: 5µs/Div.

LARGE SIGNAL RESPONSE

INPUT

OUTPUT



$+V_{SUPPLY} = +5V$, $-V_{SUPPLY} = 0V$

Vertical Scale: Input = 100mV/Div.; Output = 50mV/Div.
Horizontal Scale: 5µs/Div.

SMALL SIGNAL RESPONSE

Typical Performance Curves $V_S = \pm 2.5V$, $T_A = 25^oC$, Unless Otherwise Specified

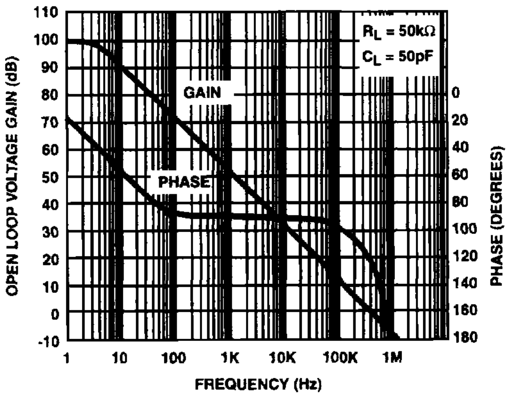


FIGURE 2. OPEN LOOP FREQUENCY RESPONSE

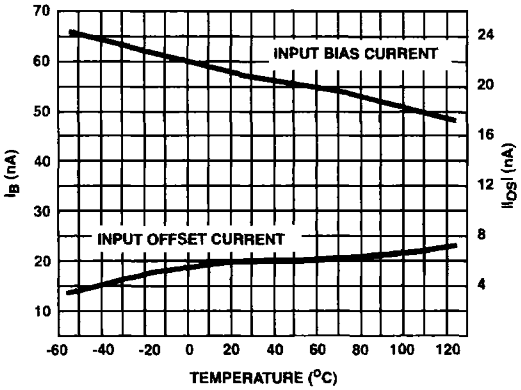


FIGURE 3. INPUT OFFSET CURRENT AND BIAS CURRENT vs TEMPERATURE

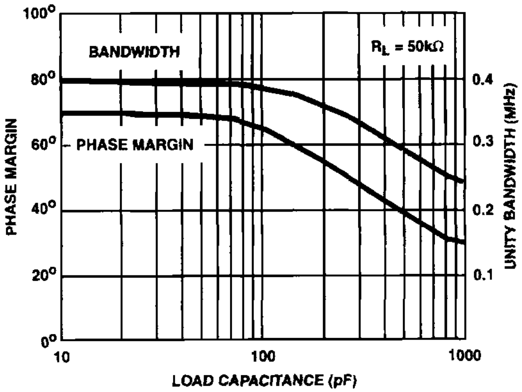


FIGURE 4. BANDWIDTH AND PHASE MARGIN vs LOAD CAPACITANCE

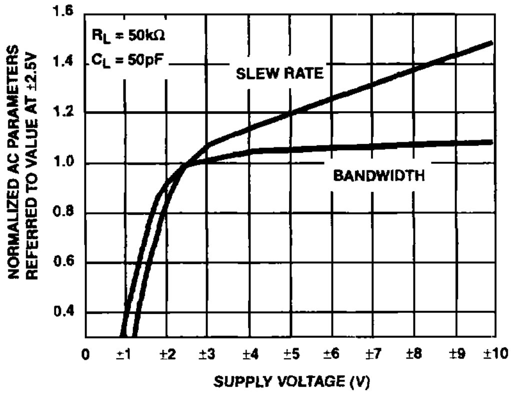


FIGURE 5. NORMALIZED AC PARAMETERS vs SUPPLY VOLTAGE

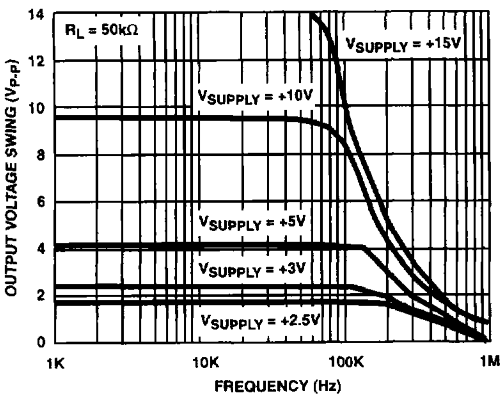


FIGURE 6. OUTPUT VOLTAGE SWING vs FREQUENCY AND SINGLE SUPPLY VOLTAGE

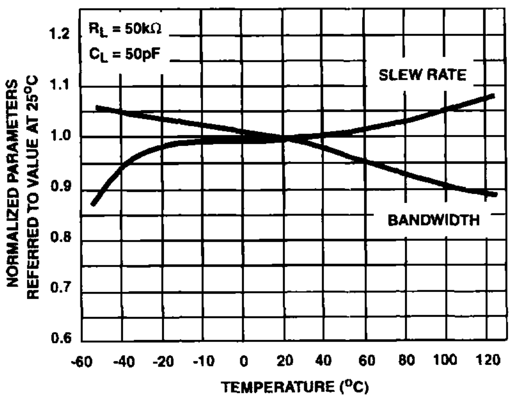


FIGURE 7. NORMALIZED AC PARAMETERS vs TEMPERATURE

3

OPERATIONAL AMPLIFIERS

Typical Performance Curves $V_S = \pm 2.5V$, $T_A = 25^oC$, Unless Otherwise Specified (Continued)

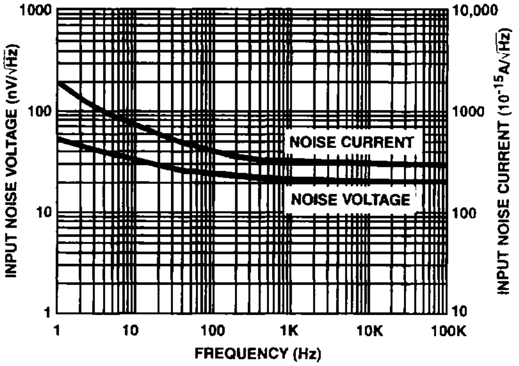


FIGURE 8. INPUT NOISE vs FREQUENCY

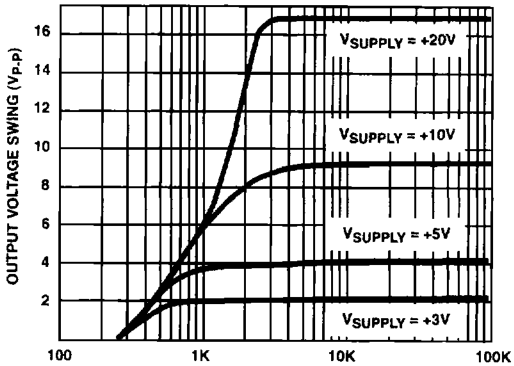


FIGURE 9. MAXIMUM OUTPUT VOLTAGE SWING vs LOAD RESISTANCE AND SINGLE SUPPLY VOLTAGE

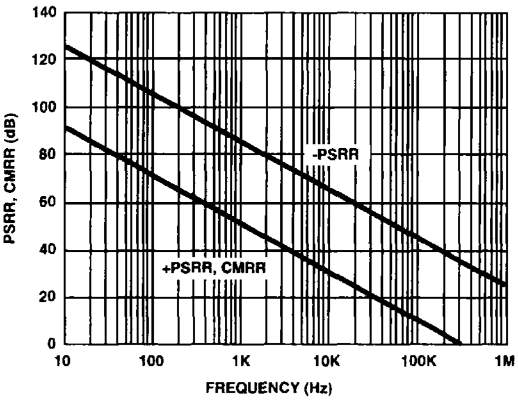


FIGURE 10. PSRR AND CMRR vs FREQUENCY

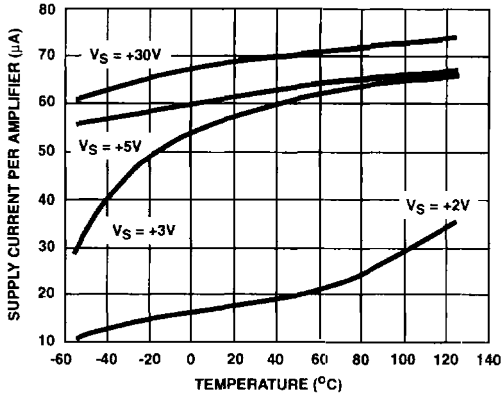


FIGURE 11. POWER SUPPLY CURRENT vs TEMPERATURE AND SINGLE SUPPLY VOLTAGE

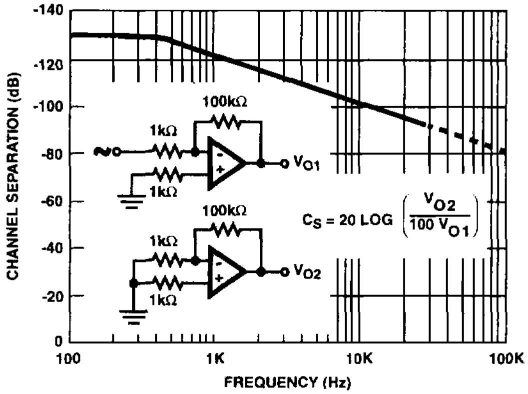


FIGURE 12. CHANNEL SEPARATION vs FREQUENCY

Die Characteristics

DIE DIMENSIONS:

104 mils x 55 mils x 19 mils
2650μm x 1400μm x 483μm

METALLIZATION:

Type: Al, 1% Cu
Thickness: 16kÅ ±2kÅ

PASSIVATION:

Type: Nitride (Si_3N_4) over Silox (SiO_2, 5% Phos.)
Silox Thickness: 12kÅ ±2kÅ
Nitride Thickness: 3.5kÅ ±1.5kÅ

TRANSISTOR COUNT:

72

SUBSTRATE POTENTIAL (Powered Up):

V-

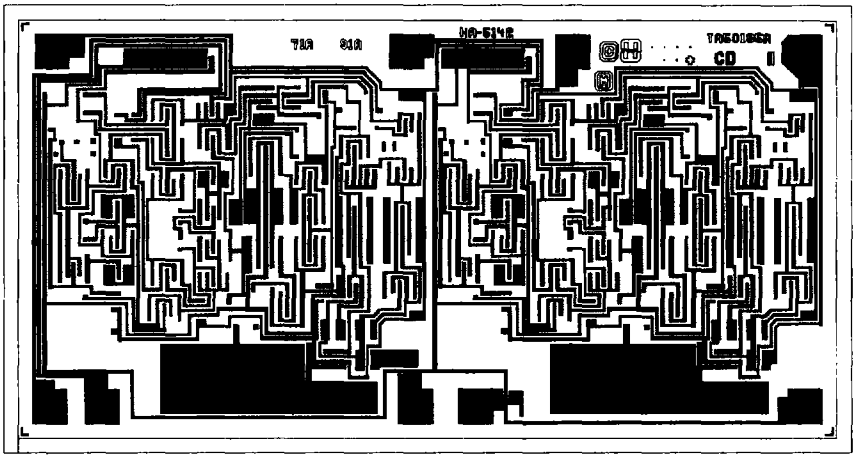
PROCESS:

Bipolar/JFET Dielectric Isolation

Metallization Mask Layout

HA-5142

V- +IN1 -IN1 OUT1



+IN2 -IN2 OUT2 NC V+