

## 8MHz Power Amps For Military, Industrial and Commercial Equipment

April 1997

### Features

- High Power Output Class B Amplifier
  - CA3020 ..... 0.5W (Typ) at  $V_{CC} = 9V$
  - CA3020A ..... 1.0W (Typ) at  $V_{CC} = 12V$
- Wide Frequency Range .. Up to 8MHz with Resistive Loads
- High Power Gain ..... 75dB (Typ)
- Single Power Supply For Class B Operation With Transformer
  - CA3020 ..... 3V to 9V
  - CA3020A ..... 3V to 12V
- Built-In Temperature-Tracking Voltage Regulator Provides Stable Operation Over -55°C to 125°C Temperature Range

### Applications

- AF Power Amplifiers For Portable and Fixed Sound and Communications Systems
- Servo-Control Amplifiers
- Wide-Band Linear Mixers
- Video Power Amplifiers
- Transmission-Line Driver Amplifiers (Balanced and Unbalanced)
- Fan-In and Fan-Out Amplifiers For Computer Logic Circuits
- Lamp-Control Amplifiers
- Motor-Control Amplifiers
- Power Multivibrators
- Power Switches

### Description

The CA3020 and CA3020A are integrated-circuit, multi-stage, multipurpose, wide-band power amplifiers on a single monolithic silicon chip. They employ a highly versatile and stable direct coupled circuit configuration featuring wide frequency range, high voltage and power gain, and high power output. These features plus inherent stability over a wide temperature range make the CA3020 and CA3020A extremely useful for a wide variety of applications in military, industrial, and commercial equipment.

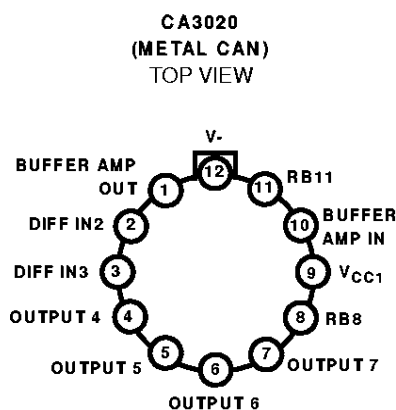
The CA3020 and CA3020A are particularly suited for service as class B power amplifiers. The CA3020A can provide a maximum power output of 1W from a 12V<sub>DC</sub> supply with a typical power gain of 75dB. The CA3020 provides 0.5W power output from a 9V supply with the same power gain.

Refer to AN5766 for application information.

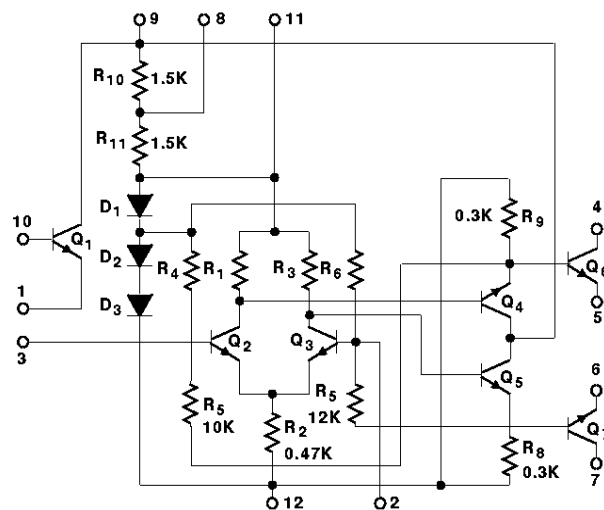
### Ordering Information

PART NUMBER	TEMP. RANGE (°C)	PACKAGE	PKG. NO.
CA3020	-55 to 125	12 Pin Metal Can	T12.B
CA3020A	-55 to 125	12 Pin Metal Can	T12.B

### Pinout



### Schematic Diagram



The resistance values included on the schematic diagram have been supplied as a convenience to assist Equipment Manufacturers in optimizing the selection of "outboard" components of equipment designs. The values shown may vary as much as 30%.

Harris reserves the right to make any changes in the Resistance Values provided such changes do not adversely affect the published performance characteristics of the device.

## CA3020, CA3020A

### Absolute Maximum Ratings

Maximum Pin 9 Supply Voltage, $V_{CC1}$ (Note 1)	
CA3020	10V
CA3020A	12V
Maximum Pin 9 Supply Current, $I_{CC1}$	20mA
Maximum Pin 11 Sink Current, $I_{11}$	20mA
Output Voltage, $V_4$ and $V_7$ (Note 1)	
CA3020	25V
CA3020A	18V
Output Current, $I_O$	300mA
Input Voltage Range, $V_2, V_3$	-2V to 2V
Maximum Input Voltage, $V_{10}$ (Ref to Pin 1)	-3V
Maximum Source Current, $V_1$	1mA

### Operating Conditions

Temperature Range ..... -55°C to 125°C

### Thermal Information

Thermal Resistance (Typical, Note 2)	$\theta_{JA}$ (°C/W)	$\theta_{JC}$ (°C/W)
Metal Can Package	165	80
Maximum Junction Temperature (Metal Can Package)	175°C	
Maximum Storage Temperature Range	-65°C to 150°C	
Maximum Lead Temperature (Soldering 10s)	300°C	

**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.

#### NOTES:

- The voltage ratings for Pin 9, Pin 4 and Pin 7 are referenced to the V- (Pin 12). A normal bias configuration for Pin 8 and Pin 11 is shown in Figure 1B. Refer to Application Note AN5766 for other options.
- $\theta_{JA}$  is measured with the component mounted on an evaluation PC board in free air.

### Electrical Specifications $T_A = 25^\circ\text{C}$

PARAMETER	SYMBOL	TEST CONDITIONS			CA3020			CA3020A			UNITS
		CIRCUIT AND PROCEDURE	DC SUPPLY VOLTAGE		MIN	TYP	MAX	MIN	TYP	MAX	
			FIGURE	$V_{CC1}$							
Collector-to-Emitter Breakdown Voltage, $Q_6$ and $Q_7$ at 10mA	$V_{(BR)CER}$	1A	-	-	18	-	-	25	-	-	V
Collector-to-Emitter Breakdown Voltage, $Q_1$ at 0.1mA	$V_{(BR)CEO}$	-	-	-	10	-	-	10	-	-	V
Idle Currents, $Q_6$ and $Q_7$	$I_{4\text{ IDLE}}$ $I_{7\text{ IDLE}}$	7	9.0	2.0	-	5.5	-	-	5.5	-	mA
Peak Output Currents, $Q_6$ and $Q_7$	$I_{4PK}$ $I_{7PK}$	7	9.0	2.0	140	-	-	180	-	-	mA
Cutoff Currents, $Q_6$ and $Q_7$	$I_{4\text{ CUTOFF}}$ $I_{7\text{ CUTOFF}}$	7	9.0	2.0	-	-	1.0	-	-	1.0	mA
Differential Amplifier Current Drain	$I_{CC1}$	7	9.0	9.0	6.3	9.4	12.5	6.3	9.4	12.5	mA
Total Current Drain	$I_{CC1} + I_{CC2}$	7	9.0	9.0	8.0	21.5	35.0	14.0	21.5	30.0	mA
Differential Amplifier Input Terminal Voltages	$V_2$ $V_3$	7	9.0	2.0	-	1.11	-	-	1.11	-	V
Regulator Terminal Voltage	$V_{11}$	7	9.0	2.0	-	2.35	-	-	2.35	-	V
$Q_1$ Cutoff (Leakage) Currents:											
Collector-to-Emitter	$I_{CEO}$	-	10.0	-	-	-	100	-	-	100	$\mu\text{A}$
Emitter-to-Base	$I_{EBO}$	-	3.0	-	-	-	0.1	-	-	0.1	$\mu\text{A}$
Collector-to-Base	$I_{CBO}$	-	3.0	-	-	-	0.1	-	-	0.1	$\mu\text{A}$
Forward Current Transfer Ratio, $Q_1$ at 3mA	$h_{FE1}$	-	6.0	-	30	75	-	30	75	-	
Bandwidth at -3dB Point	BW	8	6.0	6.0	-	8	-	-	8	-	MHz
Maximum Power Output for $R_{CC} = 130\Omega$	$P_{O(MAX)}$	9	6.0	6.0	200	300	-	200	300	-	mW
Maximum Power Output for $R_{CC} = 200\Omega$		9	9.0	9.0	400	550	-	400	550	-	mW
Maximum Power Output for $R_{CC} = 200\Omega$		9	9.0	12.0	-	-	-	800	1000	-	mW
Sensitivity for $P_{OUT} = 400\text{mW}$ , $R_{CC} = 130\Omega$	$e_{IN}$	9	9.0	9.0	-	35	55	-	-	-	mV
Sensitivity for $P_{OUT} = 800\text{mW}$ , $R_{CC} = 200\Omega$	$e_{IN}$	9	9.0	12.0	-	-	-	-	50	100	mV
Input Resistance - Terminal 3 to Ground	$R_{IN3}$	10	6.0	6.0	-	1000	-	-	1000	-	$\Omega$

## CA3020, CA3020A

**Typical Performance Data** (Note 3) A heat sink is recommended for high ambient temperature operation.

PARAMETER		SYMBOL	CA3020	CA3020A	UNITS
Power Supply Voltage		$V_{CC1}$	9.0	9.0	V
		$V_{CC2}$	9.0	12.0	V
Zero Signal Current	Differential Amplifier	$I_{CC1}$	15	15	mA
	Output Amplifier	$I_{CC2}$	24	24	mA
Maximum Signal Current	Differential Amplifier	$I_{CC1}$	16	16.6	mA
	Output Amplifier	$I_{CC2}$	125	140	mA
Maximum Power Output at THD = 10%		PO	550	1000	mW
Sensitivity		$e_{IN}$	35	45	mV
Power Gain		$G_P$	75	75	dB
Input Resistance		$R_{IN}$	55	55	k $\Omega$
Efficiency		$\eta$	45	55	%
Signal-to-Noise Ratio		S/N	70	66	dB
THD at 150mW Level			3.1	3.3	%
Test Signal Frequency from 600 $\Omega$ Generator			1000	1000	Hz
Equivalent Collector-to-Collector Load Resistance		$R_{CC}$	130	200	$\Omega$

NOTE:

3. Refer to Figures 7 through 11 for measurement and symbol information.

### Test Circuits and Waveforms

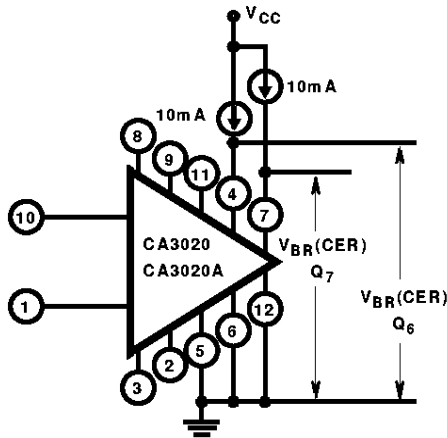


FIGURE 1A. COLLECTOR-TO-EMITTER BREAKDOWN VOLTAGE ( $Q_6$  AND  $Q_7$ ) CIRCUIT

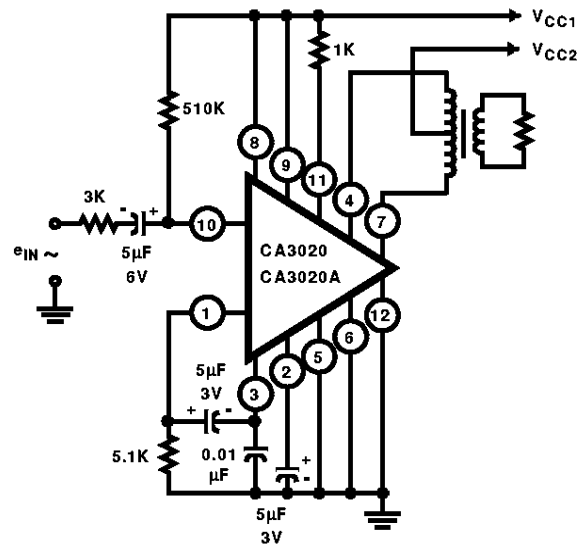


FIGURE 1B. TYPICAL AUDIO AMPLIFIER CIRCUIT UTILIZING THE CA3020 OR CA3020A AS AN AUDIO PREAMPLIFIER AND CLASS B POWER AMPLIFIER

FIGURE 1.

Test Circuits and Waveforms (Continued)

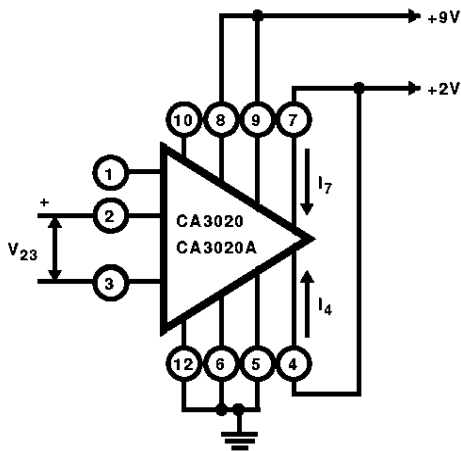


FIGURE 2A. TEST SETUP

FIGURE 2. TYPICAL TRANSFER CHARACTERISTICS

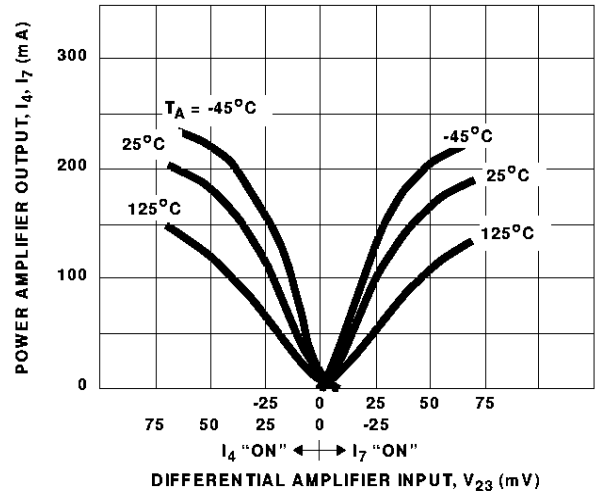


FIGURE 2B. CHARACTERISTICS WITH  $R_{10}$  SHORTED OUT

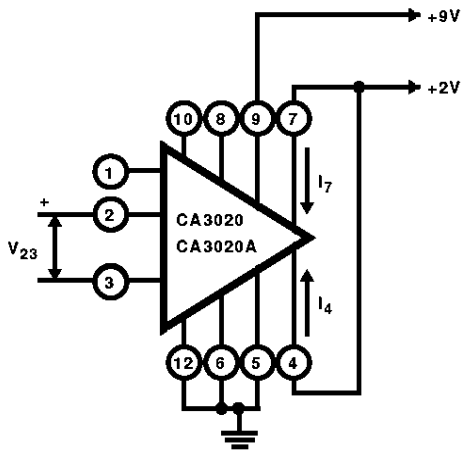


FIGURE 3A. TEST SETUP

FIGURE 3. TYPICAL TRANSFER CHARACTERISTICS

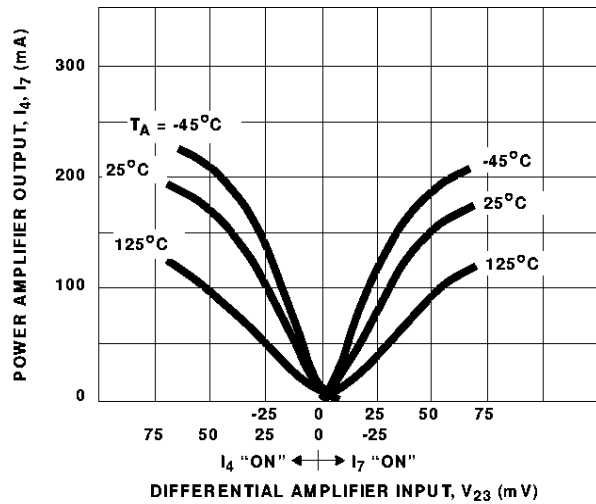


FIGURE 3B. CHARACTERISTIC WITH  $R_{10}$  IN CIRCUIT

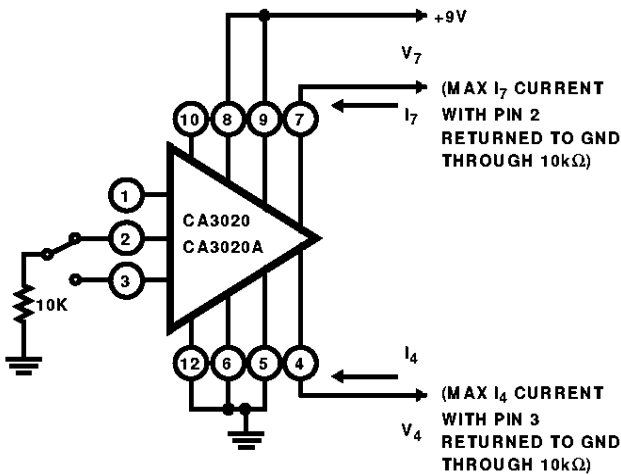


FIGURE 4A. TEST SETUP

FIGURE 4. "MINIMUM DRIVE" TYPICAL CURRENT-VOLTAGE SATURATION CURVE

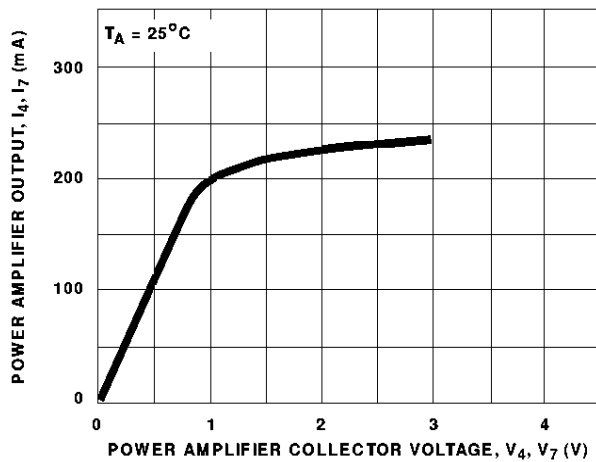


FIGURE 4B. CHARACTERISTIC

Test Circuits and Waveforms (Continued)

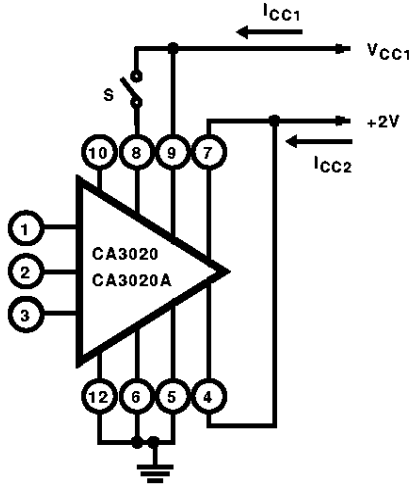


FIGURE 5A. TEST SETUP

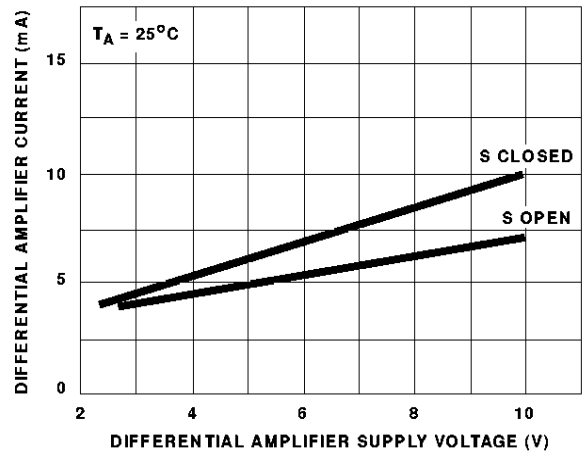


FIGURE 5B. DIFFERENTIAL AMPLIFIER CHARACTERISTICS OF  $I_{CC1}$  CURRENT vs  $V_{CC1}$  VOLTAGE

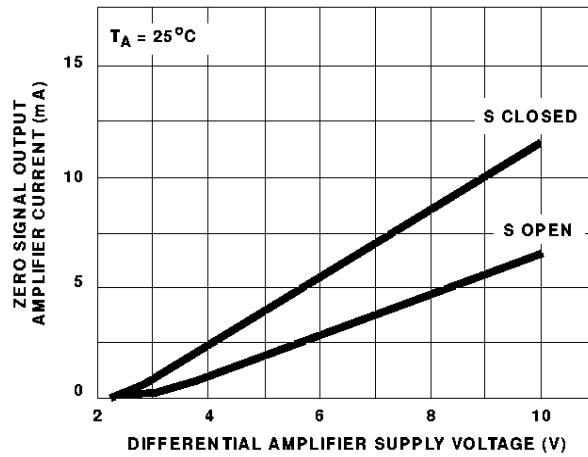


FIGURE 5C. OUTPUT AMPLIFIER CHARACTERISTICS OF  $I_{CC2}$  CURRENT vs  $V_{CC1}$  VOLTAGE

FIGURE 5. ZERO SIGNAL AMPLIFIER CURRENT vs DIFFERENTIAL AMPLIFIER SUPPLY VOLTAGE

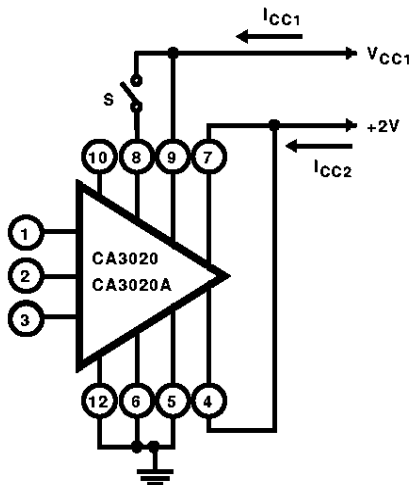


FIGURE 6A. TEST SETUP

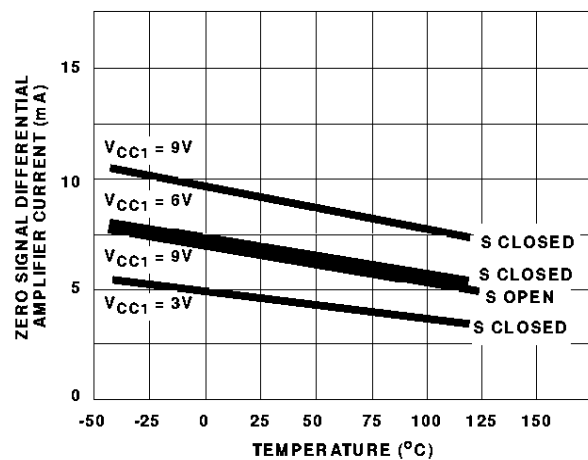


FIGURE 6B. DIFFERENTIAL AMPLIFIER CHARACTERISTICS OF  $I_{CC1}$  CURRENT vs AMBIENT TEMPERATURE

FIGURE 6. ZERO SIGNAL AMPLIFIER CURRENT vs AMBIENT TEMPERATURE

# CA3020, CA3020A

## Test Circuits and Waveforms (Continued)

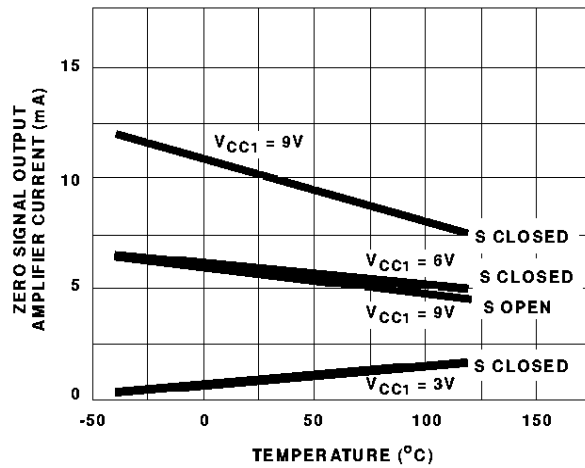
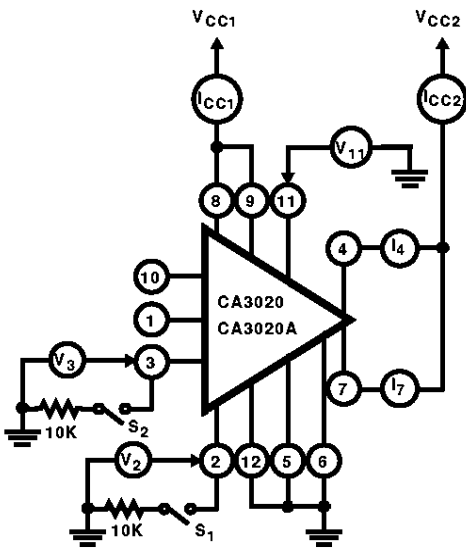


FIGURE 6C. OUTPUT AMPLIFIER CHARACTERISTICS OF I<sub>CC2</sub> CURRENT vs AMBIENT TEMPERATURE  
 FIGURE 6. ZERO SIGNAL AMPLIFIER CURRENT vs AMBIENT TEMPERATURE

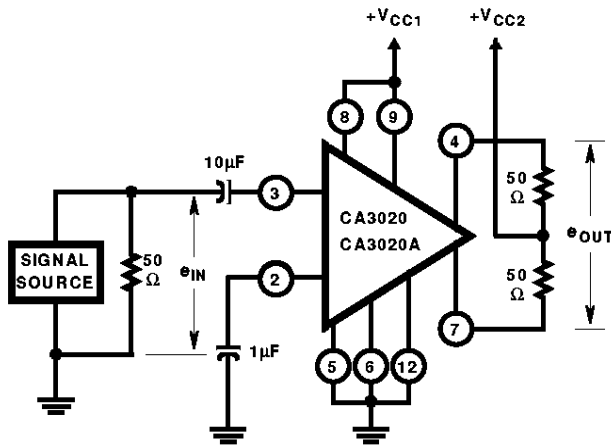


CURRENTS OR VOLTAGES	S <sub>1</sub>	S <sub>2</sub>
I <sub>4</sub> -IDLE	OPEN	OPEN
I <sub>7</sub> -IDLE	OPEN	OPEN
I <sub>4</sub> -PEAK	OPEN	CLOSE
I <sub>7</sub> -PEAK	CLOSE	OPEN
I <sub>4</sub> -CUTOFF	CLOSE	OPEN
I <sub>7</sub> -CUTOFF	OPEN	CLOSE

CURRENTS OR VOLTAGES	S <sub>1</sub>	S <sub>2</sub>
I <sub>CC1</sub>	OPEN	OPEN
I <sub>CC2</sub>	OPEN	OPEN
V <sub>2</sub>	OPEN	OPEN
V <sub>3</sub>	OPEN	OPEN
V <sub>11</sub>	OPEN	OPEN

FIGURE 7. STATIC CURRENT AND VOLTAGE TEST CIRCUIT

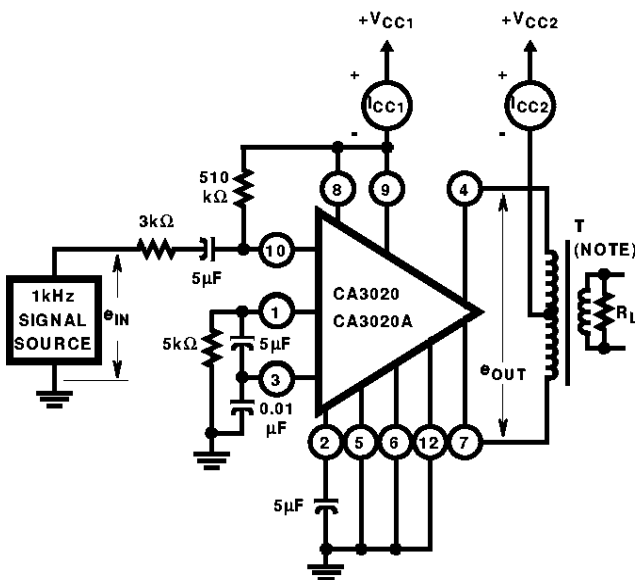
## CA3020, CA3020A



**FIGURE 8. MEASUREMENT OF BANDWIDTH AT -3dB POINTS**

### PROCEDURES:

1. Apply desired value of  $V_{CC1}$  and  $V_{CC2}$ .
2. Apply 1kHz input signal and adjust for  $e_{IN} = 5mV_{RMS}$ .
3. Record the resulting value of  $e_{OUT}$  in dB (reference value).
4. Vary input-signal frequency, keeping  $e_{IN}$  constant at 5mV, and record frequencies above and below 1kHz at which  $e_{OUT}$  decreases 3dB below reference value.
5. Record bandwidth as frequency range between -3dB points.



NOTE: Push-pull output transformer; load resistance ( $R_L$ ) should be selected to provide indicated collector-to-collector load impedance ( $R_{CC}$ ).

### PROCEDURES:

1. Apply desired value of  $V_{CC1}$  and  $V_{CC2}$  and reduce  $e_{IN}$  to 0V.
2. Record resulting values of  $I_{CC1}$  and  $I_{CC2}$  in mA as Zero-Signal DC Current Drain.
3. Apply desired value of  $V_{CC1}$  and  $V_{CC2}$  and adjust  $e_{IN}$  to the value at which the Total Harmonic Distortion in the output of the amplifier = 10%.
4. Record resulting value of  $I_{CC1}$  and  $I_{CC2}$  in mA as Maximum Signal DC Current Drain.
5. Determine resulting amplifier power output in watts and record as Maximum Power Output ( $P_{OUT}$ ).
6. Calculate Circuit Efficiency ( $\eta$ ) in % as follows:

$$\eta = 100 \frac{P_{OUT}}{V_{CC1}I_{CC1} + V_{CC2}I_{CC2}}$$

where  $P_{OUT}$  is in watts,  $V_{CC1}$  and  $V_{CC2}$  are in volts, and  $I_{CC1}$  and  $I_{CC2}$  are in amperes.

7. Record value of  $e_{IN}$  in  $mV_{RMS}$  required in Step 3 as Sensitivity ( $e_{IN}$ ).
8. Calculate Transducer Power Gain ( $G_p$ ) in dB as follows:

$$G_p = 10 \log_{10} \frac{P_{OUT}}{P_{IN}}$$

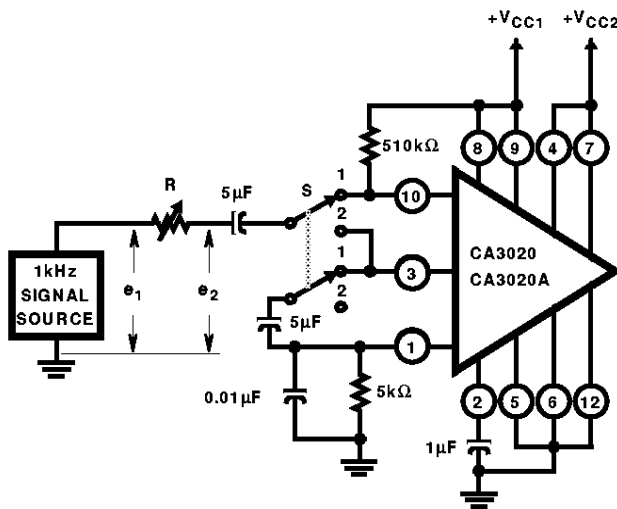
$$\text{where } P_{IN}(\text{in mW}) = \frac{e_{IN}^2}{3000 + R_{IN(10)}} \text{ (Note 4)}$$

NOTE:

4. See Figure 10 for definition of  $R_{IN(10)}$ .

**FIGURE 9. MEASUREMENTS OF ZERO-SIGNAL DC CURRENT DRAIN, MAXIMUM-SIGNAL DC CURRENT DRAIN, MAXIMUM POWER OUTPUT, CIRCUIT EFFICIENCY, SENSITIVITY, AND TRANSDUCER POWER GAIN**

## CA3020, CA3020A



### PROCEDURES:

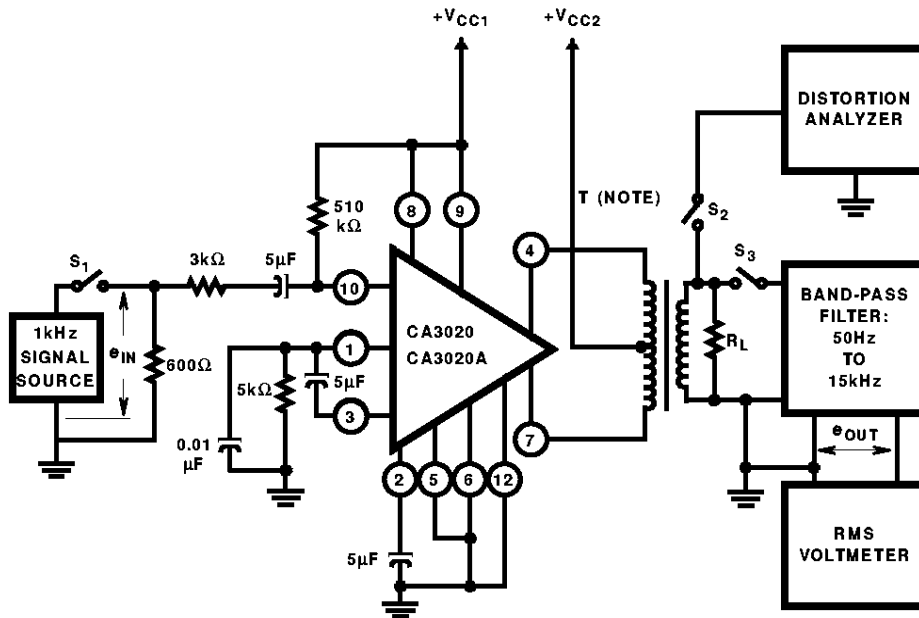
Input Resistance Terminal 10 to Ground ( $R_{IN10}$ ).

1. Apply desired value of  $V_{CC1}$  and  $V_{CC2}$  and set S in Position 1.
2. Adjust 1kHz input for desired signal level of measurement
3. Adjust R for  $e_2 = e_1/2$ .
4. Record resulting value of R as  $R_{IN10}$ .

Input Resistance Terminal 3 to Ground ( $R_{IN3}$ ).

1. Apply desired value of  $V_{CC1}$  and  $V_{CC2}$  and set S in Position 2.
2. Adjust 1kHz input for desired signal level of measurement
3. Adjust R for  $e_2 = e_1/2$ .
4. Record resulting value of R as  $R_{IN3}$ .

FIGURE 10. MEASUREMENT OF INPUT RESISTANCE



NOTE: Push-pull output transformer; load resistance ( $R_L$ ) should be selected to provide indicated collector-to-collector load impedance ( $R_{CC}$ ).

### PROCEDURES:

Signal-to-Noise Ratio

1. Close  $S_1$  and  $S_3$ ; open  $S_2$ .
2. Apply desired values of  $V_{CC1}$  and  $V_{CC2}$ .
3. Adjust  $e_{IN}$  for an amplifier output of 150mW and record resulting value of  $e_{OUT}$  in dB as  $e_{OUT1}$  (reference value).
4. Open  $S_1$  and record resulting value of  $e_{OUT}$  in dB as  $e_{OUT2}$
5. Signal-to-Noise Ratio (S/N) =  $20 \log_{10} \frac{e_{OUT1}}{e_{OUT2}}$ .

Total Harmonic Distortion

1. Close  $S_1$  and  $S_2$ ; open  $S_3$ .
2. Apply desired values of  $V_{CC1}$  and  $V_{CC2}$ .
3. Adjust  $e_{IN}$  for desired level amplifier output power.
4. Record Total Harmonic Distortion (THD) in %.

FIGURE 11. MEASUREMENT OF SIGNAL-TO-NOISE RATIO AND TOTAL HARMONIC DISTORTION