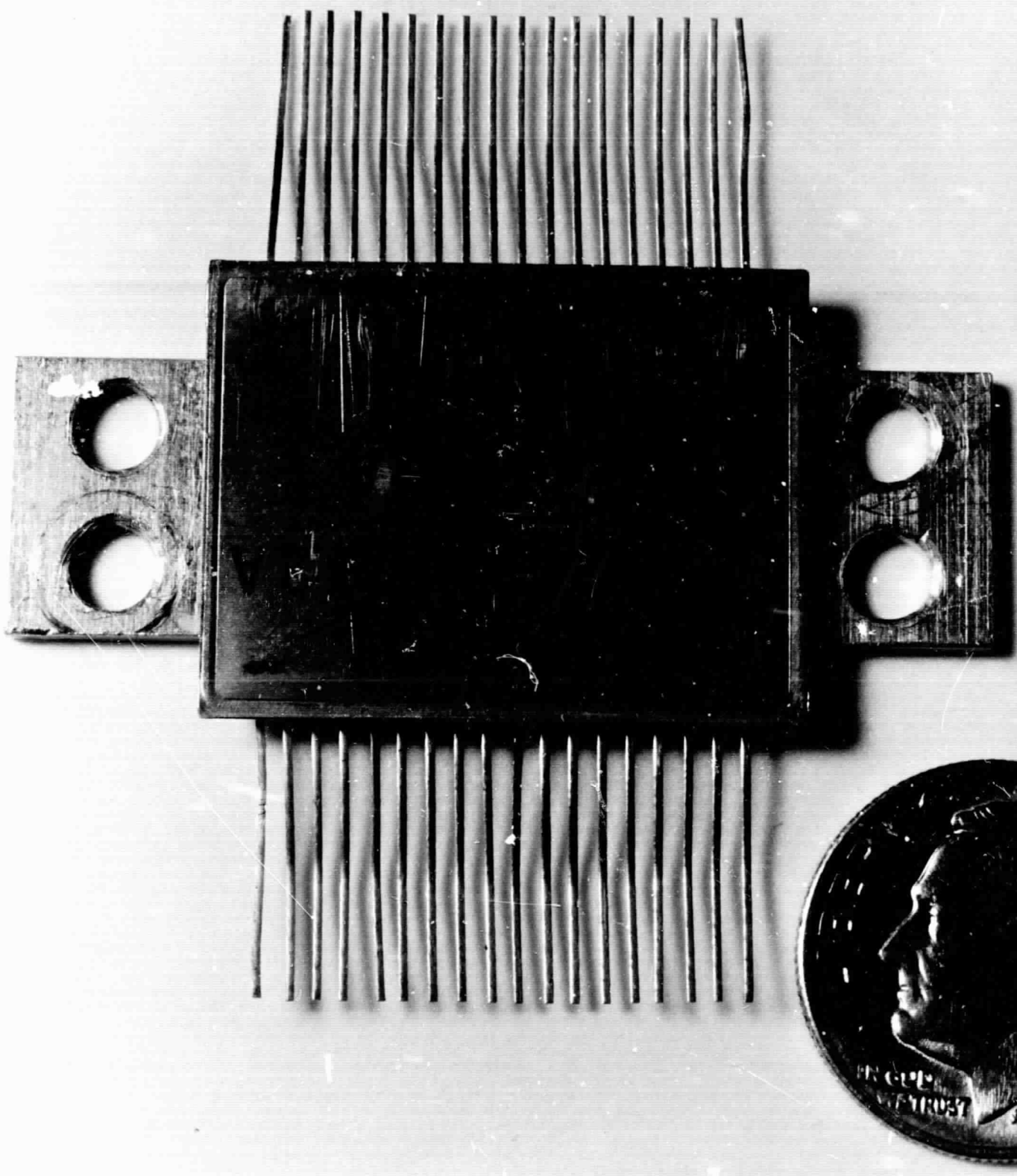


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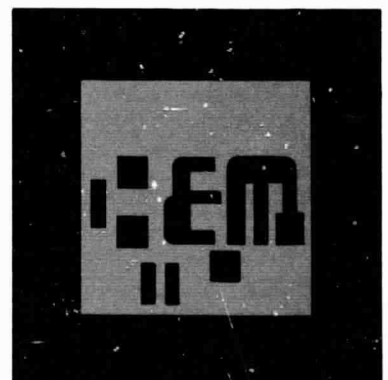
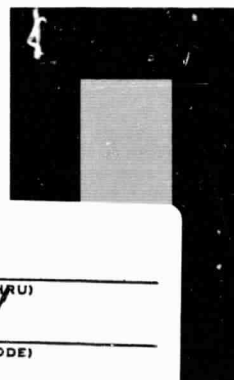
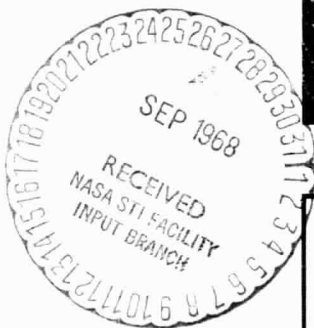
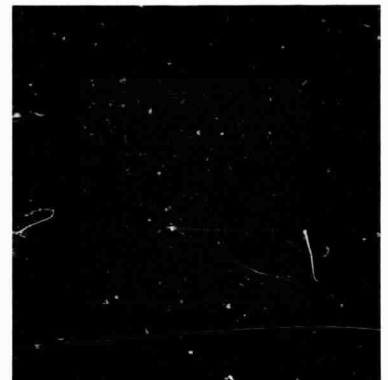
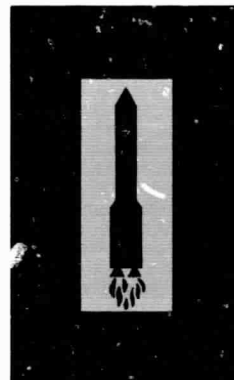
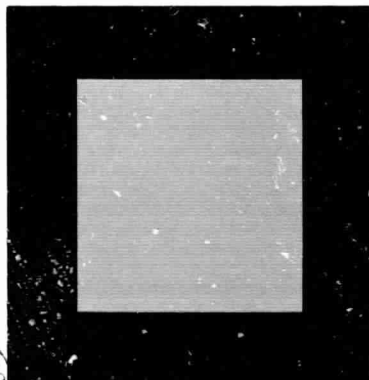
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INTEGRATED 10 WATT AMPLIFIER

Contract No.: NAS-8-20846



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(ACCESSION NUMBER) **N69-26706** (THRU) _____

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INTEGRATED 10 WATT AMPLIFIER

Contract No.: NAS-8-20846

Prepared for:

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George C. Marshall Space Flight Center
Huntsville, Alabama

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1.0 PURPOSE

The purpose of this document is to summarize the results and conclusion arising from the design, development, and test of a 10 Watt Integrated Amplifier by General Precision Systems Inc., Kearfott Group, Kearfott Systems Division (KSD) under NASA Contract No. NAS-8-23846. The amplifier, designated amplifier, and power module was designed and tested by KSD under the aforementioned NASA Contract. The unit was manufactured by Amelco against KSD Specification H196000032 and associated statement of work.

1.1 - CIRCUIT DESCRIPTION

The object of the design was to produce a driver which would provide a differential output at a mean level of ± 14 volts on response to input to single-ended input signals at ground level.

Utilization of standard integrated circuits was the basic idea behind the circuit configuration of Figure 1. (Schematic diagram _____). A few deposited resistors were used to join the active devices into a functional system.

The first amplifier (AR1 in Figure 1) provides the gain. The nominal gain of AR1 is 4.7 v/v ; it can be adjusted to any value between 5 and 50 v/v by connection of an appropriate resistor (R_x) between pins 1 and 36. The value of R_x can be determined within 5% from equation 2.

$$F_x = \frac{R_{23}(R_2 + R_6)}{R_2(c/2 - 1) - (R_6 + R_{23})}$$

$$= \frac{155}{2.759 - 25.5} \quad \text{volts}$$

Where:

G = overall gain of the driver.

The quiescent voltage at the output of AE1 is at ground level.

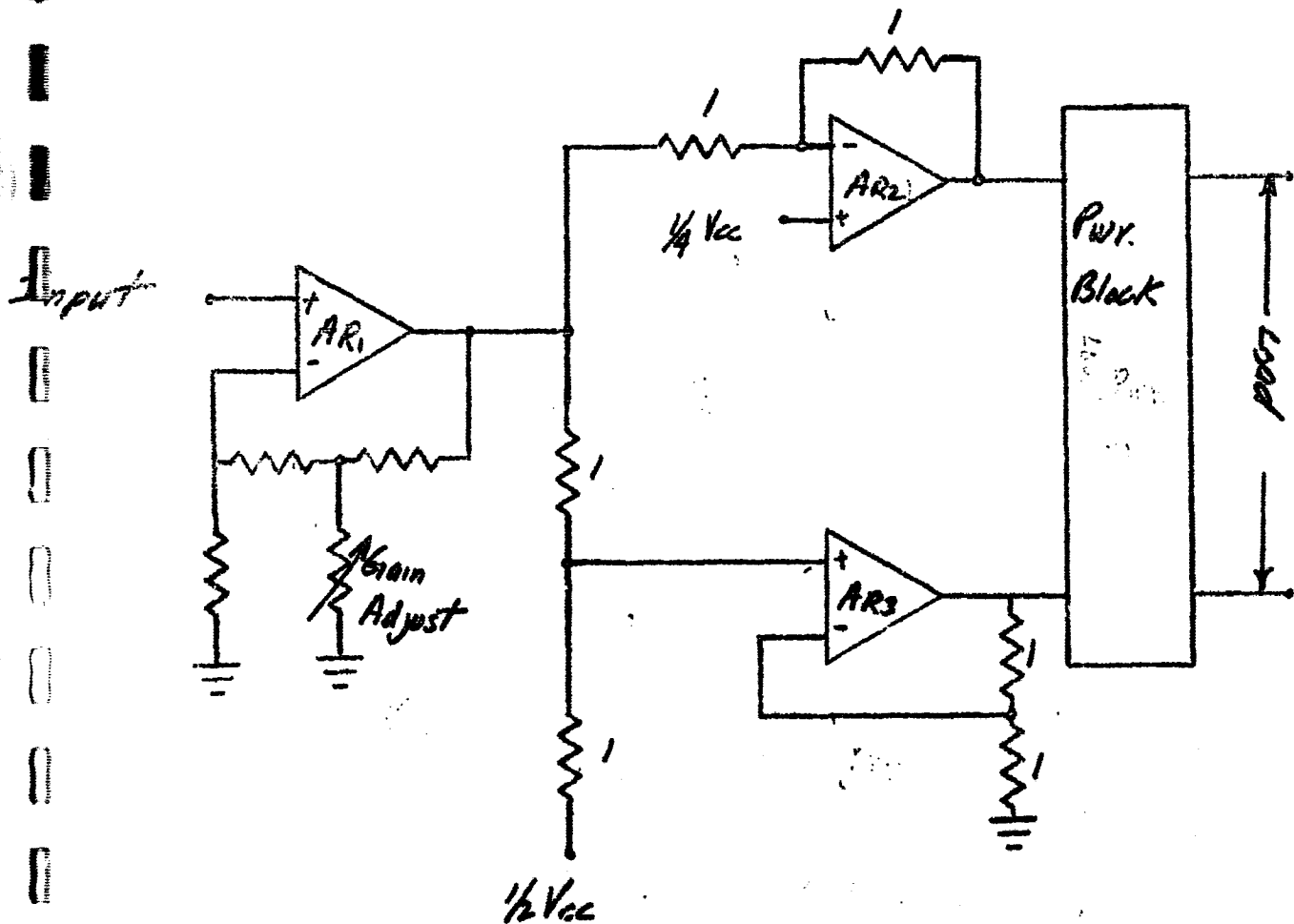
The combination AR2 & AR3 works as a phase-splitter. AR2 inverts the signal, AR3 does not. Thus the effective gain of the aforementioned pair is 2 v/v. Thereby providing an overall gain adjustment of from 10 v/v to 100 v/v input to output. The quiescent level at the output of AR2, as well as AR3, is 14 volts, or 1/2 of the supply line voltage.

Transistors Q2 through Q9 provide current gain the pairs Q2/Q6 and Q4/Q8 are arranged in the Darlington Configuration. The pairs Q5/Q7 and Q5/Q9 are operated as compound emitter-followers. A capacitor (C9) is provided for the purpose of line decoupling. There are a few ancilliary components. Transistor Q1 and lever diode CR1 form a 15 volt regulator, used on the positive supply for AE1. Capacitors C7, C8 and resistors R11 and R12 stabilize the feedback loops of AR2 and AR3 respectively. The differential output of the power section is capable of delivering 10 watts continuously.

Good gain stability, wide frequency response and high efficiency are the major electrical characteristics of the above driver. There are many mechanical advantages. The package is small, it can be easily mounted and it has good thermal characteristics.

FIGURE 1

Block diagram of the 10 Watt Driver :



It should be noted that the Amplifier circuitry described in the aforementioned paragraph is the alternate approach submitted to NASA in report #3, dated 10/15/67. The first approach, subsequently approved by NASA, was predicated on the availability of the Norden Master Die NM-3025. Availability of the die appeared to be assured at the time of the initial proposal and at the time of submittal of report #3. The die was in production at Norden for about two years and was used in a number of Government contracts and some assemblies manufactured by the General Precision Laboratories. Representatives of the United Aircraft Corporation assured us that the Master Die NM-3025 would become a major product of the recently established Electronics Components Division (ECD, see Page 7 of Vector catalogue IOM - 7/67). They submitted a quote on November 3, 1967 (ECD quote #7-051) for the production of the die and assemble of the amplifiers.

Subsequently, as indicated in report #4, ECD has withdrawn their quote, stating that they have decided to discontinue manufacture of Master Die NM-3025.

Therefore, KSD negotiated with other semiconductor houses for the availability of a die equivalent to the NM-3025. However, major contractors like Texas Instrument, Westinghouse, ITT, Amelco, and Fairchild would only produce integrated circuitry that utilize standard circuits, package and assembly techniques. In fact, Fairchild Semiconductor and Amelco claimed they would only assemble circuits utilizing devices manufactured within their own organization.

The reasons Fairchild and Amelco do not intend to use devices manufactured by other semiconductor houses is the additional problems encountered in testing and reliability of components procured from outside sources.

For the aforementioned reasons, KSD was forced to pursue the approach submitted to NASA as alternate in the October submittal. However, upon further investigation, the alternate approach, utilizing standard uA-709 integrated circuits for the amplifier stage (the power stage remains the same), has proven more practical than the original approach recommended to NASA in the October submittal.

1.2 - THERMAL ANALYSIS

To insure that the MEMA concept is capable of the required dissipation for this package, a thermal analysis of the output power transistors and operational amplifier section was performed. The output transistor has a thermal resistance from the junction to moly tab to which it is gold-silicon eutectic soldered of $5^{\circ}\text{C}/\text{watt}$. The moly tab is .100 x .100 inches which will result in another $5^{\circ}\text{C}/\text{watt}$ thermal resistance to the flange heat sink. The heat flow in the flange heat sink is both down and toward its connecting screw, with no more than $2^{\circ}\text{C}/\text{watt}$. This total thermal resistance is less than half the value which is dictated by a 150°C junction, 100°C ambient, and 2.3 watt dissipation.

If the power from the output transistors were to develop a thermal gradient between the input transistors to the operational amplifiers, then a deleterious offset voltage would be created. It will now be shown, that this effect produces only a negligible effect.

The fact that the entire operational amplifier will go up and down in temperature is not relevant since it is designed to operate over a substantial temperature range.

It is safe to assume that two watts of power from the output transistors is a maximum amount that might be flowing laterally in the heat sink below the operational amplifiers. The 1/2 x 1/16 inch copper flange, being a good heat conductor, would have a thermal gradient.

$$\frac{T}{e} = \frac{^{\circ}\text{C-inch}}{10 \text{ watts}} \times \frac{2 \text{ watts}}{1/2 \times 1/16"} = 6.4^{\circ}\text{C/inch}$$

The input transistors are only .005" apart so the temperature difference is only .032°C. Offset is generated at 2 millivolts per °C so that an offset of only 64 microvolts would be generated by this effect. This value is substantially below the 6 millivolt specification which applies to the 709. Additionally, the input transistors are mounted on a moly tab which is separated by .026" of alumina from the copper flange. There is less thermal gradient in the moly tab than in the copper. Lastly, the operational amplifiers are oriented on the heat sink such that the input transistors lie on a equitemperature line which should cause no thermal difference at all.

-7-

1.3 - TEST RESULTS

The following table depicts the specification limits versus typical test results, actual test results: **inclosed in** [redacted], the circuit as originally designed performed very well meeting or exceeding the electrical specifications contained in Kearfott Systems Division document BL96000032 Section 3 as shown in the table below.

TABLE 1

Test	Spec. Limit	Typical Data
Power Req	+27ma	13ma
Conversion Gain Stability *	4.28 to 4.72	4.58 to 4.68
Diff Output	±.3 Volt	±.1 Volt
Diff Output Drift *	±50mV	±10mV
Output Voltage Swing *	22vp-p	-22vp-p
Freq Res *	±db to 100KHz	-.5db to 100KHz
Slew Rate	6v/usec	7.5 to 11v/usec
Sat Voltage *	-1.5V @ 400ma	.8 to 1.3
Current Gain *	-1000 @ VCE=5V	4K to 20K
Oscillations *	-2mV	No observable osc. above noise

* Tested over temp. range of -25 to 100°C

Included herein is additional test data to verify the affects of the Power Section on the drift characteristics of AR1, AR2 and AR3.

TEST SET UP

1. AR1, AR2 and AR3 set up so that they are independent of power section.
Pins 23 and 25, 14 and 17 are shorted.
2. Run gain checker with and without power section on.
3. Adjust power dissipation so that package temperature doesn't exceed 100°C. (read with a MiniMite)

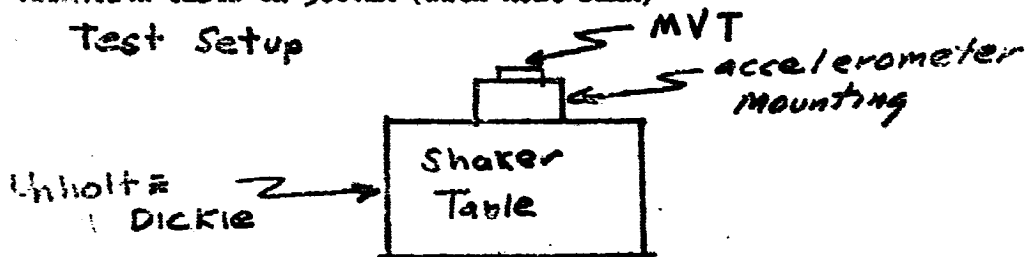
Test Data

With Power Section off				With Power Section on (Package Temp 80°C)			
Ein	EO1	EO2	EO3	Ein	EO1	EO2	EO3
2.17	+10.00	4.10	24.42	2.17	10.00	4.05	24.41
1.09	+ 5.00	9.14	19.28	1.09	5.00	9.09	19.26
.00	0.00	+14.16	+14.14	.00	0.00	14.12	14.12
-1.07	-5.00	19.18	8.99	-1.06	-5.00	19.14	8.98
-2.14	-10.00	24.20	3.86	-2.15	-10.00	24.18	3.83

Although the vibration tests were not required to be performed, Amelco performed these tests at their own option. Included herein is a summary of these test results.

VIBRATION TESTS ON 5680DM (with heat sink)

Test Setup



Test Conditions

1. Mounted package on 8.2 lbs of aluminum to get proper G level
2. Set amplitude to give 10g force on package
3. Run sweep freq. from 100 to 2000cps
4. Electrical tests prior to tests were run then after 106, 156, and 246.

		1.00	100	150	240
Test 3A					
	E01	13.98	13.98	13.98	13.98
Output at Zero in	E02	14.21	14.21	14.22	14.22
8A					
Frequency Resp. & Amplitude	E01	OK (22V)	OK(22V)	22V	22V
	E02	OK (22V)	OK(22V)	22V	22V
10A					
VCE SAT					
	Q6	1.17	1.15	1.16	1.15
	Q8	1.01	1.00	1.00	1.00
	Q7	1.17	1.15	1.16	1.15
	Q9	.98	.96	.96	.97

1.2 - NUCLEAR RADIATION TESTING

Two 10 watt amplifiers, developed under Contract #NAS8-20846, together with a number of items from other projects, were subjected to a nuclear radiation environment on 5-24-68.

One of the amplifiers (Serial #10) was irradiated under normal operating conditions, with a load of 62 ohms. This amplifier failed within 1/2 hour from the commencement of the test. The residual gamma rate of the reactor was approximately 20,000 Rads per hour. That radiation was apparently sufficient to inflict permanent catastrophic damage, probably by burnout of transistors, initiated by gamma induced leakage.

The other module (Serial #12) was irradiated under non-operating conditions. It was exposed to a total dose of 10¹⁴ Rads.

Tests performed on 6-25-68 disclose the following changes in the characteristics of the amplifier:

1. Operating level:	No significant change
2. Output offset voltage at a gain of 10:	172 mv pre-radiation 132 mv post-radiation
3. Input current:	.77 micro A. pre- 2.6 micro A. post-
4. Input leakage current:	.1 micro A. pre- .1 micro A. post-
5. Output swing, no load:	45 volts pk-pk pre- 43 volts pk-pk post-
6. Output swing, 30 ohms load:	45 volts pk-pk pre- 23 volts pk-pk post-

7. Stand-by power consumption:	No significant change
8. Gain:	9.66 pre 9.57 post

Test 3, 5 and 6 are significant in the light of established theory of neutron-inflicted radiation damage. Test 3 shows a degradation in h_{fe} of the input transistors from approximately 52 to about 15. Combination of the results of test 5 and 6 indicates degradation of the h_{fe} of the output Darlington's to approximately 46, from an initial value in excess of 1000.

It is apparent that further efforts at radiation hardening of the amplifier should begin with the output stage. An improvement of an order of magnitude can be achieved by slight modification in device and circuit design.

1.5 - CONCLUSION

As it can be evidenced from table 1, section 1.3, it can be determined that the modules meet the specification in all areas.

However, all modules were tested for oscillations prior to shipment over the temperature extremes by Amelco and were passed as having less than 2mV of noise and/or oscillation as specified. Testing of the modules by KSD showed that some modules were oscillating at 2MHz with an amplitude of approximately 50 to 100 millivolts. Three units were returned to Amelco by KSD for tests to verify these oscillations. It was shown that the Amelco test set-up used by Amelco could not observe noise levels less than 100mV in amplitude.

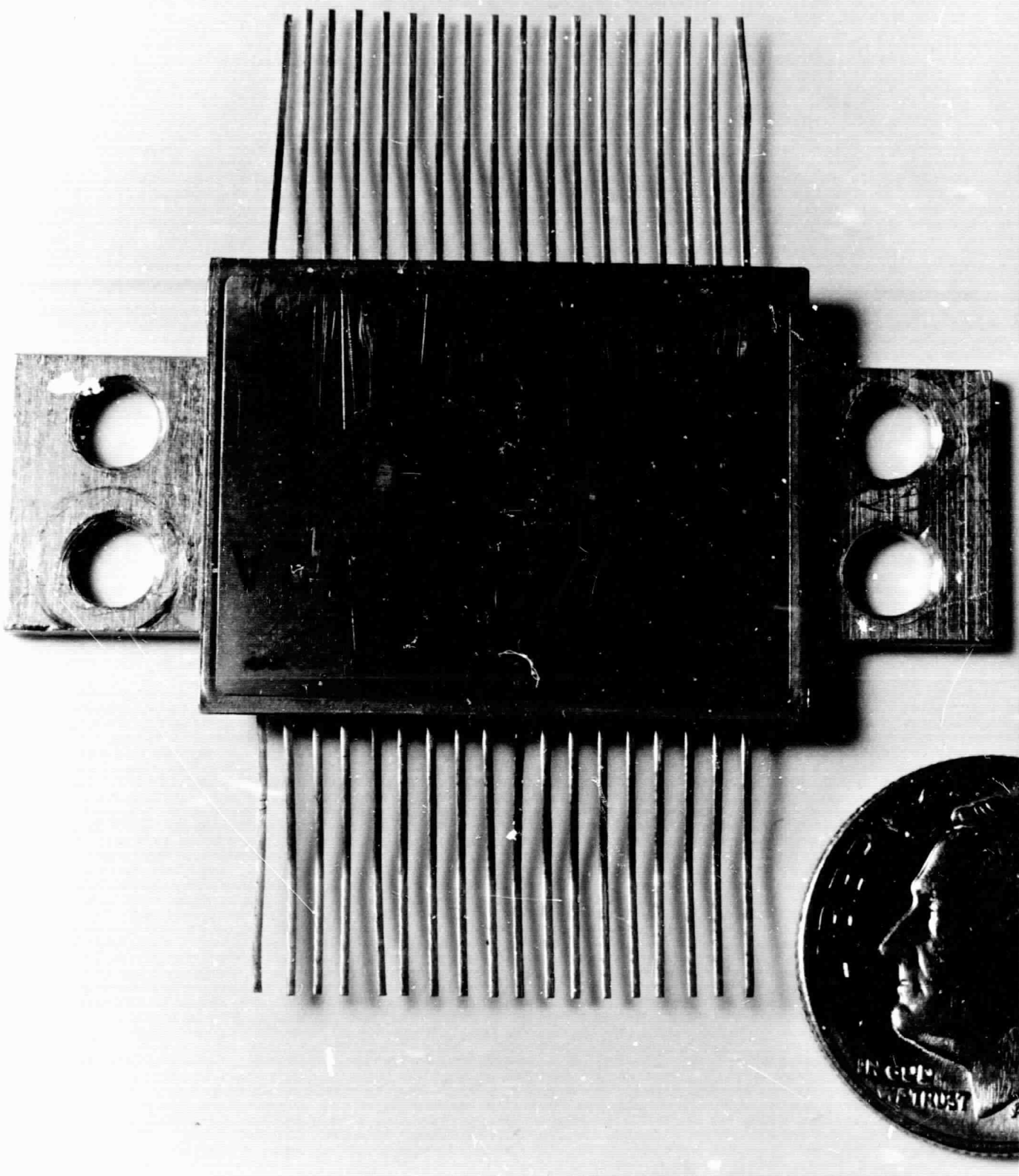
-12-

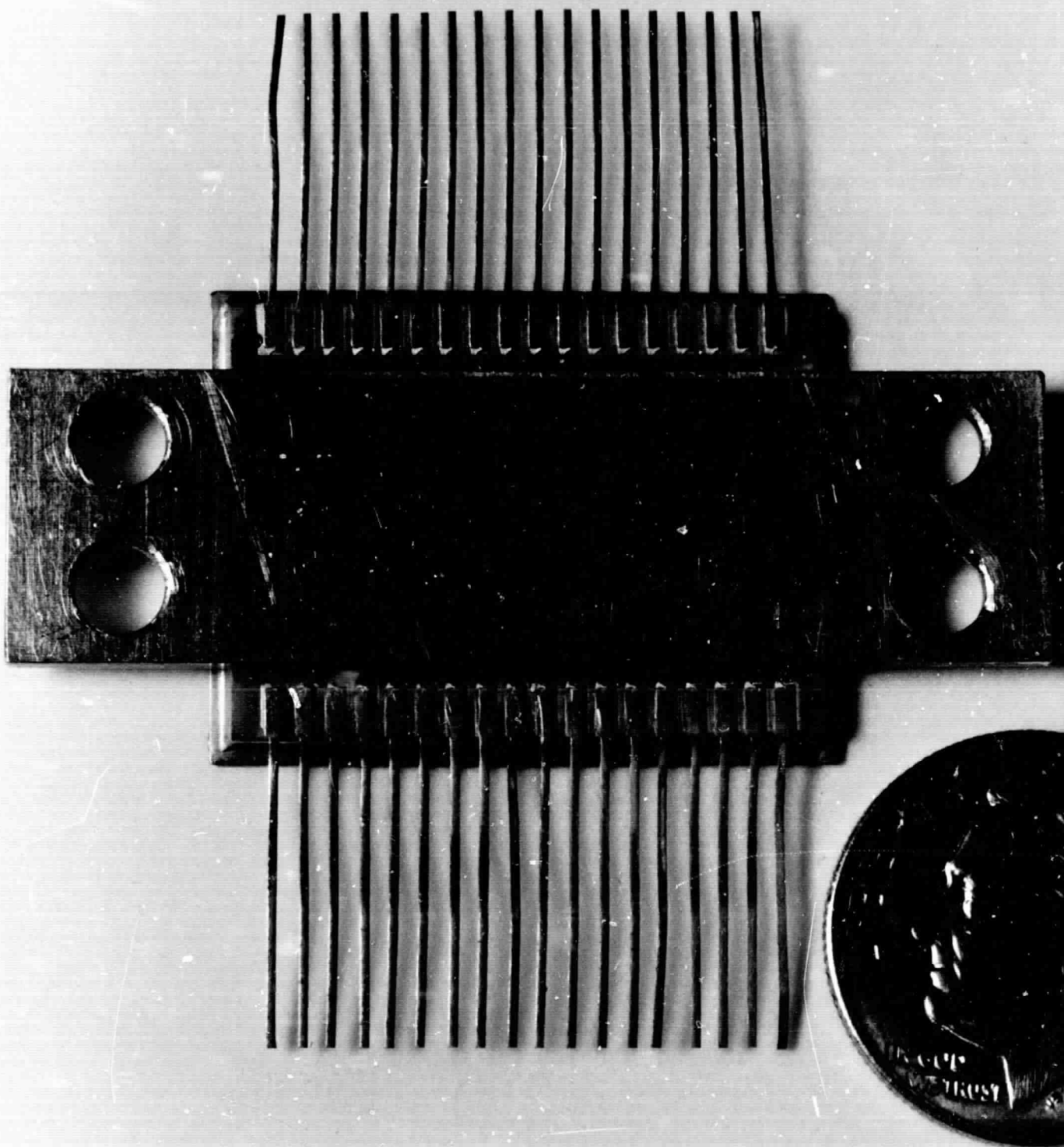
Investigations showed that these low level oscillations were due to under compensation of the input amplifier. Recommended compensation for this amplifier with a gain of 5 is a 5000pf capacitor in series with 1.5K and another 200pf capacitor from pin 5 to pin 6. This would very seriously limit the slew rate however.

Therefore, it is recommended that a compromise between frequency response and slew rate be made on future units. The frequency response data included in Appendix B appears to be a reasonable compromise. Frequency response was flat to 60KHz with some peaking occurring at 100KHz. Slew rate is decreased down to approximately 1V/ussec and distortion starts occurring at 50-60KHz for a 22 volt swing on the output of AR2 and AR3. In addition it would appear reasonable to provide paths for leakage currents around the base emitter junctions of the power stages for future modules. These alterations could be accomplished with a minimum of layout pattern changes. The remaining portions would not have to be changed. The three modified units, Serial #9, 11, and 16 were then submitted to NASA.

APPENDIX A

TEST RESULTS





4) $+I_{vcc} = 14.02 \text{ mA}$
 $-I_{vcc} = 3.49 \text{ mA}$

6)

	+25°C
V ₁₇	14.12
V ₂₅	14.15

7)

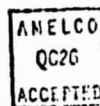
	+25°C
V ₁₇	22.0 V
V ₂₅	21.5 V
Osc. Amp	—

Will go to 22 volts

8)

	+25°C	freq
V ₁₇	22.1	0 HZ
V ₁₇	22.1	100 HZ
V ₁₇	22.1	1 KHZ
V ₁₇	22.1	10 KHZ
V ₁₇	22.1	100 KHZ
V ₂₅	22.0	0 HZ
V ₂₅	22.0	100 HZ
V ₂₅	22.0	1 KHZ
V ₂₅	22.0	10 KHZ
V ₂₅	22.0	100 KHZ

V₁₇ Rise time = $11 \text{ V}/\mu\text{sec}$
V₂₅ Rise time = $10 \text{ V}/\mu\text{sec}$



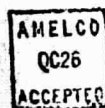
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10.)

+25 °C	
V _{CE SAT} Q6	1.20 V
V _{CE SAT} Q8	1.12 V
V _{CE SAT} Q7	1.10
V _{CE SAT} Q9	0.95

11.)

+25 °C	
I _B Q2	.097 mA
I _B Q4	.110
I _B Q3	.036
I _B Q5	.046



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FINAL TEST DATA

4) $+I_{VCC} = 14.0 \text{ ma}$

$-I_{VCC} = 3.50 \text{ ma}$

5) $I_{in}(+6V) = 1.00 \mu\text{a}$

$I_{in}(-6V) = 0.01 \mu\text{a}$

6)

	-25°C	+25°C	+100°C
V ₁₇	14.13V	14.13V	14.13
V ₂₅	14.15V	14.16V	14.16
$\frac{A(V_{17}-V_{25})}{\Delta T}$	10mV		0

7)

	-25°C	+25°C	+100°C	f _{req.}
V ₁₇	22.0V	22.0V	22.0V	100HZ
V ₂₅	21.5V	21.5V	21.5V	100HZ
Osc Amp	<2mV	<2mV	<2mV	100HZ

8)

	-25°C	+25°C	+100°C	f _{req.}
V ₁₇	22.0V	22.0V	22.0V	0HZ
V ₁₇	22.0	22.0	22.0	100HZ
V ₁₇	22.0	22.0	22.0	1KHZ
V ₁₇	22.0	22.0	22.0	10KHZ
V ₁₇	22.0	22.0	22.5	100KHZ
V ₂₅	21.8V	21.8V	21.8V	CHZ
V ₂₅	21.5	21.5	21.5	100HZ
V ₂₅	21.5	21.5	21.5	1KHZ
V ₂₅	21.5	21.5	21.5	10KHZ
V ₂₅	21.5	21.8	22.0	100KHZ

9) $V_{17} \text{ Rise time} = 1.8 \mu\text{sec}$

$V_{25} \text{ Rise time} = 1.8 \mu\text{sec}$

11)	VCE SAT Q6	1.20 V	1.19 V	1.38
	VCE SAT Q8	1.12	1.13	1.29
	VCE SAT Q7	1.12	1.11	1.15
	VCE SAT Q9	1.04	0.97	0.97

		-25°C	+25°C	+100°C
11)	IB Q2	.250 ma	.100 ma	.042 ma
	IB Q4	.200	.100	.060
	IB Q3	.080	.034	.015
	IB Q5	.100	.046	.020

12.) Vout on Pin 24 = 20.5 V P-P
Vout on Pin 18 = 21.0 V P-P

FINAL ACCEPTANCE TEST DATA

PACKAGE # 2
SC80 DM

A) $+I_{VCC} = 12.48 \text{ ma}$
 $-I_{VCC} = 2.67 \text{ ma}$

	+25°C
V17	14.10 v
V25	14.19 v

	+25°C
V17	22.0 volts
V25	22.0 volts
Osc Amp	—

	+25°C	freq
V17	22.0 volts	0 HZ
V17	22.0 volts	100 HZ
V17	22.0 volts	1 K HZ
V17	22.0 volts	10 K HZ
V17	23.0 volts	100 K HZ
V25	22.0 volts	0 HZ
V25	22.0 volts	100 HZ
V25	22.0 volts	1 K HZ
V25	21.5 volts	10 K HZ
V25	22.0 volts	100 K HZ

P) V17 Rise time = 9 v/μsec
V25 Rise time = 8.5 v/μsec



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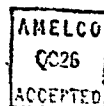
10.)

		+25 °C
VCE SAT	Q6	1.17 v
VCE SAT	Q8	1.16 v
VCE SAT	Q7	1.13 v
VCE SAT	Q9	1.02 v

5680 D 11

11.)

		+25 °C
IB Q2		.089
IB Q4		.115 ma
IB Q3		.036 ma
IB Q5		.038 ma



APR 18 '69

PACKAGE # 2

FINAL TEST DATA

7) $+I_{vec} = 12.18 \text{ ma}$

$-I_{vec} = 2.69 \text{ ma}$

8A) $I_{in} (+6V) = 1.05 \mu\text{a}$

$I_{on} (-6V) = 0.02 \mu\text{a}$

	-25°C	+25°C	+100°C
V17	14.11	14.10	14.10
V25	14.20	14.20	14.20
$\frac{d(V17-V25)}{dT}$	10 mV		0

	-25°C	+25°C	+100°C	freq
V17	22.0	22.0	22.0	100 HZ
V25	21.5	21.5	21.5	100 HZ
Osc. Amp	<2 mV	<2 mV	<2 mV	100 HZ

	-25°C	+25°C	+100°C	freq
V17	22.0	22.0	22.0	0 HZ
V17	22.0	22.0	22.0	100 HZ
V17	22.0	22.0	22.0	1 KHZ
V17	22.0	22.0	22.0	10 KHZ
V17	23.0	22.0	25.0	100 KHZ
V25	21.8	21.8	21.8	0 HZ
V25	21.5	21.5	21.5	100 HZ
V25	21.5	21.5	21.5	1 KHZ
V25	21.5	21.5	21.5	10 KHZ
V25	22.0	21.5	22.5	100 KHZ

9) V17 Rise time = 2.3 μsec

V25 Rise time = 2.0 μsec

10)

		-25 °C	+25 °C	+100 °C
V _{CE SAT}	Q6	1.22	1.29 V	1.24 V
V _{CE SAT}	Q8	1.16	1.17 V	1.33
V _{CE SAT}	Q7	1.14	1.23 V	1.18
V _{CE SAT}	Q9	1.03	1.03 V	1.05

11)

		-25 °C	+25 °C	+100 °C
I _B	Q2	.18	.065 ma	.046 ma
I _B	Q4	.30	.08 ma	.051
I _B	Q3	.074	.03 ma	.018
I _B	Q5	.070	.028 ma	.016

12)

V_{out} on Pin 24 = 20.8 V P-P

V_{out} on Pin 18 = 21.0 V P-P

FINAL ACCEPTANCE TEST DATA

5680 DM

+I_{vcc} = 12.10 ma

-I_{vcc} = 2.55 ma

	+25°C
V ₁₇	13.92
V ₂₅	14.00

	+25°C
V ₁₇	22.0v
V ₂₅	22.0v
Osc Amp	—

	+25°C	f _{req}
V ₁₇	22.0v	0 HZ
V ₁₇	22.0v	100 HZ
V ₁₇	22.0v	1K HZ
V ₁₇	22.0v	10K HZ
V ₁₇	22.0v	100K HZ
V ₂₅	22.0v	0 HZ
V ₂₅	21.5v	100 HZ
V ₂₅	22.0v	1K HZ
V ₂₅	22.0v	10K HZ
V ₂₅	23.0v	100K HZ

V₁₇ Rise time = 25v/μsec

V₂₅ Rise time = 10v/μsec



APR 18 '68

SI 4

5680 DM

V _{CE SAT} Q6	1.28 volts
V _{CE SAT} Q8	1.01 volts
V _{CE SAT} Q7	1.10 volts
V _{CE SAT} Q9	.95 volts

+25 °C

I _B Q2	.084 ma
I _B Q4	.107 ma
I _B Q3	.030 ma
I _B Q5	.022 ma

AHELCO
QC26
ACCEPTED



SEP 18 '68

FINAL TEST DATA

4) $+I_{vee} = 12.35 \text{ ma}$

$-I_{vee} = 2.56 \text{ ma}$

5A) $I_{in} (+6V) = 0.48 \mu\text{a}$

$I_{in} (-6V) = 0.01 \mu\text{a}$

6)

	-25°C	$+25^{\circ}\text{C}$	$+100^{\circ}\text{C}$
V_{17}	13.93	13.93	13.93
V_{25}	14.00	14.00	14.00
$\frac{\Delta(V_{17}-V_{25})}{\Delta T}$	0 mV		
			0 mV

7)

	-25°C	$+25^{\circ}\text{C}$	$+100^{\circ}\text{C}$	f _{req}
V_{17}	21.8	21.8	21.8	100 HZ
V_{25}	21.2	21.2	21.2	100 HZ
Exc Amp	< 2 mV	< 2 mV	< 2 mV	100 HZ

8)

	-25°C	$+25^{\circ}\text{C}$	$+100^{\circ}\text{C}$	f _{req}
V_{17}	21.8	21.8	21.8	0 HZ
V_{17}	21.8	21.8	21.8	100 HZ
V_{17}	21.8	21.8	21.8	1 KHZ
V_{17}	21.8	21.9	21.8	10 KHZ
V_{17}	22.0	21.9	22.5	100 KHZ
V_{25}	21.6	21.2	21.2	0 HZ
V_{25}	21.2	21.2	21.2	100 HZ
V_{25}	21.2	21.2	21.2	1 KHZ
V_{25}	21.2	21.2	21.2	10 KHZ
V_{25}	22.0	22.5	25.0	100 KHZ

9)

$V_{17} \text{ Rise time} = 2.6 \mu\text{sec}$

$V_{25} \text{ Rise time} = 1.8 \mu\text{sec}$

10)	$V_{CE SAT}$ Q6	1.23	1.26	1.56
	$V_{CE SAT}$ Q8	1.15	1.11	1.13
	$V_{CE SAT}$ Q7	1.10	1.11	1.15
	$V_{CE SAT}$ Q9	1.00	0.97	0.98

		$-25^{\circ}C$	$+25^{\circ}C$	$+100^{\circ}C$
11)	I_B Q2	.16	.087	.046
	I_B Q4	.17	.097	.057
	I_B Q3	.052	.028	.017
	I_B Q5	.056	.026	.012

12) V_{out} on Pin 24 = 20.2 V P-P
 V_{out} on Pin 18 = 20.5 V P-P

FINAL ACCEPTANCE TEST DATA

PACKAGE # 5

5680 DM

4) $+I_{rec} = 13.78 \text{ ma}$
 $-I_{rec} = 2.96 \text{ ma}$

	+25°C
V17	14.17 volts
V25	14.15 volts

	+25°C
V17	22.0 volts
V25	22.0 volts
Csc. Amp	---

	+25°C	freq.
V17	22.3 volts	0 HZ
V17	22.0 volts	100 HZ
V17	22.0 volts	1 KHZ
V17	22.0 volts	10 KHZ
V17	22.0 volts	100 KHZ
V25	22.0 volts	0 HZ
V25	21.5 volts	100 HZ
V25	21.5 volts	1 KHZ
V25	21.5 volts	10 KHZ
V25	21.5 volts	100 KHZ



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V17 Rise time = 11 volts/ μ sec

V25 Rise time = 9 volts/ μ sec

10.)

+25°C	
VCE SAT Q6	1.06V
VCE SAT Q8	1.06V
VCE SAT Q7	1.04 volts
VCE SAT Q9	.96 volts

#5
5G80DM

+25°C

IB Q2	.061
IB Q4	.062
IB Q3	.061
+B Q5	.048



FEB 16 '69



FINAL TEST DATA

1700 N1500 11 0

4) $+I_{rec} = 13.75 \text{ ma}$

$-I_{rec} = 2.96 \text{ ma}$

5A) $I_{in} (+V) = 1.68 \mu\text{a}$

$I_{in} (-V) = .02 \mu\text{a}$

6)

	-25°C	+25°C	+100°C
V17	14.17	14.18 V	14.18
V25	14.16 V	14.15 V	14.16
$\Delta(V17-V25)$ AT	20 mV		10 mV

7)

	-25°C	+25°C	+100°C	freq
V17	22.0V	22.0V	22.0V	100 HZ
V25	(OK at 22.0V) 21.5 V	(OK at 22.0V) 21.5V	(OK at 22.0V) 21.5V	100 HZ
Dist Amp	< 2 mV	< 2 mV	< 2 mV	100 HZ

8)

	-25°C	+25°C	+100°C	freq
V17	22.0 V	22.0 V	22.0 V	5 HZ
V17	22.0	22.0	22.0	100 HZ
V17	22.0	22.0	22.0	1 KHZ
V17	22.0	22.0	22.0	10 KHZ
V17	22.2	22.2	22.5	100 KHZ
V25	21.5 V	21.5 V	21.5 V	5 HZ
V25	21.5	21.5	21.5	100 HZ
V25	21.5	21.5	21.5	1 KHZ
V25	21.5	21.5	21.5	10 KHZ
V25	21.5	21.5	22.0	100 KHZ

9)

$V17 \text{ Rise time} = 1.7 \mu\text{sec}$

$V25 \text{ Rise time} = 1.8 \mu\text{sec}$

10)

	-25°C	+25°C	+100°C
V _{CE SAT} Q6	1.09V	1.07V	1.16V
V _{CE SAT} Q8	1.08V	1.07V	1.20V
V _{CE SAT} Q7	1.09V	1.06V	1.06V
V _{CE SAT} Q9	1.00V	0.97V	0.99V

11)

	-25°C	+25°C	+100°C
I _B Q2	.16mA	.048mA	.023mA
I _B Q4	.095mA	.046mA	.026mA
I _B Q3	.092mA	.045mA	.024mA
I _B Q5	.080mA	.038mA	.020mA

12)

V_{out} on Pin 24 = 20.4V P-P
V_{out} on Pin 18 = 20.8V P-P

RELEASE 08
5680DM

FINAL ACCEPTANCE TEST DATA

4) $+I_{VCC} = 13.52 \text{ mA}$

$-I_{VCC} = 2.62 \text{ mA}$

+25°C

V17 14.13 V.

V25 13.94 V.

+25°C

V17 22.0 V.

V25 21.5 V

Qsc Amp —

+25°C

freq

V17 22.2 V. 0 HZ

V17 22.0 V. 100 HZ

V17 22.0 1 KHZ

V17 22.0 10 KHZ

V17 22.0 100 KHZ

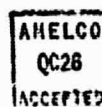
V25 22.0 V. 0 HZ

V25 21.5 V. 100 HZ

V25 21.5 1 KHZ

V25 21.5 10 KHZ

V25 21.5 100 KHZ



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9) $V_{17} \text{ Rise Time} = 9 \text{ V./}\mu\text{sec.}$

$V_{25} \text{ Rise time} = 8.5 \text{ V./}\mu\text{sec.}$

		+25°C
V _{CE} SAT	Q6	1.16 V.
V _{CE} SAT	Q8	1.12 V.
V _{CE} SAT	Q7	1.09 V.
V _{CE} SAT	Q9	1.02 V.

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		+25°C
I _B	Q2	.046 ma
I _B	Q4	.082 ma
I _B	Q3	.041 ma
I _B	Q5	.058 ma



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PACKAGE 18

FINAL TEST DATA

4) $+I_{VCC} = 13.49 \text{ ma}$

$-I_{VCC} = 2.66 \text{ ma}$

5A) $I_{in} (+6V) = 0.92 \mu\text{a}$

$I_{in} (-6V) = 0.01 \mu\text{a}$

	-25°C	+25°C	+100°C
V17	14.13	14.14	14.14
V25	13.95	13.96	13.96
$\frac{A(V17-V25)}{AT}$	0 mV		0 mV

	-25°C	+25°C	+100°C	freq
V17	22.0V (OK AT 22.0V)	22.0V (OK AT 22.0V)	22.0V (OK AT 22.0V)	100 HZ
V25	21.5V	21.5V	21.5V	100 HZ
Osc Amp	< 2 mV	< 2 mV	< 2 mV	100 HZ

	-25°C	+25°C	+100°C	freq
V17	22.0V	22.0V	22.0V	5 HZ
V17	22.0	22.0	22.0	100 HZ
V17	22.0	22.0	22.0	1 KHZ
V17	22.0	22.0	22.0	10 KHZ
V17	22.0	22.1	22.5	100 KHZ
V25	21.5V	21.5V	21.5V	5 HZ
V25	21.5	21.5	21.5	100 HZ
V25	21.5	21.5	21.5	1 KHZ
V25	21.5	21.5	21.5	10 KHZ
V25	21.5	21.5	22.0	100 KHZ

7) $V_{17} \text{ Rise Time} = 2.0 \mu\text{sec.}$

$V_{25} \text{ Rise Time} = 2.0 \mu\text{sec.}$

		-25°C	$+25^{\circ}\text{C}$	$+100^{\circ}\text{C}$
10)	$V_{CE\text{ SAT}} Q_6$	1.14V	1.18V	1.46V
	$V_{CE\text{ SAT}} Q_8$	1.12V	1.13V	1.23V
	$V_{CE\text{ SAT}} Q_7$	1.10V	1.10V	1.14V
	$V_{CE\text{ SAT}} Q_9$	1.05V	1.04V	1.07V

		-25°C	$+25^{\circ}\text{C}$	$+100^{\circ}\text{C}$
11)	$I_B Q_2$	.18ma	.044ma	.07ma
	$I_B Q_4$	.088ma	.08ma	.04ma
	$I_B Q_3$	.072ma	.09ma	.022ma
	$I_B Q_5$	.12ma	.058ma	.028ma

12) V_{out} on Pin 24 = 20.5V P-P

V_{out} on Pin 18 = 21.0V P-P

FINAL ACCEPTANCE TEST DATA

1700 NAD- 1

5680.DM

+I_{vcc} = 13.30 mA

-I_{vcc} = 3.35 mA

+25°C

V ₁₇	14.00 V.
V ₂₅	13.94 V.

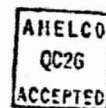
+25°C

V ₁₇	22.0 V.
V ₂₅	21.5 V
Osc. Amp	—

+25°C

f_{req}

V ₁₇	22.0 V.	0 HZ
V ₁₇	22.0 V.	100 HZ
V ₁₇	22.0 V.	1 K HZ
V ₁₇	22.0 V.	10 K HZ
V ₁₇	22.5 V.	100 K HZ
V ₂₅	22.0 V.	0 HZ
V ₂₅	21.5 V.	100 HZ
V ₂₅	21.5 V.	1 K HZ
V ₂₅	21.0 V.	10 K HZ
V ₂₅	21.5 V.	100 K HZ



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V₁₇ Rise Time = 10 μsec

V₂₅ Rise Time = 10 μsec

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+25°C	
V _{CE SAT} Q6	1.12 V.
V _{CE SAT} Q8	1.17 V.
V _{CE SAT} Q7	1.10 V.
V _{CE SAT} Q9	0.99 V.

+25°C	
I _B Q2	.077 mA
I _B Q4	.090 mA
I _B Q3	.042 mA
I _B Q5	.011 mA

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QC26
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FINAL TEST DATA

$$+I_{VCC} = 13.30 \text{ mA}$$

$$-I_{VCC} = 3.35 \text{ mA}$$

$$I_{IN} (+6V) = 0.60 \mu A$$

$$I_{IN} (-6V) = 0.02 \mu A$$

	-25°C	+25°C	+100°C
V _{I7}	14.02 V	14.01 V	14.00 V
V ₂₅	13.97 V	13.96 V	13.96 V
$\frac{\Delta(V_{I7}-V_{25})}{\Delta T}$	0 mV		10 mV

	-25°C	+25°C	+100°C	freq
V _{I7}	22.0 V	22.0 V	22.5 V	100 Hz
V ₂₅	21.5 V	21.5 V	21.5 V	100 Hz
Osc Amp	Not Measurable	Not measurable	Not measurable	100 Hz

	-25°C		+25°C		+100°C		freq
V _{I7}	22.0		22.0		22.5		0 Hz
V _{I7}	22.0	4.2 V	22.0	4.1 V	22.5	4.4 V	100 Hz
V _{I7}	22.0	4.2	22.0	4.4	22.5	4.4	1 KHz
V _{I7}	22.0	4.2	22.0	4.4	22.5	4.4	10 KHz
V _{I7}	9.0	5.0	8.0	5.0	7.0	4.7	100 KHz
V ₂₅	21.5		21.5		21.5		0 Hz
V ₂₅	21.5	4.0	21.5	4.2	21.5	4.2	100 Hz
V ₂₅	21.5	4.0	21.5	4.2	21.5	4.2	1 KHz
V ₂₅	21.5	4.0	21.5	4.2	21.5	4.2	10 KHz
V ₂₅	8.0	5.0	8.5	5.0	7.0	5.0	100 KHz

$$V_{I7} \text{ Rise time} = 2.0 \text{ V}/\mu\text{sec} \quad (\approx 10 \text{ V output pulse})$$

$$V_{25} \text{ Rise time} = 2.8 \text{ V}/\mu\text{sec}$$

10.)

	-25°C	$+25^{\circ}\text{C}$	$+100^{\circ}\text{C}$
$V_{CE\text{ SAT}} Q_6$	1.15V	1.18V	1.36V
$V_{CE\text{ SAT}} Q_8$	1.18	1.21	1.47
$V_{CE\text{ SAT}} Q_7$	1.10	1.10	1.10
$V_{CE\text{ SAT}} Q_9$	1.03	1.02	1.06

11.)

	-25°C	$+25^{\circ}\text{C}$	$+100^{\circ}\text{C}$
$I_B Q_2$	0.16mA	0.074mA	.044mA
$I_B Q_4$	0.15	0.074	.038
$I_B Q_3$	0.085	0.042	.024
$I_B Q_5$	0.030	0.012	.006

12.)

V_{out} on Pin 24 = 20.5V P-P

V_{out} on Pin 18 = 21.0V P-P.

FINAL ACCEPTANCE TEST DATA

5680 DM

+I_{vcc} = 14.80 Ma

-I_{vcc} = 3.75 ma

	+ 25°C
V ₁₇	14.00 V.
V ₂₅	14.14 V.

	+ 25°C
V ₁₇	22.0V
V ₂₅	21.5V
Osc Amp	—

	+ 25°C	f _{req}
V ₁₇	22.0 V.	0 HZ
V ₁₇	22.0 V	100 HZ
V ₁₇	22.0 V	1 KHZ
V ₁₇	22.0 V	10 KHZ
V ₁₇	22.0 V	100 KHZ
V ₂₅	22.0 V.	0 HZ
V ₂₅	21.5 V	100 HZ
V ₂₅	21.5 V	1 KHZ
V ₂₅	21.5 V	10 K HZ
V ₂₅	21.5 V	100 K HZ

V₁₇ Rise time = 12.5 V/μsec.

V₂₅ Rise time = 11 V./μsec.



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10.)

		+25°C
VCE SAT	Q6	1.18V
VCE SAT	Q8	1.09V
VCE SAT	Q7	0.98V
VCE SAT	Q9	1.01V

11.)

		+25°C
IS Q2		.097mA
IB Q4		.063mA
IB Q3		.034mA
IS Q5		.069mA

AMELCO
QC26
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FINAL TEST DATA

4) $+I_{VCC} = 14.82 \text{ ma}$

$-I_{VCC} = 3.76 \text{ ma}$

5) $I_{in} (+6V) = 1.23 \mu\text{a}$

$I_{in} (-6V) = 0.01 \mu\text{a}$

	-25°C	-25°C	+100°C
V17	13.95	13.95	13.94
V25	14.15	14.15	14.15
$\frac{A(V17-V25)}{AT}$	0mV		1.0mV

	-25°C	+25°C	+100°C	freq
V17	22.0	22.0	22.0	100 Hz
V25	21.5	21.5	21.5	100 Hz
Q2 Amp	>2mV	>2mV	>2mV	100 Hz

	-25°C	+25°C	+100°C	freq
V17	22.0	22.0	22.0	0 Hz
V17	22.0	22.0	22.0	100 Hz
V17	22.0	22.0	22.0	1 KHz
V17	22.0	22.0	22.0	10 KHz
V17	22.0	22.0	22.0	100 KHz
V25	21.8	21.8	21.8	0 Hz
V25	21.5	21.5	21.5	100 Hz
V25	21.5	21.5	21.5	1 KHz
V25	21.5	21.5	21.5	10 KHz
V25	21.5	21.8	21.5	100 KHz

9) $V17 \text{ Rise time} = 1.5 \mu\text{sec.}$

$V25 \text{ Rise time} = 1.8 \mu\text{sec.}$

10)

		-25°C	+25°C	+100°C
V _{CE SAT}	Q6	1.20V	1.17V	1.40
V _{CE SAT}	Q8	1.10	1.09	1.19
V _{CE SAT}	Q7	1.05	1.00	1.00
V _{CE SAT}	Q9	1.06	1.03	1.04

11)

		-25°C	+25°C	+100°C
I _B	Q2	.19mA	.102mA	.044
I _B	Q4	.11	.068	.038
I _B	Q3	.064	.034	.018
I _B	Q5	.15	.080	.036

12)

V_{out} on Pin 24 = 20.5
V_{out} on Pin 18 = 21.0

PACKAGE # 11

5680DM

FINAL ACCEPTANCE TEST DATA

+I_{VCC} = 13.59 mA

-I_{rec} = 2.83 mA

+25°C	
V ₁₇	14.04 V.
V ₂₅	14.22 V.

+25°C	
V ₁₇	22.0 V.
V ₂₅	22.0 V
C _{ce} Amp	—

	+25°C	freq.
V ₁₇	22.0 V.	0 HZ
V ₁₇	22.0 V.	100 HZ
V ₁₇	22.0 V.	1 K HZ
V ₁₇	22.0 V.	10 K HZ
V ₁₇	22.0 V.	100 K HZ
V ₂₅	22.0 V.	0 HZ
V ₂₅	22.0 V.	100 HZ
V ₂₅	22.0 V.	1 K HZ
V ₂₅	21.5 V.	10 K HZ
V ₂₅	22.0 V.	100 K HZ

V₁₇ Rise time = 12 V/μsec

V₂₅ Rise time = 9.5 V/μsec



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+25 °C	
V _{CE SAT} Q ₆	1.24 V.
V _{CE SAT} Q ₈	1.01 V.
V _{CE SAT} Q ₇	1.09 V.
V _{CE SAT} Q ₉	0.98 V.

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5680 DM

+25 °C	
I _B Q ₂	0.094 mA
I _B Q ₄	0.039 mA
I _B Q ₃	0.064 mA
I _B Q ₅	0.018 mA



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FINAL TEST DATA

4) $+I_{VCC} = 13.61 \text{ ma}$

$-I_{VCC} = 2.84 \text{ ma}$

5A) $I_{IN} (+6V) = 0.96 \mu\text{a}$

$I_{IN} (-6V) = 0.01 \mu\text{a}$

	-25°C	+25°C	+100°C
V ₁₇	14.05	14.04	14.04
V ₂₅	14.22	14.22	14.24
$\frac{\Delta(V_{17}-V_{25})}{\Delta T}$	10 mV		20 mV

	-25°C	+25°C	+100°C	Freq
V ₁₇	22.0	22.0	22.0	100 Hz
V ₂₅	21.5	21.5	21.5	100 Hz
Osc Amp	< 2 mV	< 2 mV	< 2 mV	100 Hz

				freq
V ₁₇	22.0	22.0	22.0	0 Hz
V ₁₇	22.0	22.0	22.0	100 Hz
V ₁₇	22.0	22.0	22.0	1 kHz
V ₁₇	22.0	22.0	22.0	10 kHz
V ₁₇	22.0	22.0	22.5	100 kHz
V ₂₅	21.8	21.8	21.8	0 Hz
V ₂₅	21.5	21.5	21.5	100 Hz
V ₂₅	21.5	21.5	21.5	1 kHz
V ₂₅	21.5	21.5	21.5	10 kHz
V ₂₅	21.5	22.0	23.5	100 kHz

6) $V_{17} \text{ Rise Time} = 2.2 \mu\text{sec}$

$V_{25} \text{ Rise time} = 1.7 \mu\text{sec}$

14)

	-25°C	+25°C	+100°C
V _{CE SAT} Q6	1.20V	1.24V	1.50V
V _{CE SAT} Q8	1.05	1.02	1.13
V _{CE SAT} Q7	1.12	1.10	1.12
V _{CE SAT} Q9	1.00	0.99	1.03

	-25°C	+25°C	+100°C
I _B Q2	.20mA	.092mA	.050
I _B Q4	.08	.035	.020
I _B Q3	.12	.064	.034
I _B Q5	.031	.016	.009

V_{out} on Pin 24 = 20.6V P-P

V_{out} on Pin 18 = 21.0V P-P

FINAL ACCEPTANCE TEST DATA

5680 DM

1) $+I_{VCC} = 12.04 \text{ ma}$

$-I_{VCC} = 2.45 \text{ ma}$

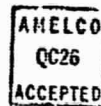
	+25°C
V17	14.17V ✓
V25	14.00V ✓

	+25°C
V17	22.0V
V25	22.0V
Osc Amp	10/A

	+25°C	freq
V17	22.5V	0 Hz
V17	22.0V	100 Hz
V17	22.0V	1K Hz
V17	22.0V	10K Hz
V17	23.0V	100K Hz
V25	22.0V	0 Hz
V25	22.0V	100 Hz
V25	22.0V	1K Hz
V25	22.0V	10K Hz
V25	25.0V	100K Hz

9) $V_{17} \text{ Rise time} = 7.5 \text{ V}/\mu\text{sec.}$

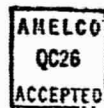
$V_{25} \text{ Rise time} = 7.5 \text{ V}/\mu\text{sec.}$



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		+25°C
V _{CE SAT}	Q ₆	1.16 V.
V _{CE SAT}	Q ₈	1.10 V.
V _{CE SAT}	Q ₇	1.12 V.
V _{CE SAT}	Q ₉	0.94 V.

		+25°C
I _B	Q ₂	0.074 mA
I _B	Q ₄	0.066 mA
I _B	Q ₃	0.047 mA
I _B	Q ₅	0.036 mA



APR 18 '68

FINAL TEST DATA

4) $+I_{VCC} = 12.02 \text{ mA}$

$-I_{VCC} = 2.46 \text{ mA}$

5A) $I_{IN} (+6V) = 0.70 \mu\text{A}$

$I_{IN} (-6V) = 0.01 \mu\text{A}$

6)

	-25°C	+25°C	+100°C
V ₁₇	14.19	14.19	14.20
V ₂₅	14.02	14.02	14.01
$\frac{\Delta(V_{17}-V_{25})}{\Delta T}$	0		20 mV

7)

	-25°C	+25°C	+100°C	freq
V ₁₇	22.0	22.5	22.0	100 Hz
V ₂₅	21.9	22.0	22.0	100 Hz
Osc Amp	< 2 mV	< 2 mV	< 2 mV	100 Hz

8)

	-25°C	+25°C	+100°C	freq
V ₁₇	22.0	22.0	22.0	0 Hz
V ₁₇	22.0	22.5	22.0	100 Hz
V ₁₇	22.0	22.5	22.0	1 kHz
V ₁₇	22.0	22.0	22.0	10 kHz
V ₁₇	22.5	22.9	24.5	100 kHz
V ₂₅	21.8	22.0	22.0	0 Hz
V ₂₅	21.9	22.0	22.0	100 Hz
V ₂₅	21.9	22.0	22.0	1 kHz
V ₂₅	21.9	21.5	22.0	10 kHz
V ₂₅	23.0	24.0	26.0	100 kHz

9) V₁₇ Rise Time = 3.0 μsec

V₂₅ Rise time = 2.3 μsec

	-25°C	+25°C	+100°C
V _{CE SAT} Q6	1.15 V	1.17 V	1.35
V _{CE SAT} Q8	1.12	1.11	1.31
V _{CE SAT} Q7	1.13	1.13	1.19
V _{CE SAT} Q9	1.01	0.95	0.95

	-25°C	+25°C	+100°C
I _B Q2	.13 _{mA}	.078 _{mA}	.040
I _B Q4	.13	.068	.030
I _B Q3	.088	.050	.027
I _B Q5	.070	.032	.020

V_{OUT} ON PIN 24 = 21.0 V P-P

V_{OUT} ON PIN 18 = 21.2 V P-P

FINAL ACCEPTANCE TEST DATA

5680DM

+I_{VCC} = 13.50 ma

-I_{VCC} = 2.48 ma

	+25°C
V ₁₇	14.00 V.
V ₂₅	14.08 V.

	+25°C
V ₁₇	22.0 V
V ₂₅	21.5 V
Osc Amp	—

	+25°C	freq
V ₁₇	22.0 V.	0 Hz
V ₁₇	22.0	100 Hz
V ₁₇	22.0	1 KHz
V ₁₇	22.0	10 KHz
V ₁₇	22.0	100 KHz
V ₂₅	22.0	0 Hz
V ₂₅	21.5	100 Hz
V ₂₅	21.5	1 KHz
V ₂₅	21.5	10 KHz
V ₂₅	21.0	100 KHz



AMELCO
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APR 18 '68

V₁₇ Rise time = 9 V/μSec.

V₂₅ Rise time = 9 V/μSec.

5680DM

	+25°C
VCE SAT Q6	1.18 V
VCE SAT Q8	1.11 V
VCE SAT Q7	1.05 V
VCE SAT Q9	1.00 V

	+25°C
IB Q2	0.088 ma
IB Q4	0.083 ma
IB Q3	0.017 ma
IB Q5	0.013 ma



AMELCO
QC26
ACCEPTED



APR 18 '68

FINAL TEST DATA

4) $+I_{VCC} = 13.52 \text{ ma}$

$-I_{VCC} = 2.48 \text{ ma}$

5) $I_{IN} (+6V) = .22 \mu\text{a}$

$I_{IN} (-6V) = .01 \mu\text{a}$

	-25°C	+25°C	+100°C
V17	13.96	13.97	13.94
V25	14.08	14.09	14.10
$\frac{\Delta(V17-V25)}{\Delta T}$	0 mV		40 mV

	-25°C	+25°C	+100°C	f req
V17	21.8	21.8	22.0	100Hz
V25	21.3	21.3	21.5	100Hz
Osc. Amp	<2mV	<2mV	<2mV	100Hz

	-25°C	+25°C	+100°C	f req
V17	21.8	21.8	21.8	0Hz
V17	21.8	21.8	22.0	100Hz
V17	21.8	21.8	22.0	1KHz
V17	22.0	22.0	22.0	10KHz
V17	22.0	22.3	25.0	100KHz
V25	21.7	21.8	21.8	0Hz
V25	21.3	21.3	21.5	100Hz
V25	21.3	21.3	21.5	1KHz
V25	21.5	21.5	21.5	10KHz
V25	21.5	21.5	23.0	100KHz

V17 Rise Time = 1.9 μsec

V25 Rise time = 2.0 μsec

		-25°C	+25°C	+100°C
10)	V _{CE SAT} Q ₆	1.22 V	1.18 V	1.27 V
	V _{CE SAT} Q ₈	1.19	1.12	1.19
	V _{CE SAT} Q ₇	1.07	1.06	1.08
	V _{CE SAT} Q ₉	1.01	1.01	1.02

		-25°C	+25°C	+100°C
11)	I _B Q ₂	.180 ma	.086 ma	.043 ma
	I _B Q ₄	.180	.078	.037
	I _B Q ₃	.034	.016	.008
	I _B Q ₅	.020	.012	.007

12) V_{out} on Pin 24 = 21.0

V_{out} on Pin 18 = 20.3

PACKAGE # 16

FINAL ACCEPTANCE TEST DATA

5680 DM

$$+I_{VCC} = 13.73 \text{ mA}$$

$$-I_{VCC} = 2.70 \text{ mA}$$

+25°C

V ₁₇	14.18 V
V ₂₅	14.12 V

+25°C

V ₁₇	22.0 V
V ₂₅	21.5 V
Osc Amp	—

+25°C

freq

V ₁₇	22.0 V	0 Hz
V ₁₇	22.0 V	100 Hz
V ₁₇	22.0 V	1 KHz
V ₁₇	22.0 V	0 KHz
V ₁₇	22.5 V	100 KHz
V ₂₅	22.0 V	0 Hz
V ₂₅	21.5 V	100 Hz
V ₂₅	21.5 V	1 KHz
V ₂₅	21.5 V	10 KHz
V ₂₅	21.5 V	100 KHz

 AMELCO
QC23
ACCEPTED

MAY 3 1965



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$$V_{17} \text{ Rise Time} = 10 \text{ V} / \mu\text{s}$$

$$V_{25} \text{ Rise time} = 8.5 \text{ V} / \mu\text{s}$$

		+25°C
V _{CE} SAT	Q6	1.19V
V _{CE} SAT	Q8	1.17V
V _{CE} SAT	Q7	1.15V
V _{CE} SAT	Q9	1.15V

SC80DM

		+25°C
I _B Q2		.095 mA
I _B Q4		.098 mA
I _B Q3		.024 mA
I _B Q5		.034 mA

ANALOG
Q23
ACCEPTED

MAY 5 1968



FINAL TEST DATA

$$+I_{VCC} = 13.70 \text{ ma.}$$

$$-I_{VCC} = 2.72 \text{ ma}$$

$$I_{in} (+V) = 0.98 \mu\text{a}$$

$$I_{in} (-V) = 0.01 \mu\text{a}$$

	-25°C	+25°C	+100°C
V ₁₇	14.18	14.19	14.16
V ₂₅	14.11	14.11	14.11
$\Delta(V_{17}-V_{25})$	10 mV	X	
ΔT			
			30 mV

	-25°C	+25°C	+100°C	freq
V ₁₇	22.0	22.0	22.0	100 Hz
V ₂₅	21.5	21.5	21.5	100 Hz
C _{sc} Amp	<2 mV	<2 mV	<2 mV	100 Hz

	-25°C	+25°C	+100°C	freq
V ₁₇	22.0	22.0	22.0	0 Hz
V ₁₇	22.0	22.0	22.0	100 Hz
V ₁₇	22.0	22.0	22.0	1 KHz
V ₁₇	22.0	22.0	22.0	10 KHz
V ₁₇	22.0	22.0	22.5	100 KHz
V ₂₅	21.7	21.5	21.7	0 Hz
V ₂₅	21.5	21.5	21.5	100 Hz
V ₂₅	21.5	21.5	21.5	1 KHz
V ₂₅	21.5	21.5	21.5	10 KHz
V ₂₅	21.5	21.5	21.5	100 KHz

$$V_{17} \text{ Rise time} = 1.8 \mu\text{Sec.}$$

$$V_{25} \text{ Rise time} = 1.9 \mu\text{Sec.}$$

		-25°C	+25°C	+100°C
V _{CE SAT}	Q6	1.19 V	1.16 V	1.27 V
V _{CE SAT}	Q8	1.13	1.13	1.28
V _{CE SAT}	Q7	1.13	1.12	1.16
V _{CE SAT}	Q9	1.06	1.04	1.03

		-25°C	+25°C	+100°C
I _B	Q2	.18 _{ma}	.090 _{ma}	.042 _{ma}
I _B	Q4	.180	.092	.052
I _B	Q3	.048	.021	.011
I _B	Q5	.054	.026	.016

V_{out} on Pin 24 = 20.5 V

V_{out} on Pin 18 = 21.1 V

FINAL ACCEPTANCE TEST DATA

5680DM

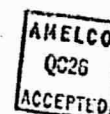
+I_{rec} = 14.06 mA

-I_{vcc} = 2.77 mA

	+25°C
V ₁₇	14.08 V
V ₂₅	14.03 V

	+25°C
V ₁₇	22.0
V ₂₅	21.5
Osc Amp	

	+25°C	f _{req}
V ₁₇	22.0 V	0 HZ
V ₁₇	22.0	100 HZ
V ₁₇	22.0	1 K HZ
V ₁₇	22.0	10 K HZ
V ₁₇	22.0	100 K HZ
V ₂₅	22.0	0 HZ
V ₂₅	21.5	100 HZ
V ₂₅	21.5	1 K HZ
V ₂₅	21.5	10 K HZ
V ₂₅	21.5	100 K HZ



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V₁₇ Rise time = 8.5 V/μsec.

V₂₅ Rise time = 10 V/μsec.

5680DM

		+25 °C
V _{CE} SAT	Q6	1.12 V.
V _{CE} SAT	Q8	1.06 V.
V _{CE} SAT	Q7	1.09 V.
V _{CE} SAT	Q9	0.89 V.

		+25 °C
I _B Q2	0.050 mA	
I _B Q4	0.035 mA	
I _B Q3	0.028 mA	
I _B Q5	0.013 mA	
	0.050 mA	

ANELCO
QC26
ACCEPTED



APR 18 '68.

FINAL TEST DATA

7) $+I_{rcc} = 13.87 \text{ ma}$

$-I_{rcc} = 2.76 \text{ ma}$

5A) $I_{in} (+6V) = 0.83 \mu\text{a}$

$I_{in} (-6V) = 0.00 \mu\text{a}$

	-25°C	+25°C	+100°C
V17	14.08	14.08	14.07
V25	14.04	14.04	14.04
$\frac{\Delta(V17-V25)}{\Delta T}$	0mV		10mV

	-25°C	+25°C	+100°C	freq
V17	22.0	22.0	22.0	100Hz
V25	21.5	21.5	21.5	100Hz
Use Amp	<2mV	<2mV	<2mV	100Hz

	-25°C	+25°C	+100°C	freq
V17	22.0	22.0	22.0	0Hz
V17	22.0	22.0	22.0	100Hz
V17	22.0	22.0	22.0	1KHz
V17	22.2	22.0	22.0	10KHz
V17	22.0	22.5	24.0	100KHz
V25	21.8	21.5	21.8	0Hz
V25	21.5	21.5	21.5	100Hz
V25	21.5	21.5	21.5	1KHz
V25	21.5	21.5	21.8	10KHz
V25	21.5	21.5	21.8	100KHz

9) $V17 \text{ Rise Time} = 2.0 \mu\text{sec}$

$V25 \text{ Rise time} = 1.8 \mu\text{sec}$

10)

		-25°C	$+25^{\circ}\text{C}$	$+100^{\circ}\text{C}$
VCE SAT	Q6	1.12 V	1.14 V	1.33
VCE SAT	Q8	1.05	1.07	1.23
VCE SAT	Q7	1.11	1.10	1.15
VCE SAT	Q9	0.96	0.90	0.88

11)

		-25°C	$+25^{\circ}\text{C}$	$+100^{\circ}\text{C}$
IB	Q2	.160 _{ma}	.050 _{ma}	.025 _{ma}
IB	Q4	.070	.035	.016
IB	Q3	.057	.026	.014
IB	Q5	.027	.011	.006

12) Vout on Pin 24 = 21.0
Vout on Pin 18 = 20.3

PACKAGE 118

FINAL ACCEPTANCE TEST DATA

5680 DM

1) $+I_{VCC} = 13.80 \text{ mA}$

$-I_{VCC} = 2.83 \text{ mA}$

+25°C

V17	14.20V
V25	14.09V

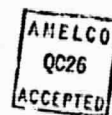
+25°C

V17	22.0V
V25	21.5V
Osc Amf	N/A

+25°C

freq

V17	22.0V	0 HZ
V17	22.0V	100 HZ
V17	22.0V	1 K HZ
V17	22.0V	10 K HZ
V17	22.0V	100 K HZ
V25	21.5V	0 HZ
V25	21.5	100 HZ
V25	21.5V	1 K HZ
V25	21.5V	10 K HZ
V25	21.5V	100 K HZ



APR 18 '68

2) V17 Rise time = 8.5V/μsec.

V25 Rise time = 7.5V/μsec.

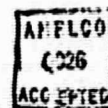
10)

	+25°C
VCE SAT Q6	1.25V
VCE SAT Q8	1.07V
VCE SAT Q7	1.14V.
VCE SAT Q9	1.00V.

18

11)

	+25°C
IB Q2	0.112mA
IB Q4	0.043mA
IB Q3	0.016mA
IB Q5	0.012mA



APR 18 '68

FINAL TEST DATA

$$+I_{VCC} = 13.74 \text{ ma}$$

$$-I_{VCC} = 2.82 \text{ ma}$$

$$I_{in} (+6V) = 0.31 \mu\text{a}$$

$$I_{in} (-6V) = 0.01 \mu\text{a}$$

	-25°C	+25°C	+100°C
V17	14.20	14.20	14.20
V25	14.09	14.10	14.11
$\frac{\Delta(V17-V25)}{\Delta T}$	10 mV		10 mV

	-25°C	+25°C	+100°C	Freq
V17	22.0	22.0	22.0	100 Hz
V25	21.5	21.5	21.5	100 Hz
Use Amp	< 2 mV	< 2 mV		100 Hz

	-25°C	+25°C	+100°C	Freq
V17	22.2	22.2	22.2	0 Hz
V17	22.0	22.0	22.0	100 Hz
V17	22.0	22.0	22.0	1 KHz
V17	22.0	22.0	22.0	10 KHz
V17	22.2	22.0	22.8	100 KHz
V25	22.0	22.0	22.0	0 Hz
V25	21.5	21.5	21.5	100 Hz
V25	21.5	21.5	21.5	1 KHz
V25	21.5	21.5	21.5	10 KHz
V25	21.5	21.5	22.0	100 KHz

$$V17 \text{ Rise time} = 2.0 \mu\text{sec}$$

$$V25 \text{ Rise time} = 2.2 \mu\text{sec}$$

		-25 °C	+25 °C	+100 °C
14)	V _{CE SAT} Q ₆	1.25	1.26	1.42
	V _{CE SAT} Q ₈	1.05	1.02	1.04
	V _{CE SAT} Q ₇	1.14	1.14	1.15
	V _{CE SAT} Q ₉	1.02	1.02	1.02

14)	I _B Q ₂	.270	.100	.050
	I _B Q ₄	.096	.038	.020
	I _B Q ₃	.030	.013	.008
	I _B Q ₅	.018	.010	.006

15) V_{out} on Pin 24 = 20.6

V_{out} on Pin 18 = 21.1

PACKAGE # 19

FINAL ACCEPTANCE TEST DATA

5680 DA1

$$+I_{VCC} = 13.78 \text{ ma}$$

$$-I_{VCC} = 2.73 \text{ ma}$$

	+25°C
V ₁₇	14.18 V.
V ₂₅	14.02 V.

	+25°C
V ₁₇	22.0
V ₂₅	21.0
Cse Amp	—

	+25°C	freq
V ₁₇	22.0 V.	0 HZ
V ₁₇	22.0 V.	100 HZ
V ₁₇	22.0 V.	1K HZ
V ₁₇	22.0 V.	10K HZ
V ₁₇	22.0 V.	100K HZ
V ₂₅	23.0 V.	0 HZ
V ₂₅	21.5 V.	100 HZ
V ₂₅	21.0 V.	1K HZ
V ₂₅	21.0 V.	10K HZ
V ₂₅	21.0 V.	100K HZ



MAY 9 1968



OK. TO SHIP. Sgr

$$V_{17} \text{ Rise time} = 9 \text{ V.}/\mu\text{sec.}$$

$$V_{25} \text{ Rise time} = 8 \text{ V.}/\mu\text{sec.}$$

	+25°C
VCE SAT Q6	1.13 V.
VCE SAT Q8	1.13 V.
VCE SAT Q7	1.12 V.
VCE SAT Q9	1.04 V.

19
5680 DM

	+25°C
IB Q2	.055 mA
IB Q4	.094 mA
IB Q3	.016 mA
IB Q5	.012 mA



MAY 3 1968



FINAL TEST DATA

$$+I_{VCC} = 13.77 \text{ ma}$$

$$-I_{VCC} = 2.71 \text{ ma}$$

$$I_{in} (+6V) = 0.29 \mu\text{a}$$

$$I_{in} (-6V) = 0.01 \mu\text{a}$$

	-25°C	+25°C	+100°C
V ₁₇	14.17V	14.17V	14.14
V ₂₅	14.01V	14.01V	14.00
$\frac{\Delta(V_{17}-V_{25})}{\Delta T}$	0 mV		20 mV

	-25°C	+25°C	+100°C	f _{req}
V ₁₇	22.0V	22.0V	22.0V	100 Hz
V ₂₅	21.5V	21.5V	21.5V	100 Hz
Osc Amp	< 2 mV	< 2 mV	< 2 mV	100 Hz

	-25°C	+25°C	+100°C	f _{req}
V ₁₇	22.2V	22.2V	22.0V	0 Hz
V ₁₇	22.0	22.0	22.0	100 Hz
V ₁₇	22.0	22.0	22.0	1 KHz
V ₁₇	22.0	22.0	22.0	10 KHz
V ₁₇	22.0	22.0	23.0	100 KHz
V _{R5}	22.0V	22.0V	21.8V	0 Hz
V ₂₅	21.5	21.5	21.5	100 Hz
V ₂₅	21.5	21.5	21.5	1 KHz
V ₂₅	21.5	21.5	21.5	10 KHz
V _{R5}	21.5	21.5	22.0	100 KHz

$$V_{17} \text{ Rise time} = 2.0 \mu\text{sec}$$

$$V_{25} \text{ Rise time} = 2.3 \mu\text{sec}$$

	-25°C	$+25^{\circ}\text{C}$	$+100^{\circ}\text{C}$
$V_{CE\text{ SAT}} Q_6$	1.17 V	1.15 V	1.24 V
$V_{CE\text{ SAT}} Q_8$	1.21	1.14	1.21
$V_{CE\text{ SAT}} Q_7$	1.13	1.14	1.15
$V_{CE\text{ SAT}} Q_9$	1.05	1.05	1.04

	-25°C	$+25^{\circ}\text{C}$	$+100^{\circ}\text{C}$
$I_B Q_2$	.120 mA	.056 mA	.022 mA
$I_B Q_4$	.200 mA	.106 mA	.050 mA
$I_B Q_3$	.032 mA	.016 mA	.007 mA
$I_B Q_5$	.018 mA	.011 mA	.006 mA

V_{out} on Pin 24 = 20.2 V P-P

V_{out} on Pin 18 = 21.0 V P-P

ADDITIONAL TEST RESULTS

- a) Frequency response depicting incorporation of design modification.
- b) Test performed on resistors, capacitors and transistors.
(No data recorded).
- c) Test of affects of power section on drift characteristics
of AR1, AR2, AR3.
- d) Vibration Tests -
Although vibration testing was part of the initial program,
approval was not forthcoming to perform this test. Therefore,
Amelco performed vibration test as defined in Section D.

ELECTRICAL TEST RESULTS

Contained within this section is the electrical test results of three MEMAS that were returned to Amelco and modified from the original design. The modification of these MEMAS incorporated increasing the values of the compensating capacitors in AR1 from 150pf and 5pf to 300pf and 30 pf respectively.

The MEMAS containing serial numbers 9, 11 and 16 were modified as defined above and proved to perform satisfactorily as evidenced by the following test data for each MEMA. These tests were not verified by Government Source Inspection.

TEST BEFORE AGE

+25°C

PACKAGE # 9

5A)	<u>E_{in}</u>	<u>E₀₁ (23 ± 25)</u>	<u>E₀₂ (14 ± 17)</u>
	0.00		
	+1.00		
	+2.20		
	-1.00		
	-2.20		

8A)	<u>freq</u>	<u>E₀₁</u>	<u>E₀₂</u>
	100 Hz		
	1 KHz		
	10 KHz		
	100 KHz		

TEST AFTER AGE

DATE 5/27/68

3A)	<u>E_{in}</u>	<u>E₀₁ (23 ± 25)</u>	<u>E₀₂ (14 ± 17)</u>
	0.00	+13.96	+14.01
	+1.00	9.32	18.86
	+2.20	3.80	24.65
	-1.00	18.52	9.22
	-2.20	24.00	3.47

+100°C

13.96 | 14.00 |

To Seal

6A)		<u>-25°C</u>	<u>+25°C</u>	<u>+100°C</u>
1.)	E ₀₁		21.5 V	21.5
2.)	E ₀₂		22.5 V	22.5

7A)	<u>freq</u>		<u>-25°C</u>	<u>+25°C</u>	<u>+100°C</u>
	100 Hz	E ₀₁		21.5	21.5
	1 KHz	E ₀₁		21.5	21.5
	10 KHz	E ₀₁		22.0	22.0
	100 KHz	E ₀₁		8.5	7.0
	38 KHz	E ₀₁		26.0	26.5

31 KHz

+25°C		+75°C		+100°C	
100 Hz	EOL		22.5	22.5	
1K Hz	EOL		22.5	22.5	
10K Hz	EOL		23.0	23.0	
100K Hz	EOL		8.0	6.5	
38K Hz	EOL		26.0	26.5	31K Hz

	+25°C	+100°C
A) $V_{CE SAT} Q_6$	1.15 V	1.26 V
B) $V_{CE SAT} Q_8$	1.17 V	1.39 V
C) $V_{CE SAT} Q_7$	1.15 V	1.13 V
D) $V_{CE SAT} Q_9$	1.01 V	1.04 V

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TEST BEFORE AGE

DATE 5/27/68

PACKAGE # 16

+25°C

<u>E_{in}</u>	<u>E₀₁ (23±25)</u>	<u>E₀₂ (14±17)</u>
0.00		
+1.00		
+2.20		
-1.00		
-2.20		

+25°C

<u>freq</u>	<u>E₀₁</u>	<u>E₀₂</u>
100 Hz		
1 KHz		
10 KHz		
100 KHz		

TEST AFTER AGE

DATE 5/27/68

+25°C

<u>E_{in}</u>	<u>E₀₁ (23±25)</u>	<u>E₀₂ (14±17)</u>
0.00	14.14	14.18
+1.00	9.44	18.98
+2.20	3.82	24.69
-1.00	18.80	9.48
-2.20	24.42	3.75

+100°C

14.15 | 14.18

To Seal

-25°C

+25°C

+100°C

1) E₀₁

21.5

22.0

2) E₀₂

22.0

22.0

freq

-25°C

+25°C

+100°C

100 Hz

E₀₁

21.5

22.0

1 KHz

E₀₁

21.5

22.0

10 KHz

E₀₁

22.0

22.0

100 KHz

E₀₁

12.5

11.0

55 KHz

E₀₁

24.5

26.0 @ 51 KHz

1.001 0.010 0.001 0.001

PRECEDING PAGE BLANK NOT FILMED.

PACKAGE # 11

+25°C		
<u>E_{in}</u>	<u>E₀₁ (23±25)</u>	<u>E₀₂ (14±17)</u>
0.00		
+1.00		
+2.20		
-1.00		
-2.20		

V_{sat} Q₆
1.58V at 100°C

+25°C		
<u>freq</u>	<u>E₀₁</u>	<u>E₀₂</u>
100 Hz		
1 KHz		
10 KHz		
100 KHz		

TEST AFTER AGE

DATE 5/27/68

+25°C		
<u>E_{in}</u>	<u>E₀₁ (23±25)</u>	<u>E₀₂ (14±17)</u>
0.00	14.22	14.08
+1.00	9.54	18.87
+2.20	3.92	24.63
-1.00	18.84	9.24
-2.20	24.44	3.61

100°C	
14.22	14.06

To seal

	<u>-25°C</u>	<u>+25°C</u>	<u>+100°C</u>
1) E ₀₁		22.0	22.0
2) E ₀₂		22.5	22.0

<u>freq</u>		<u>-25°C</u>	<u>+25°C</u>	<u>+100°C</u>
100 Hz	E ₀₁		22.0	22.0
1 KHz	E ₀₁		22.0	22.0
10 KHz	E ₀₁		22.0	22.0
100 KHz	E ₀₁		8.0	6.5
35 KHz	E ₀₁		26.0	26.5 @ 30 KHz

f _{req}		-25°C	+25°C	+100°C
100 Hz	E _{O2}		22.5	22.0
1K Hz	E _{O2}		22.5	22.0
10K Hz	E _{O2}		23.0	22.5
100K Hz	E _{O2}		7.0	5.5
35K Hz	E _{O2}		26.0	26.5 @ 27 KHz

	+25°C	+100°C
10A) V _{CE SAT} Q ₆	1.29V	1.58V
B) V _{CE SAT} Q ₈	1.05V	1.17V
C) V _{CE SAT} Q ₇	1.12V	1.14V
D) V _{CE SAT} Q ₉	1.01V	1.04V

APPENDIX "B"

Contained within this section is the electrical test results of three MEMAS that were returned to Amelco and modified from the original design. The modification of these MEMAS incorporated increasing the values of the compensating capacitors in ARL from 150pf and 5pf to 300pf and 30pf respectively.

The MEMAS containing serial numbers 9, 11 and 16 were modified as defined above and proved to perform satisfactorily as evidenced by the following test data for each MEMA.

The following data was generated to show the frequency response of the subject MEMAS after the modification of increasing the capacitors in ARL to 300pf and 30pf in component networks.

ARL Only

Gain of 50			
Freq.	E in	E out	db
10KHz	.07	3.60	51
50	.07	3.70	52
70K	.07	3.90	56
100K	.07	4.20	60
250K	.07	2.00	28
500K	.07	.84	12
1MHz	.07	.37	5.3
5MHz	.07	.07	1.0

Checked #9, (11 and 16 were essentially the same as above).

AR3 (AR1 set-up for low gain)AR2

Freq.	E in	E out	E in	E out	#16	#9	#11
10KHz	1.0V	1.0V	1.0	1.0			
50	1.0	1.1	1.0	1.0		1.15	
70	1.0	1.15	1.0	1.02			
100	1.0	1.20	1.0	1.08		1.5	1.7
250	1.0	.5	1.0	.95			.26
500	1.0	.17	1.0	.18			.1
1MHz	.5	.04	.5	.04			
5MHz							

Slew Rate

AR1 $\frac{1.2V}{.4} = 5V/\mu\text{sec} @ 4.6 \text{ volts out}$ $\frac{10V}{2.5\mu\text{s}} = 4V/\mu\text{sec} @ 10 \text{ volts}$

AR2 $2.4V/\mu\text{sec}$

AR3 $3.4V/\mu\text{sec}$

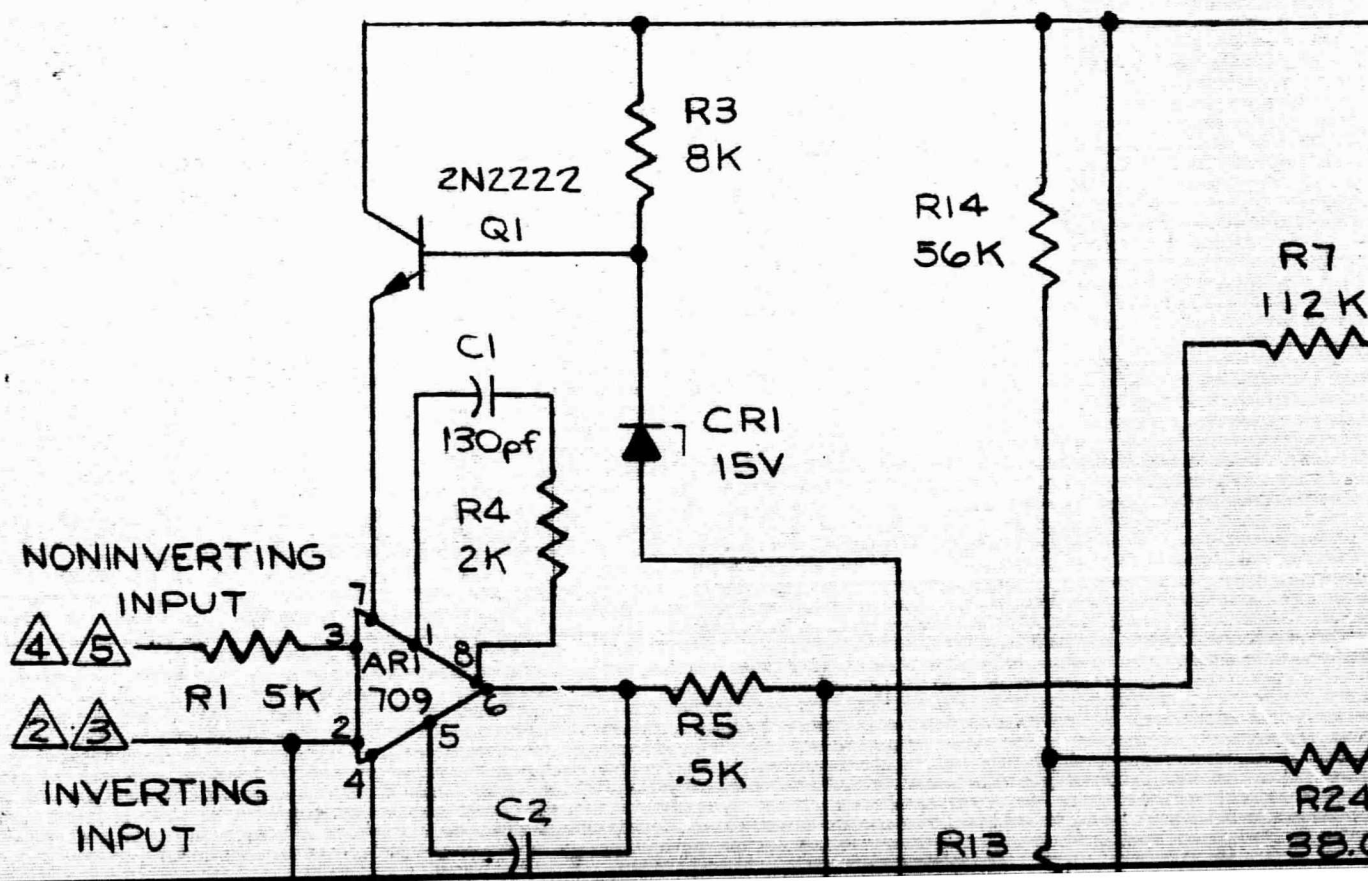
4

3

D

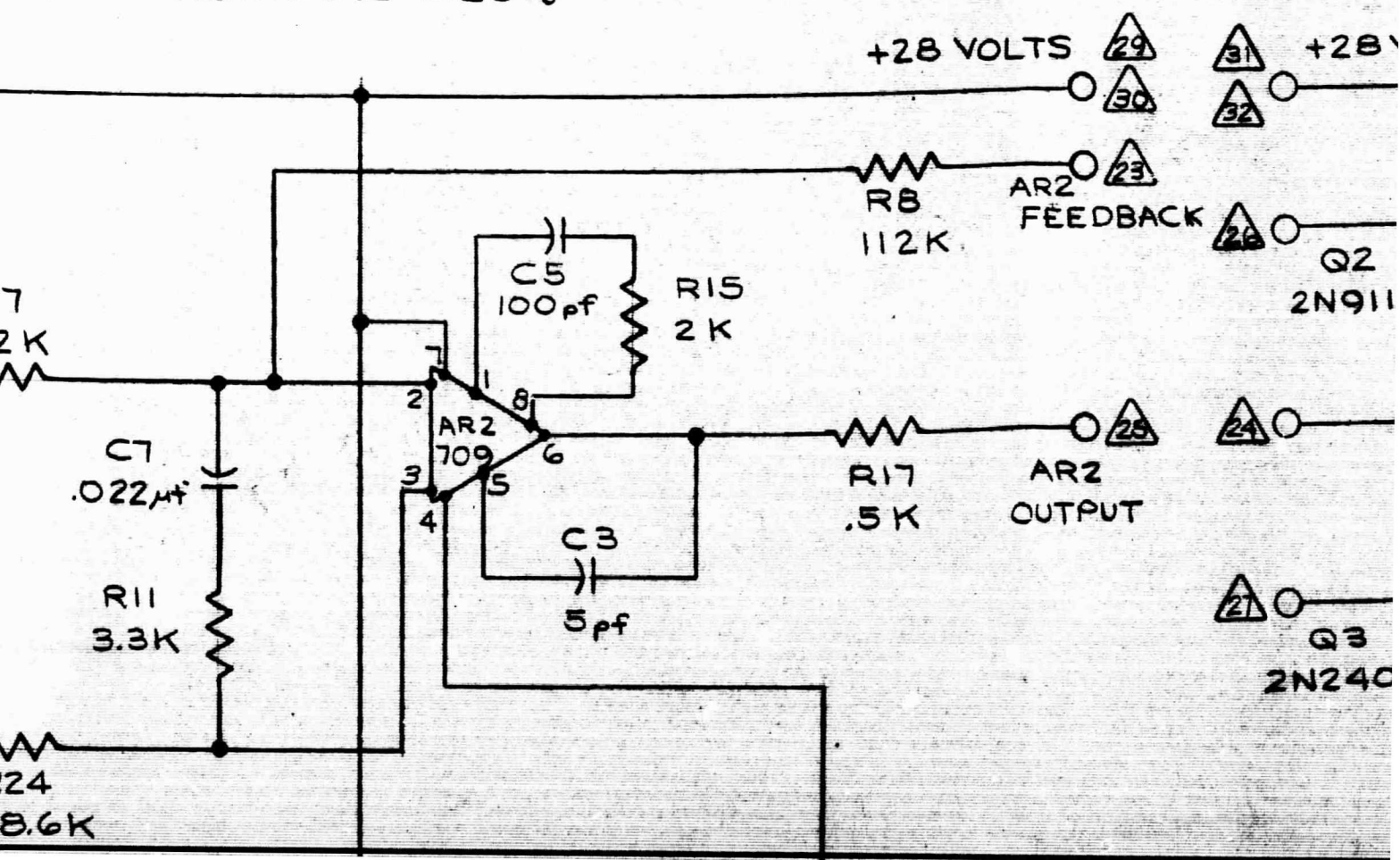
NOTES

1. ALL RESISTOR TOLERANCES ARE
2. ALL CAPACITOR TOLERANCES ARE



3	2	2	
ZONE	LTR		

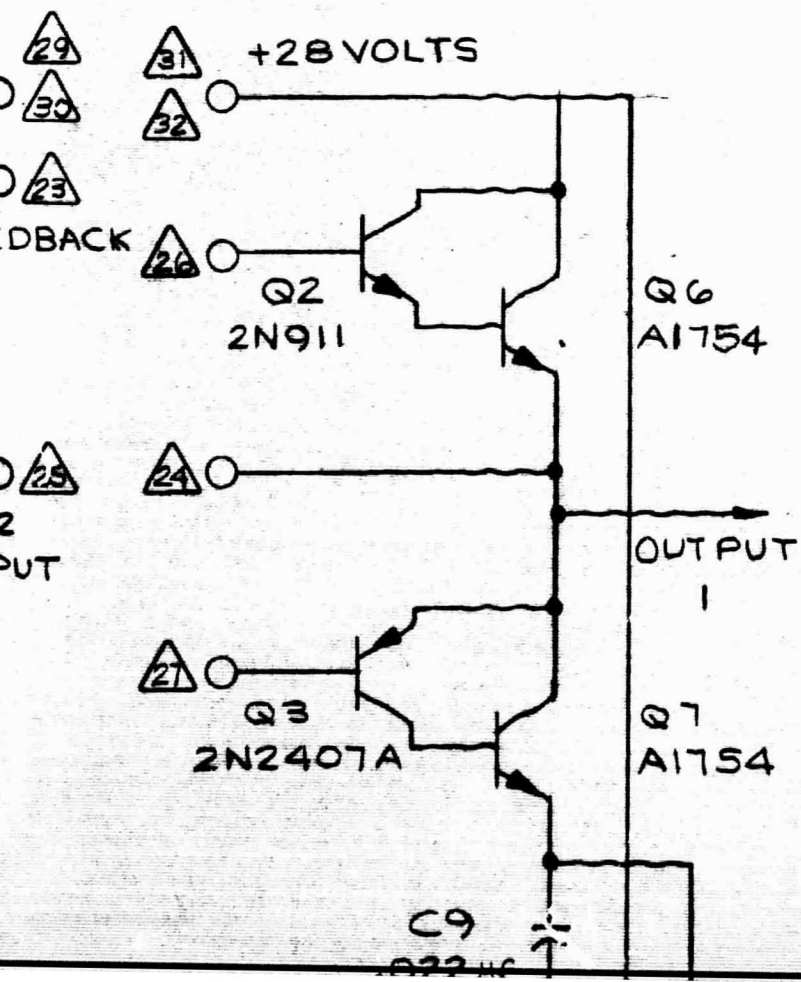
ARE A NOMINAL $\pm 10\%$
 ARE A NOMINAL $\pm 20\%$



3 1

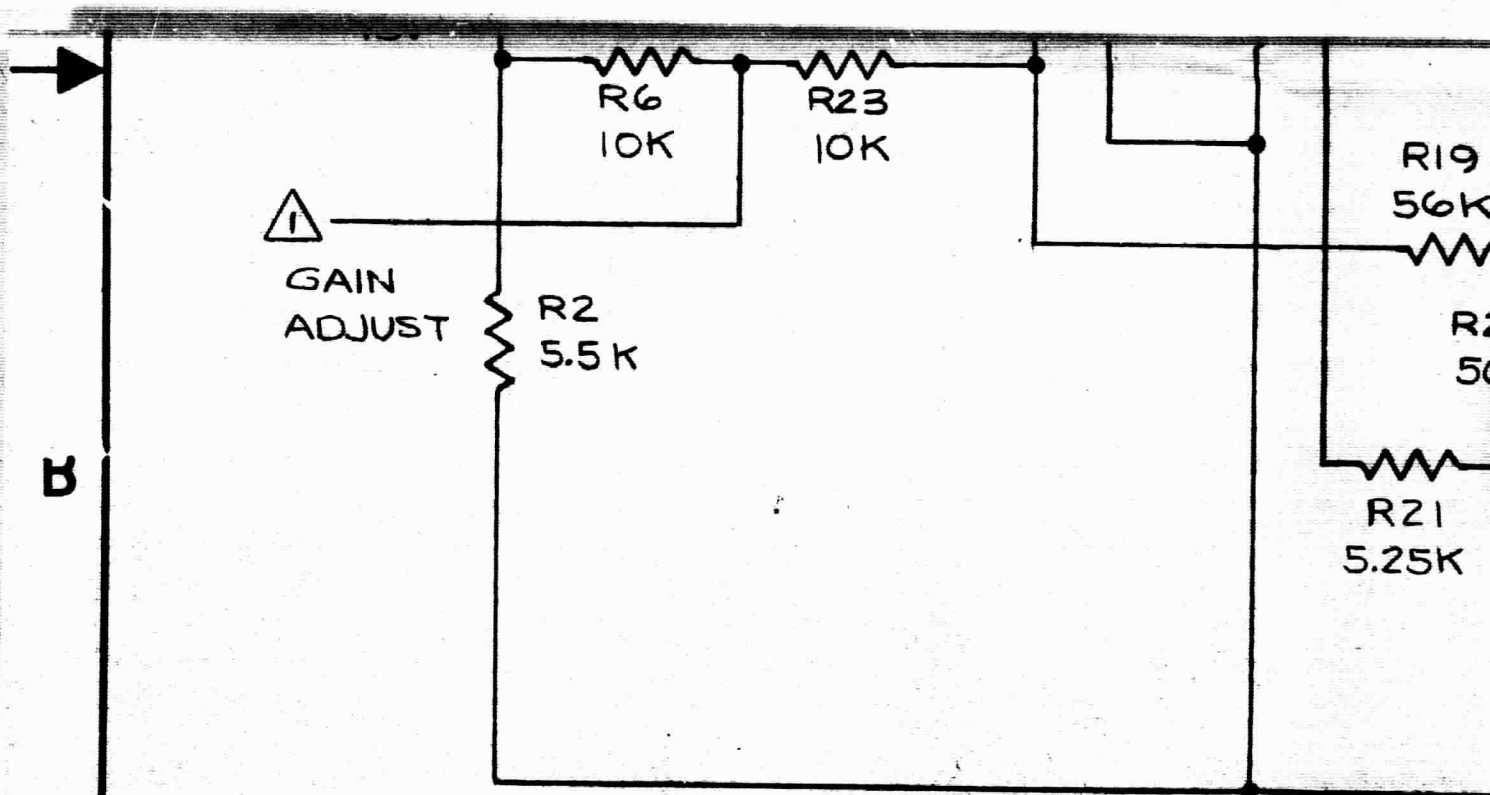
REVISIONS

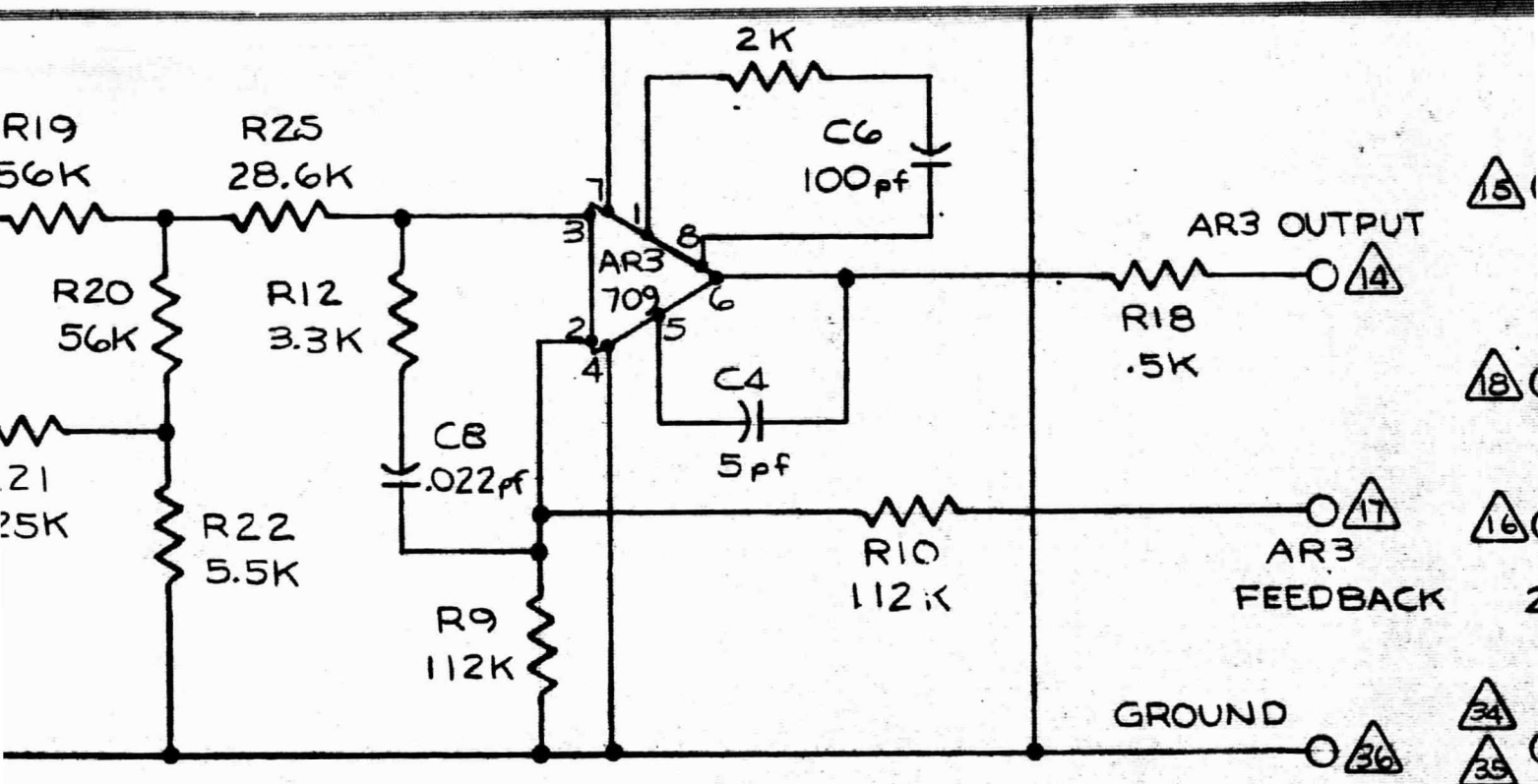
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		RELEASE		



D

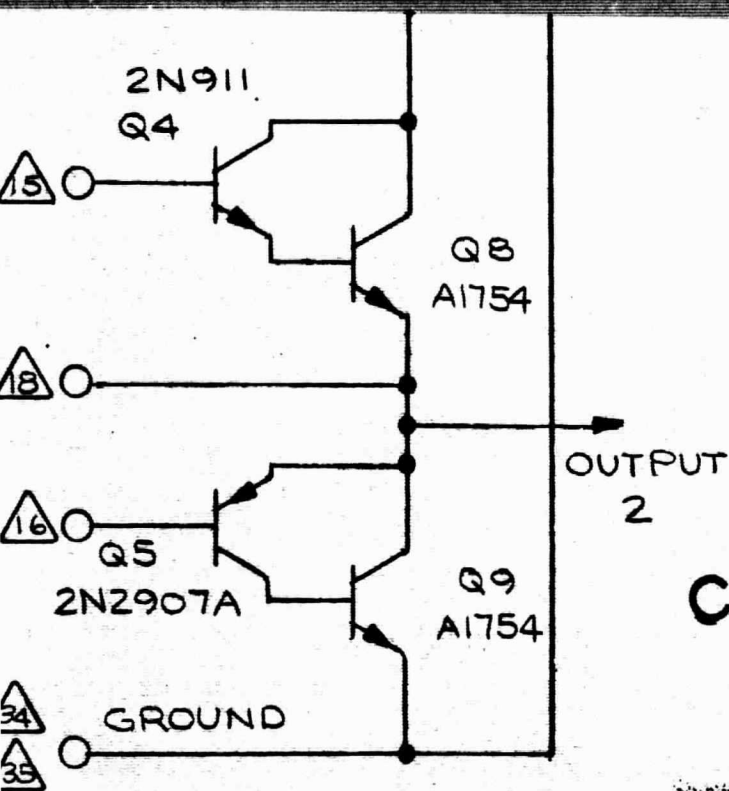
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DECIMAL TOL	ANGULAR TOL	CHK	
2 PLACE $\pm .03$	$\pm$	ENGR	
3 PLACE $\pm .010$		APPD <i>CK Gelfand</i>	8/27/6
MATERIAL			



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10 WATT INTEGRATED AMPLIFIER & POWER MODULE		
SIZE	CODE IDENT NO.	
C	14804	
SCALE	SHEET	