CA3020, CA3020A

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 $12V_{DC}$ supply with a typical power gain of 75dB. The CA3020 provides 0.5W power output from a 9V supply with the same power gain.

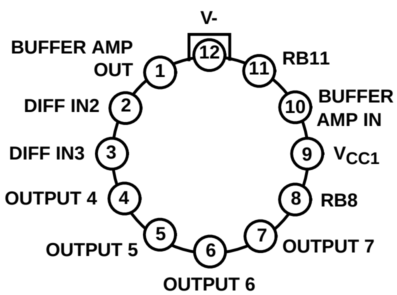
Refer to AN5766 for application information.

Ordering Information

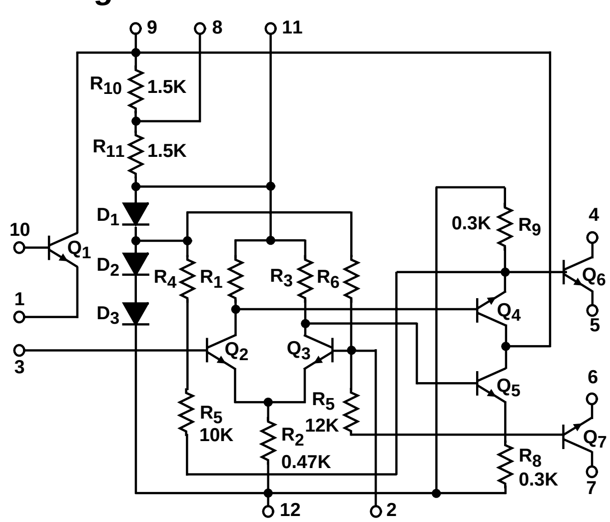
PART NUMBER	TEMP. RANGE (°C)	PACKAGE	PKG. NO.
CA3020	-55 to 125	12 Pin Metal Can	T12.B
CA3020A	-55 to 125	12 Pin Metal Can	T12.B

Pinout

CA3020
(METAL CAN)
TOP VIEW



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%.

Intersil 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.

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)	θ_{JA} (°C/W)	θ_{JC} (°C/W)
Metal Can Package	165	80

Maximum Junction Temperature (Metal CanPackage) . . . . 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:

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

Electrical Specifications $T_A = 25^oC$

PARAMETER	SYMBOL	TEST CONDITIONS: CIRCUIT AND PROCEDURE FIGURE	DC SUPPLY VOLTAGE V_{CC1}	DC SUPPLY VOLTAGE V_{CC2}	CA3020 MIN	CA3020 TYP	CA3020 MAX	CA3020A MIN	CA3020A TYP	CA3020A MAX	UNITS
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 IDLE I_7 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 CUTOFF I_7 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	µA
Emitter-to-Base	I_{EBO}		3.0	-	-	-	0.1	-	-	0.1	µA
Collector-to-Base	I_{CBO}		3.0	-	-	-	0.1	-	-	0.1	µA
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} = 130Ω	$P_{O(MAX)}$	9	6.0	6.0	200	300	-	200	300	-	mW
		9	9.0	9.0	400	550	-	400	550	-	mW
Maximum Power Output for R_{CC} = 200Ω		9	9.0	12.0	-	-	-	800	1000	-	mW
Sensitivity for P_{OUT} = 400mW, R_{CC} = 130Ω	e_{IN}	9	9.0	9.0	-	35	55	-	-	-	mV
Sensitivity for P_{OUT} = 800mW, R_{CC} = 200Ω	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	-	Ω

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	kΩ
Efficiency		η	45	55	%
Signal-to-Noise Ratio		S/N	70	66	dB
THD at 150mW Level			3.1	3.3	%
Test Signal Frequency from 600Ω Generator			1000	1000	Hz
Equivalent Collector-to-Collector Load Resistance		R_{CC}	130	200	Ω

NOTE:

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

Test Circuits and Waveforms

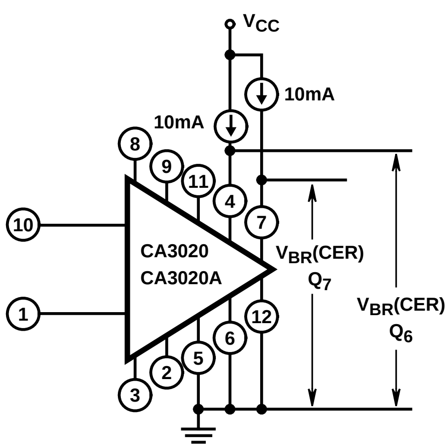


FIGURE 1A. COLLECTOR-TO-EMITTER BREAKDOWN VOLTAGE (Q_6 AND Q_7) CIRCUIT

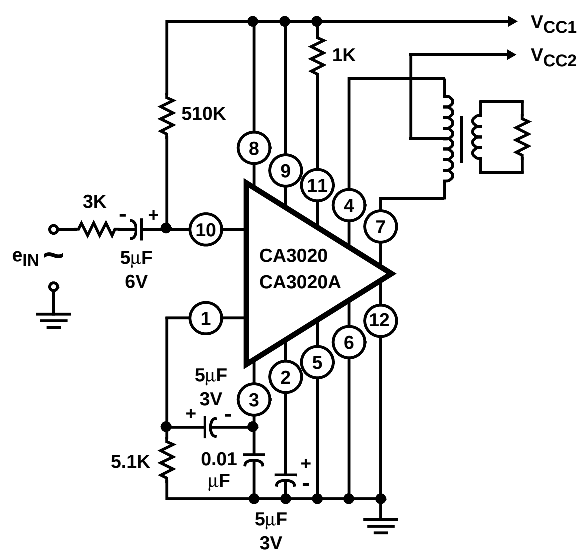


FIGURE 1B. TYPICAL AUDIO AMPLIFIER CIRCUIT UTILIZING THE CA3020 OR CA3020A AS AN AUDIO PREAMPLIFIER AND CLASS B POWER AMPLIFIER

FIGURE 1.

Test Circuits and Waveforms (Continued)

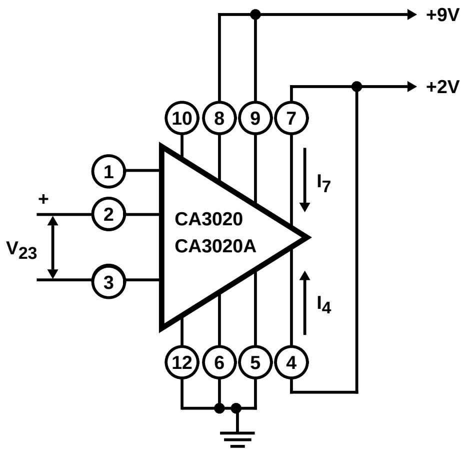


FIGURE 2A. TEST SETUP

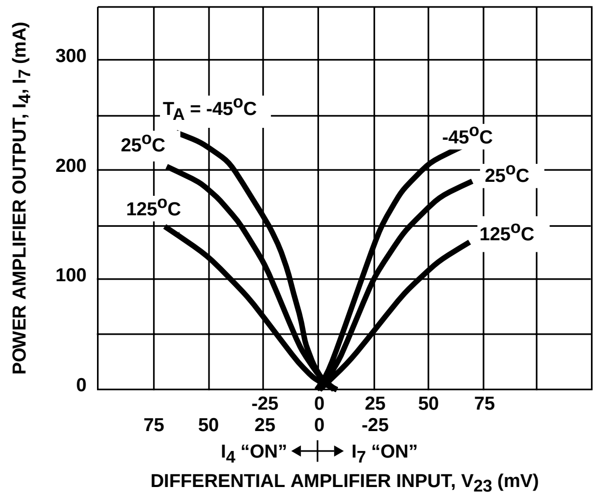


FIGURE 2B. CHARACTERISTICS WITH R_{10} SHORTED OUT

FIGURE 2. TYPICAL TRANSFER CHARACTERISTICS

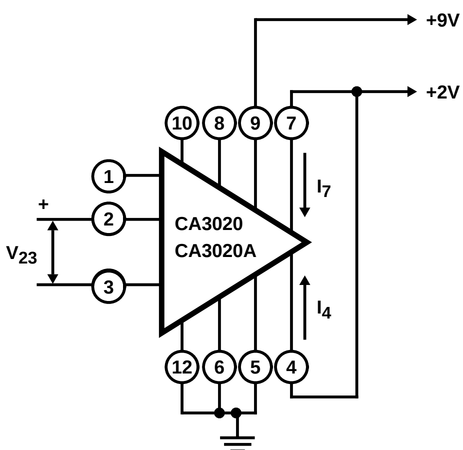


FIGURE 3A. TEST SETUP

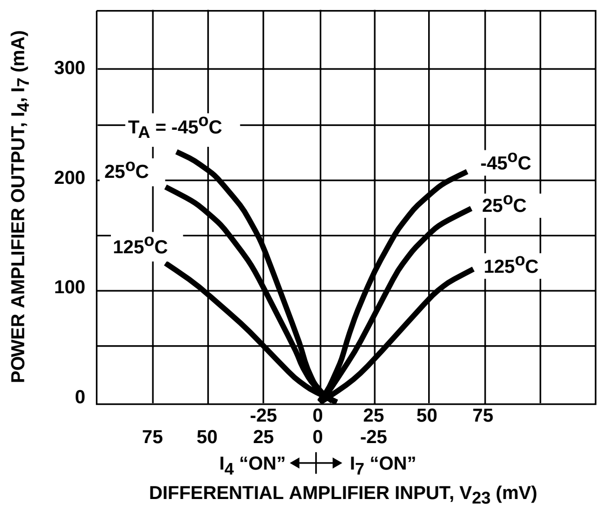


FIGURE 3B. CHARACTERISTIC WITH R_{10} IN CIRCUIT

FIGURE 3. TYPICAL TRANSFER CHARACTERISTICS

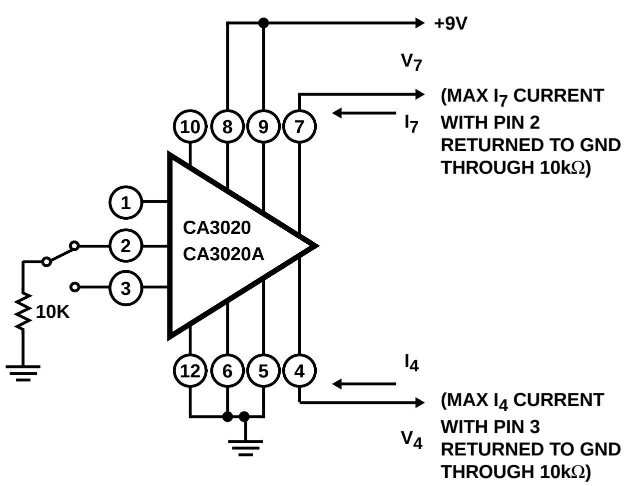


FIGURE 4A. TEST SETUP

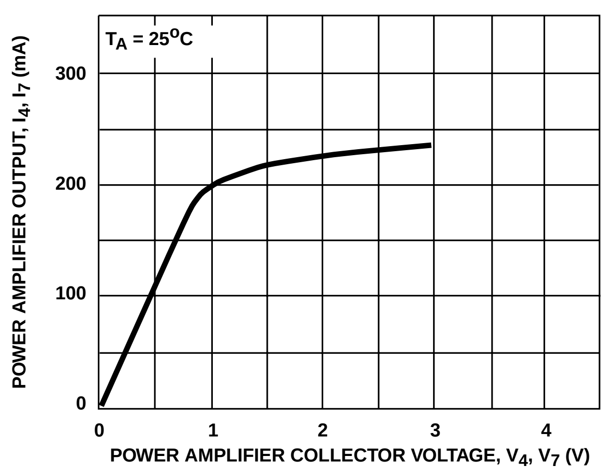


FIGURE 4B. CHARACTERISTIC

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

Test Circuits and Waveforms (Continued)

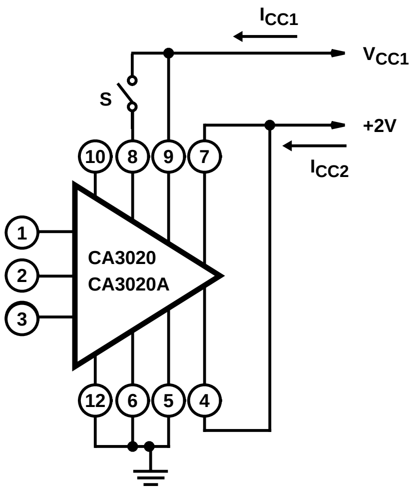


FIGURE 5A. TEST SETUP

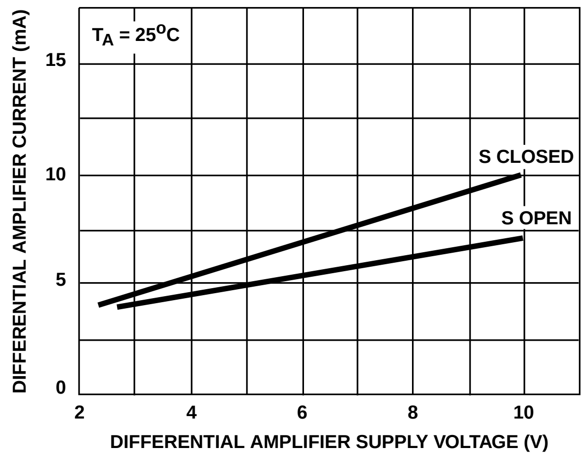


FIGURE 5B. DIFFERENTIAL AMPLIFIER CHARACTERISTICS OF I_{CC1} CURRENT vs V_{CC1} VOLTAGE

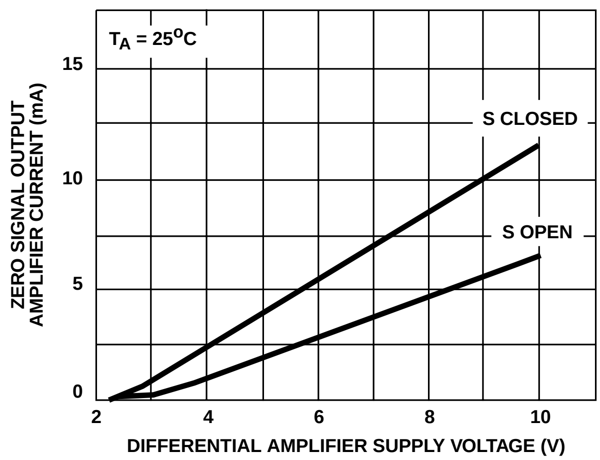


FIGURE 5C. OUTPUT AMPLIFIER CHARACTERISTICS OF I_{CC2} CURRENT vs V_{CC1} VOLTAGE

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

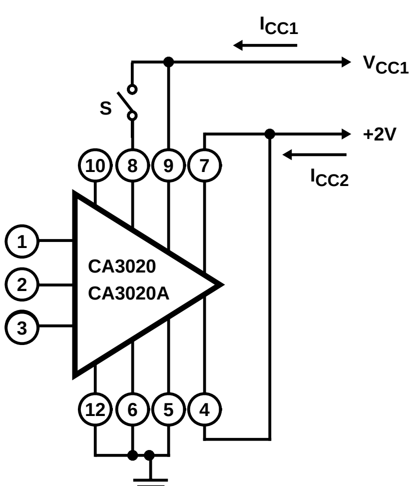


FIGURE 6A. TEST SETUP

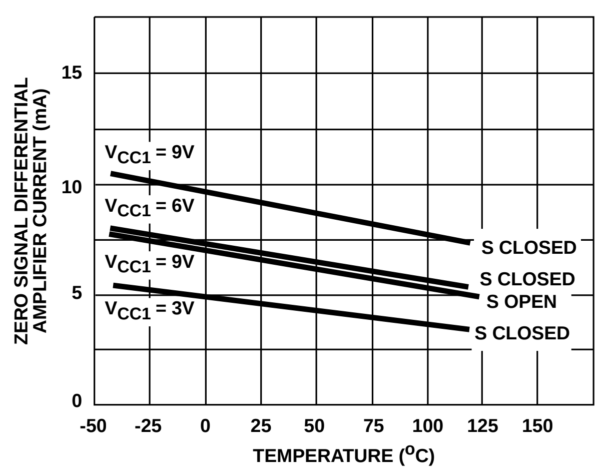


FIGURE 6B. DIFFERENTIAL AMPLIFIER CHARACTERISTICS OF I_{CC1} CURRENT vs AMBIENT TEMPERATURE

FIGURE 6. ZERO SIGNAL AMPLIFIER CURRENT vs AMBIENT TEMPERATURE

Test Circuits and Waveforms (Continued)

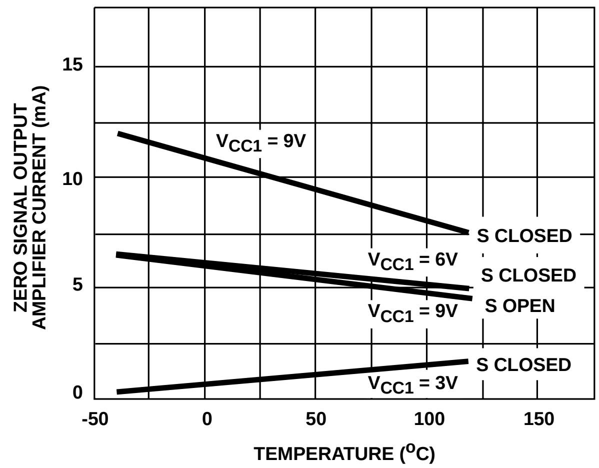
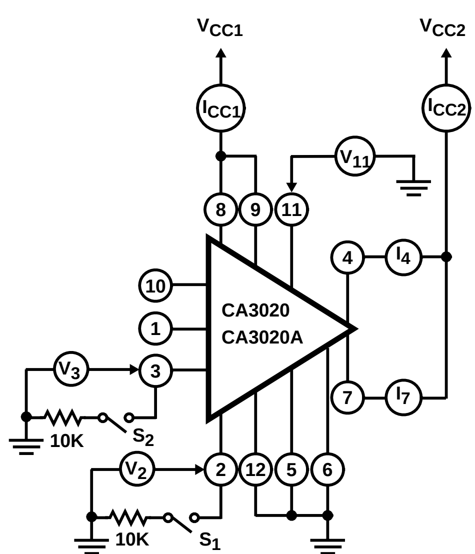


FIGURE 6C. OUTPUT AMPLIFIER CHARACTERISTICS OF I_{CC2} CURRENT vs AMBIENT TEMPERATURE

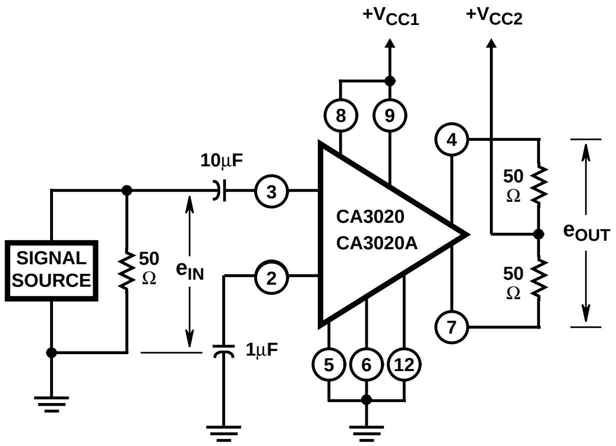
FIGURE 6. ZERO SIGNAL AMPLIFIER CURRENT vs AMBIENT TEMPERATURE



CURRENTS OR VOLTAGES	S_1	S_2
I_4 -IDLE	OPEN	OPEN
I_7 -IDLE	OPEN	OPEN
I_4 -PEAK	OPEN	CLOSE
I_7 -PEAK	CLOSE	OPEN
I_4 -CUTOFF	CLOSE	OPEN
I_7 -CUTOFF	OPEN	CLOSE

CURRENTS OR VOLTAGES	S_1	S_2
I_{CC1}	OPEN	OPEN
I_{CC2}	OPEN	OPEN
V_2	OPEN	OPEN
V_3	OPEN	OPEN
V_{11}	OPEN	OPEN

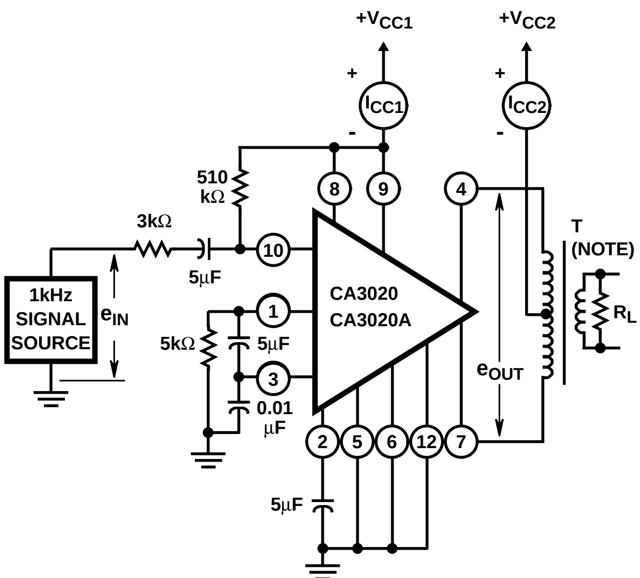
FIGURE 7. STATIC CURRENT AND VOLTAGE TEST CIRCUIT



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.

FIGURE 8. MEASUREMENT OF BANDWIDTH AT -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 (η) 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:

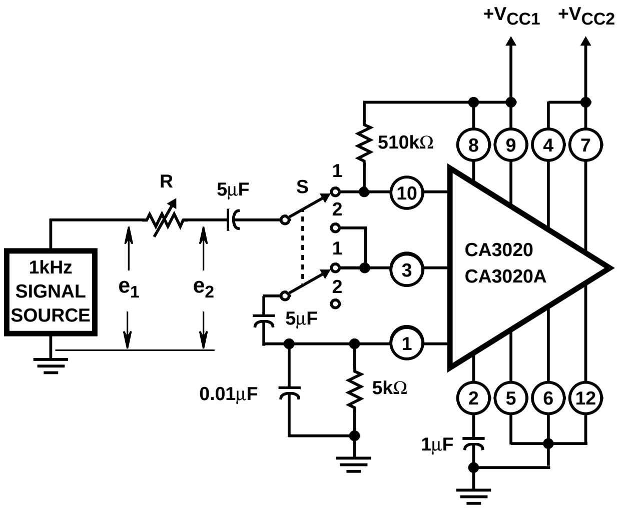
$$G_p = 10\log_{10}\frac{P_{OUT}}{P_{IN}}$$

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

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



PROCEDURES:

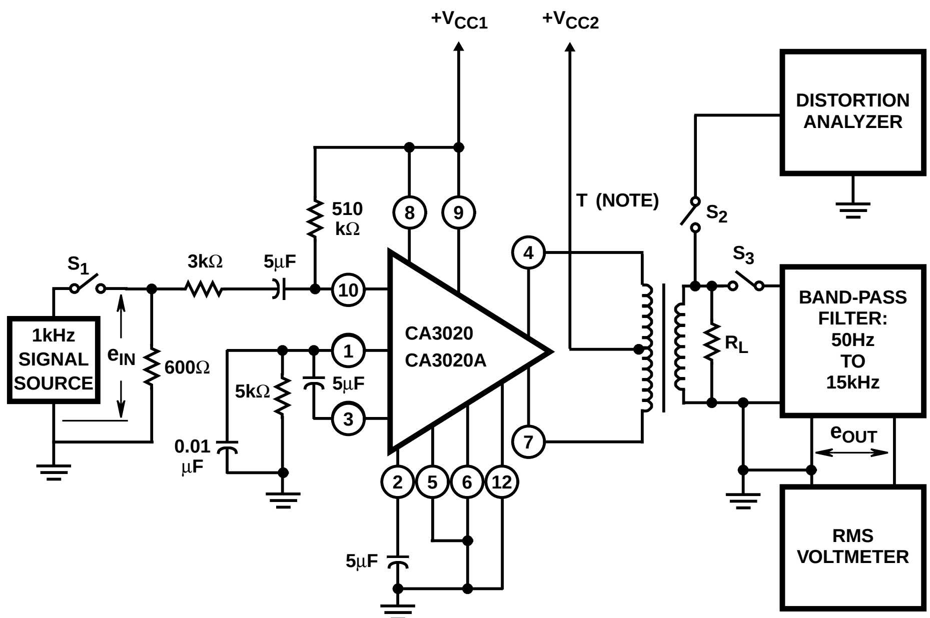
Input Resistance Terminal 10 to Ground (R_{IN10}).

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

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