

MILITARY SPECIFICATION
MICROCIRCUITS, LINEAR,
BI-FET OPERATIONAL AMPLIFIERS,
MONOLITHIC SILICON

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the detail requirements for monolithic silicon, BI-FET operational amplifiers. Three product assurance classes and a choice of case outline and lead finish are provided for each type and are reflected in the complete part number.

1.2 Part number. The part number shall be in accordance with MIL-M-38510.

1.2.1 Device type. The BI-FET operational amplifiers shall be internally compensated and shall be distinguished by the following circuit characteristics:

<u>Device type</u>	<u>Circuit</u>
01	JFET Input, low power
02	JFET Input, wide band
03	JFET Input, wide band, undercompensated
04	JFET Input, low power, low offset
05	JFET Input, wide band, low offset
06	JFET Input, wide band, undercompensated, low offset

1.2.2 Device class. The device class shall be the product assurance level as defined in MIL-M-38510.

1.2.3 Case outline. The case outline shall be designated as follows:

<u>Outline letter</u>	<u>MIL-M-38510 appendix C case outline</u>
G	A-1 (8-lead can)
H	F-4 (10-lead, 1/4" X 1/4" flat package)
P	D-4 (8-lead, 1/4" X 3/8", dual-in-line)

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Rome Air Development Center, RADC(RBRD), Griffis AFB NY 13441, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document, or by letter.

1.3 Absolute maximum ratings.

Supply voltage range - - - - -	+22 V
Input voltage range ^{1/} - - - - -	+20 V
Differential input voltage range - - - - -	+40 V
Storage temperature range- - - - -	-65°C to +150°C
Output short-circuit duration- - - - -	Unlimited ^{2/}
Lead temperature (soldering, 60 sec.)- - - - -	300°C
Junction temperature - - - - -	T _J = 175°C ^{3/}

1.4 Recommended operating conditions.

Supply voltage range - - - - -	+5 to +20 Vdc
Ambient temperature range- - - - -	-55°C to +125°C

1.5 Power and thermal characteristics.

<u>Package</u>	<u>Case outline</u>	<u>Maximum allowable power dissipation</u>	<u>Maximum θ_{J-C}</u>	<u>Maximum θ_{J-A}</u>
8-lead can	G	330 mW @ T _A = +125°C	40°C/W	150°C/W
10-lead flat pack	H	330 mW @ T _A = +125°C	60°C/W	150°C/W
8-lead DIP	P	400 mW @ T _A = +125°C	35°C/W	120°C/W

2. APPLICABLE DOCUMENTS

2.1 Issues of documents. The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

SPECIFICATION

MILITARY

MIL-M-38510 - Microcircuits, General Specification for.

STANDARD

MILITARY

MIL-STD-883 - Test Methods and Procedures for Microelectronics.

(Copies of specifications, standards, drawings, and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

- ^{1/} The absolute maximum negative input voltage is equal to the negative power supply voltage.
- ^{2/} Short circuit may be to ground or either supply. Rating applies to +125°C case temperature or +75°C ambient temperature.
- ^{3/} For short term test (in the specific burn-in and life test configuration when required and up to 168 hours maximum), T_J = 275°C.

3. REQUIREMENTS

3.1 Detail specifications. The individual item requirements shall be in accordance with MIL-M-38510, and as specified herein.

3.2 Design, construction, and physical dimensions. The design, construction and physical dimensions shall be as specified in MIL-M-38510 and T.2.3 herein.

3.2.1 Terminal connections. Terminal connections shall be as specified on figure 1.

3.2.2 Schematic circuit. The schematic circuits shall be as specified on figure 2.

3.3 Lead material and finish. Lead material and finish shall be in accordance with MIL-M-38510.

3.4 Electrical performance characteristics. The electrical performance characteristics shall be as specified in table I and, unless otherwise specified, apply over the full operating ambient temperature range for supply voltages from ± 5 Vdc to ± 20 Vdc. Unless otherwise specified, source resistance (R_s) shall be 50 Ω for all tests.

3.4.1 Offset null circuits. The nulling inputs shall be capable of being nulled 1 mV beyond the specified offset voltage limits for $-55^\circ\text{C} \leq T_A \leq 125^\circ\text{C}$ using the circuit of figure 3.

3.4.2 Instability oscillations. The devices shall be free of oscillations when operated in the test circuits of this specification.

3.5 Rebonding. Rebonding shall be in accordance with MIL-M-38510.

3.6 Electrical test requirements. Electrical test requirements shall be as specified in table III for the applicable device type and device class. The subgroups of table III and limits of table IV which constitute the minimum electrical test requirements for screening, qualification and quality conformance, by device class are specified in table II.

3.7 Marking. Marking shall be in accordance with MIL-M-38510 and 1.2 herein. At the option of the manufacturer, the country of origin may be omitted from the body of the microcircuit, but shall be retained on the initial container.

3.8 Microcircuit group assignment. The devices covered by this specification shall be in microcircuit group number 49 (see MIL-M-38510, appendix E).

4. QUALITY ASSURANCE PROVISIONS

4.1 Sampling and inspection. Sampling and inspection procedures shall be in accordance with MIL-M-38510 and method 5005 and 5007, as applicable, of MIL-STD-883, except as modified herein.

4.2 Qualification inspection. Qualification inspection shall be in accordance with MIL-M-38510. Inspections to be performed shall be those specified herein for groups A, B, C and D inspections (see 4.4.1, 4.4.2, 4.4.3, and 4.4.4).

4.3 Screening. Screening shall be in accordance with method 5004 of MIL-STD-883, and shall be conducted on all devices prior to qualification and quality conformance inspection. The following additional criteria shall apply:

a. Burn-in (method 1015 of MIL-STD-883).

1. For Class S devices: Test condition D using the circuit shown on figure 4.
2. For Class B devices: Test condition D using the circuit shown on figure 4, or test condition C using the circuit shown on figure 5, or test condition F using the circuit shown on figure 6.

NOTE: If accelerated high-temperature test conditions are used, the device manufacturer shall ensure that at least 85 percent of the applied voltage is dropped across the device at temperature. The device is not considered functional under accelerated test conditions.

TABLE I. Electrical performance characteristics.

Characteristics	Symbol	Conditions (3.4 and figure 7, unless otherwise specified)	Device type	Limits		Units
				Min.	Max.	
Input offset voltage	V_{IO}	$+V_{CC} = +5 V$ $V_{CM} = 0 V$	01, 02, 03	-5	5	mV
				04, 05, 06	-2	
		$+V_{CC} = +20 V$ $V_{CM} = +15 V, 0 V$	01, 02, 03	-7	7	mV
				04, 05, 06	-2.5	
Input offset voltage temperature sensitivity	$\frac{\Delta V_{IO}}{\Delta T}$	$-55^\circ C \leq T_A \leq +125^\circ C$	01, 02, 03	-30	30	$\mu V/^\circ C$
			04, 05, 06	-10	10	
Input offset current	I_{IO}	$+V_{CC} = +20 V$ $V_{CM} = 0 V$	All	-20	20	pA
				-20	20	nA
Input bias current	$+I_{IB}$	$+V_{CC} = +20 V$ $V_{CM} = +15 V, t \leq 25 ms$	$T_J = 25^\circ C$	-100	3500	pA
			$T_J = 125^\circ C$	-10	60	nA
	$-I_{IB}$	$+V_{CC} = +15 V$ $V_{CM} = +10 V, t \leq 25 ms$	$T_J = 25^\circ C$	-100	300	pA
			$T_J = 125^\circ C$	-10	50	nA
	2/ 3/	$+V_{CC} = +20 V$ $-15 V \leq V_{CM} \leq 0 V,$ $t \leq 25 ms$	$T_J = 25^\circ C$	-100	100	pA
			$T_J = 125^\circ C$	-10	50	nA
Power supply rejection ratio	+PSRR -PSRR	$+V_{CC} = 10 V, -V_{CC} = -20 V$ $+V_{CC} = 20 V, -V_{CC} = -10 V$		85	---	dB
				85	---	dB
Input voltage common mode rejection 4/	CMR	$+V_{CC} = +20 V$ $V_{IN} = +15 V$		85	---	dB
				85	---	dB

See footnotes at end of table.

TABLE I. Electrical performance characteristics - Continued.

Characteristics	Symbol	Conditions (3.4 and figure 7, unless otherwise specified)	Device type	Limits		Units
				Min.	Max.	
Adjustment for input offset voltage	$V_{IO ADJ(+)}$	$+V_{CC} = \pm 20 \text{ V}$	A11	+8	---	mV
	$V_{IO ADJ(-)}$	$+V_{CC} = \pm 20 \text{ V}$		---	-8	mV
Output short circuit current (for positive output) ^{5/}	$I_{OS(+)}$	$+V_{CC} = \pm 15 \text{ V}$ $t < 25 \text{ ms}$ (Short circuit to ground)	A11, 04 02, 03, 05, 06 01, 04 02, 03, 05, 05 01, 04 02, 03, 05, 05	---	---	mA
Output short circuit current (for negative output) ^{5/}	$I_{OS(-)}$	$+V_{CC} = \pm 15 \text{ V}$ $t < 25 \text{ ms}$ (Short circuit to ground)		---	50	mA
Supply current	I_{CC}	$+V_{CC} = \pm 15 \text{ V}$ $T_A = -55^\circ\text{C}$ $T_A = +25^\circ\text{C}$ $T_A = +125^\circ\text{C}$		---	6 11 4 7 4 7	mA
Output voltage swing (maximum)	V_{OP}	$+V_{CC} = \pm 20 \text{ V}, R_L = 10 \text{ K}\Omega$	A11	+16	---	V
		$+V_{CC} = \pm 20 \text{ V}, R_L = 2 \text{ K}\Omega$		+15	---	V
Open loop voltage gain (single ended) ^{6/}	$A_{VS(+)}$	$+V_{CC} = \pm 20 \text{ V}$ $R_L = 2 \text{ K}\Omega$ $T_A = 25^\circ\text{C}$	A11	50	---	V/mV
	$A_{VS(-)}$	$+V_{CC} = \pm 15 \text{ V}$ $-55^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$		25	---	V/mV
Open loop voltage gain (single ended) ^{6/}	A_{VS}	$+V_{CC} = \pm 5 \text{ V}$ $R_L = 2 \text{ K}\Omega$ $V_{OUT} = \pm 2 \text{ V}$	A11	10	---	V/mV

See footnotes at end of table.

TABLE I. Electrical performance characteristics - Continued.

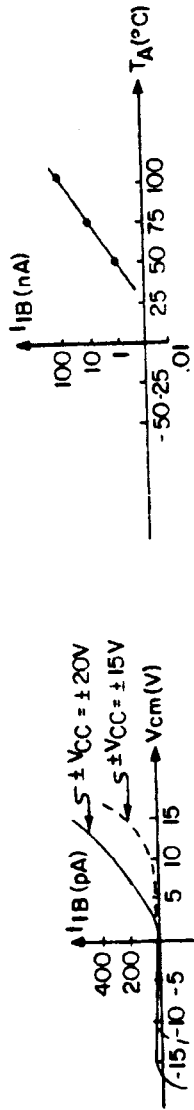
Characteristics	Symbol	Conditions (3.4 and figure 7, unless otherwise specified)	Device Type	Limits		Units
				Min.	Max.	
Transient response Rise time	TR(tr)	$V_{CC} = \pm 15$ $R_L = 2k\Omega$ $C_L = 100$ pf see figure 8 V_{IN}	01, 04 02, 05 03, 06	---	150	ns
				---	100	
Transient response Overshoot	TR(os)	V_{IN}	01, 02, 04, 05 03, 06	---	450	%
				---	25	
Slew rate	SR(+) and SR(-)	$V_{IN} = \pm 5$ V $V_{CC} = \pm 15$ V $AV = 1$ see figure 8	01 02 04 05 01 02 04 05 03 06 03 06	2	---	V/us
				7.5	---	
				3	---	
				10	---	
				5	---	
				1.5	---	
Settling time	ts(+) and ts(-)	$V_{IN} = \pm 5$ V; $AV = 5$ $V_{CC} = \pm 15$ V see figure 8	01, 02, 04, 05 03, 06	---	1500	ns
				---	800	
				---	---	
				---	---	
				---	---	
				---	---	
Noise (referred to input) broadband	N _I (BB)	$V_{CC} = \pm 15$ V; Bandwidth = 5KHZ	All	---	10	μV_{rms}
				---	---	
Noise (referred to input) popcorn	N _I (PC)	$V_{CC} = \pm 15$ V; Bandwidth = 5KHZ	All	---	80	μV_{pk}
				---	---	

NOTES:

1/ Bias currents are actually junction leakage currents which double (approximately) for each 10°C increase in junction temperature T_J. Measurement of bias current is specified at T_J rather than T_A, since normal warmup thermal transients will affect the bias currents. The measurements for bias currents must be made within 25 ms after power is first applied to the device for test. Measurement at T_A = -55°C is not necessary since expected values are too small for typical test systems.

TABLE I. Electrical performance characteristics - Continued.

2/ Bias current is sensitive to power supply voltage, common mode voltage and temperature as shown by the following typical curves:



- 3/ Negative I_{IB} minimum limits reflect the characteristics of devices with bias current compensation.
- 4/ CMR is calculated from V_{IQ} measurements at $V_{CM} = +15$ V and -15 V.
- 5/ Continuous limits shall be considerably lower. Protection for shorts to either supply exists providing that $T_J(max) \leq 175^{\circ}C$.
- 6/ Because of thermal feedback effects from output to input, open loop gain is not guaranteed to be linear or positive over the operating range. These requirements, if needed, should be specified by the user in additional procurement documents.

- b. Reverse bias burn-in (method 1015 of MIL-STD-883). This screen test shall apply to Class S devices only using the circuit shown on figure 5.
- c. Interim and final electrical test parameters shall be as specified in table II herein, except interim electrical parameters test prior to burn-in is optional at the discretion of the manufacturer.
- d. Percent defective allowable (PDA). The PDA for class S devices shall be as specified in MIL-M-38510. The PDA is specified as 10 percent for class B devices based on failures from group A, subgroup 1 test after cooldown as final electrical test in accordance with method 5004 of MIL-STD-883, and with no intervening electrical measurements. If interim electrical parameter tests are performed prior to burn-in, failures resulting from pre-burn-in screening may be excluded from the PDA. If interim electrical parameter tests prior to burn-in are omitted, then all screening failures shall be included in the PDA. The verified failures of group A, subgroup 1 after burn-in divided by the total number of devices submitted for burn-in in that lot shall be used to determine the percent defective for that lot, and the lot shall be accepted or rejected based on the PDA for the applicable device class.

TABLE II. Electrical test requirements.

MIL-STD-883 test requirement	Subgroups (see table III)		
	Class S devices	Class B devices	Class C devices
Interim electrical parameters (Pre Burn-in) (method 5004)	1	1	None
Final electrical test parameters (method 5004)	1*, 2, 3, 4	1*, 2, 3, 4	1
Group A test requirements (method 5005)	1, 2, 3, 4, 5, 6, 7, 8, 12	1, 2, 3, 4, 5, 6, 7	1, 2, 3, 4, 7
Group C end point and group B, class S, electrical parameters (method 5005)	1, 2, 3 and table IV delta limits	1 and table IV delta limits	1 and table IV delta limits
Additional electrical subgroups for group C periodic inspections	Not applicable	8, 12	5, 6, 8, 12
Group D end point electrical parameters (method 5005)	1, 2, 3	1	1

* PDA applies to subgroup 1 (see 4.3d)

4.4 Quality conformance inspection. Quality conformance inspection shall be in accordance with MIL-M-38510.

4.4.1 Group A inspection. Group A inspection shall be in accordance with table I of method 5005 of MIL-STD-883 and as follows:

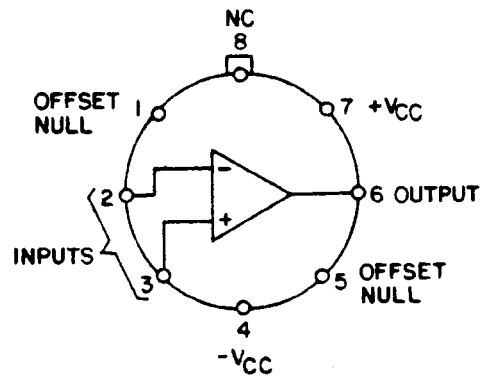
- Subgroups 9, 10 and 11 shall be omitted.
- Tests shall be as specified in table II herein.
- Subgroup 12 shall be added to group A inspection as shown in table III herein. The LTPD for subgroup 12 shall be 5 for all classes.

4.4.2 Group B inspection. Group B inspection shall be in accordance with table II of method 5005 of MIL-STD-883 and as follows:

- End point electrical parameters shall be as specified in table II herein.
- Life test for class S devices shall be in accordance with table IIa (subgroup 5) of method 5005 of MIL-STD-883, using the circuit on figure 6. If the alternate burn-in conditions are used, the circuit on figure 5 shall be used.

Device types 01, 02, 03, 04, 05, and 06

(case G)

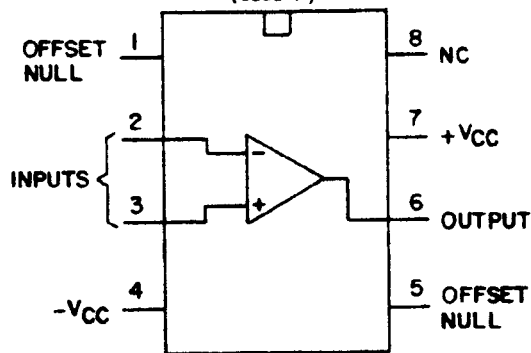


(Pin 4 connected to case)

8 lead can (top view)

Device types 01, 02, 03, 04, 05 and 06

(case P)



8 lead dual-in-line (top view)

FIGURE 1. Terminal connections.

Circuit A
Device 01, 02

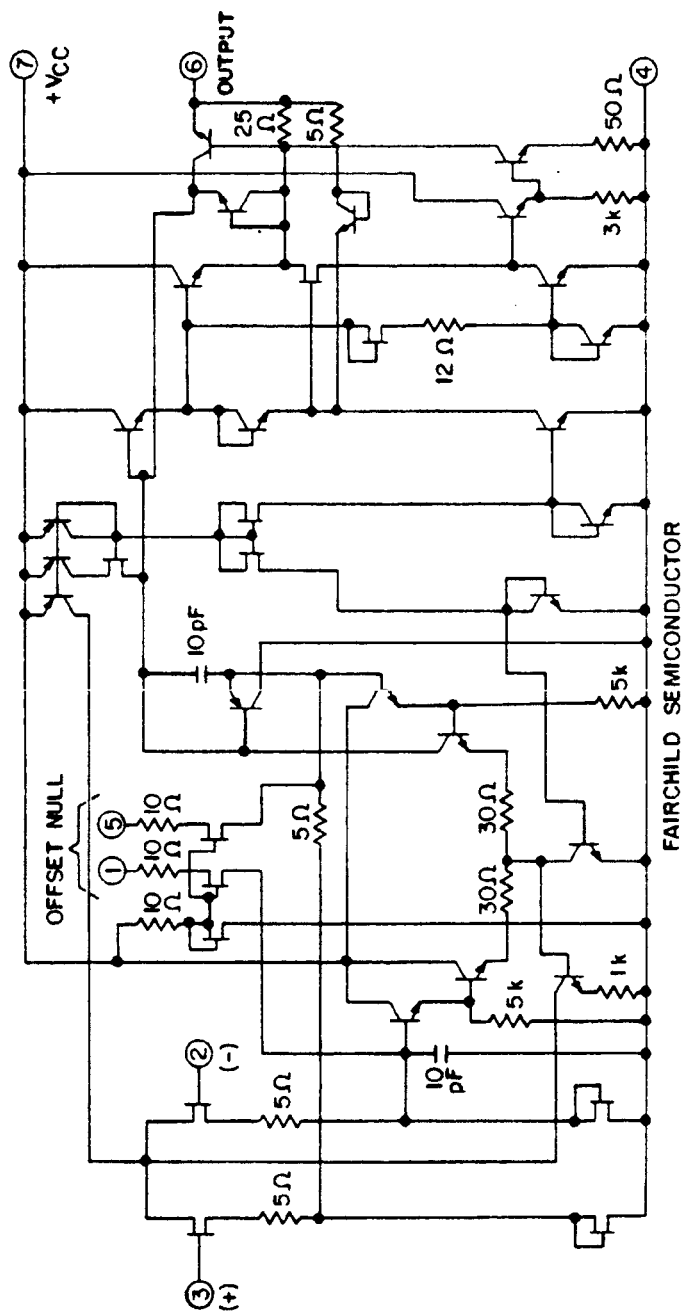
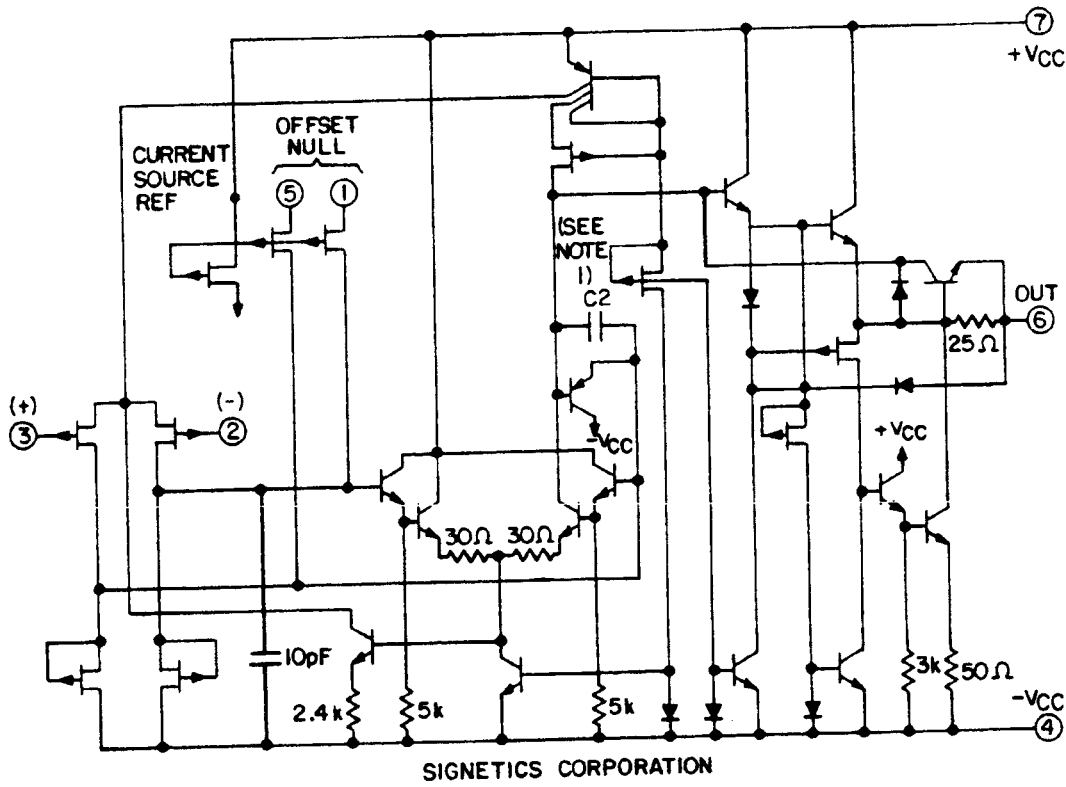


FIGURE 2. Schematic circuits.

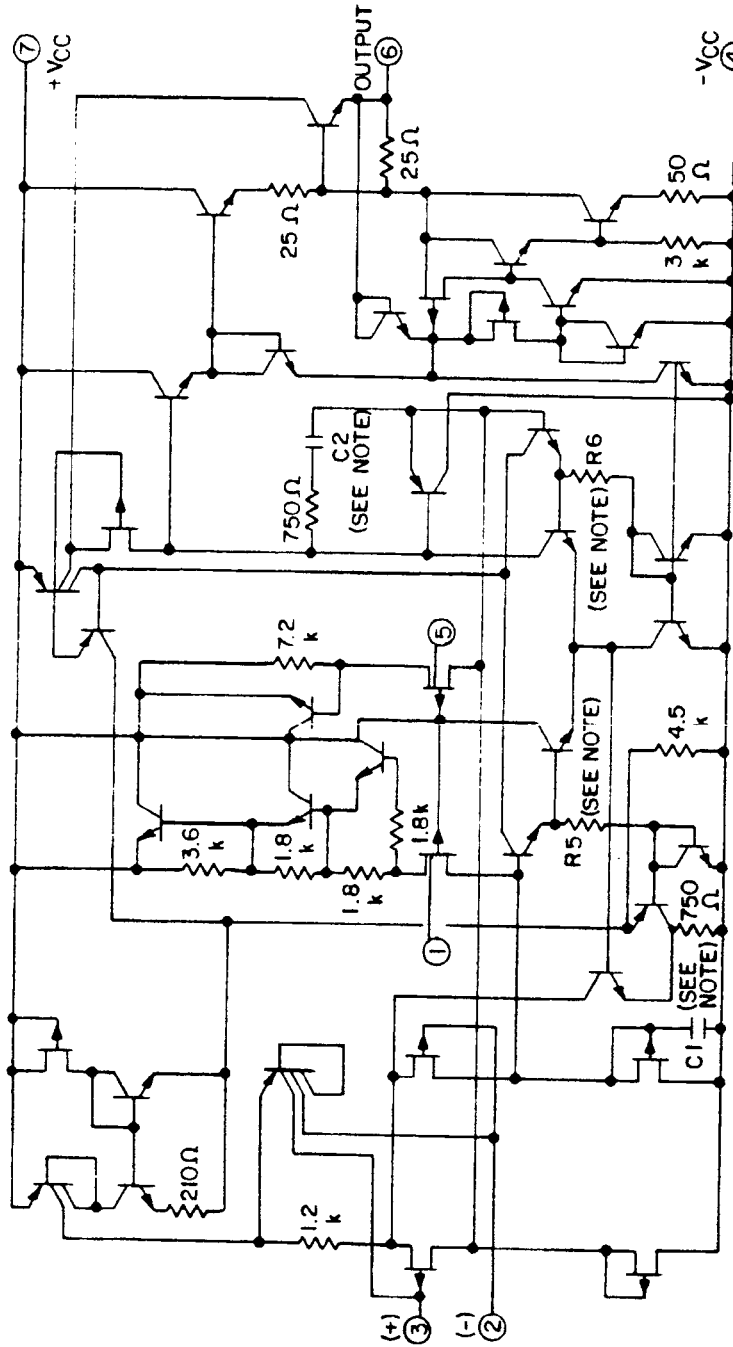
Circuit B
Device 01, 02, 03



1/ For device 01 and 02, C2 = 10 pF.
For device 03, C2 = 2 pF.

FIGURE 2. Schematic circuits - Continued.

Circuit C
Device 01, 02, 03



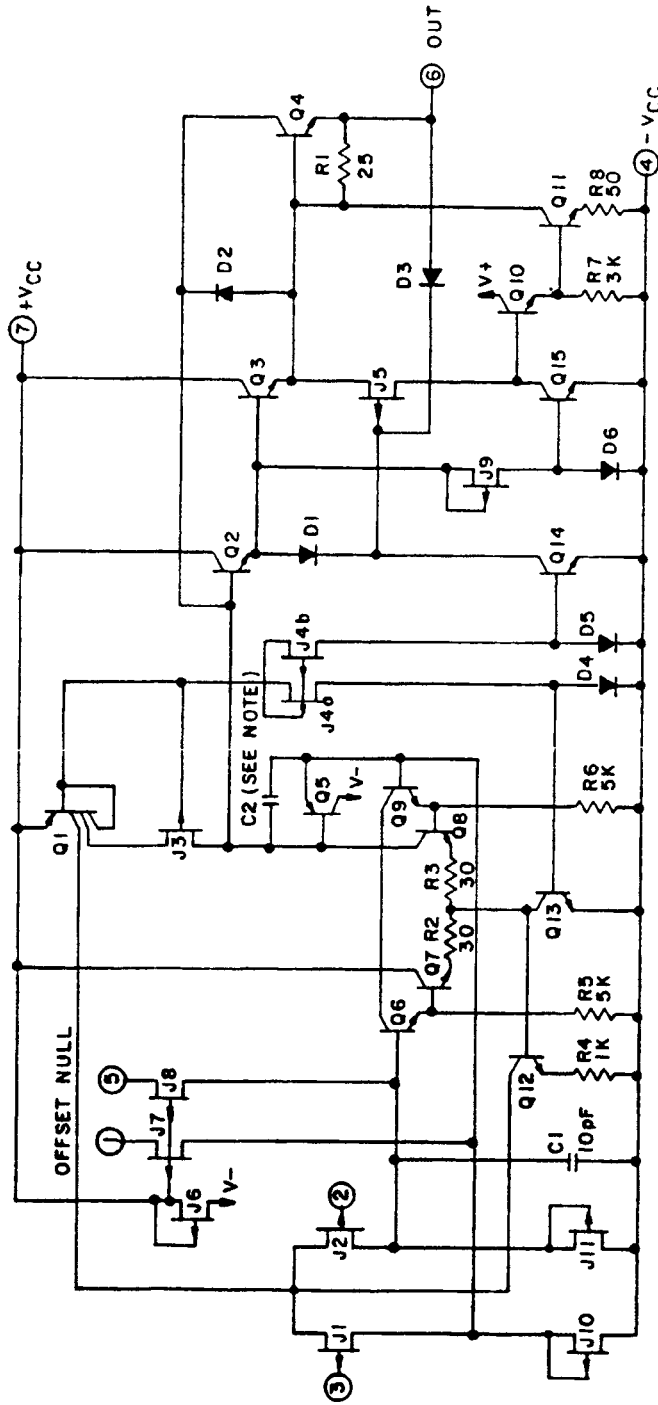
	Dev. 01	Dev. 02	Dev. 03
C1	7pf	5pf	1.7pf
C2	7pf	5pf	1.7pf
R5	7.2K	3.6k	3.6k
R6	7.2k	3.6k	3.6k

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NOTE: For values of C1, C2, R5, R6 see the following table:

FIGURE 2. Schematic circuits - Continued.

Circuit D
Device types 01, 02, 03, 04, 05, and 06



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NOTE: For device types 01, 02, 04, 05: C2 = 10 pF.
For device types 03, 06: C2 = 2 pF.

FIGURE 2. Schematic circuits - Continued.

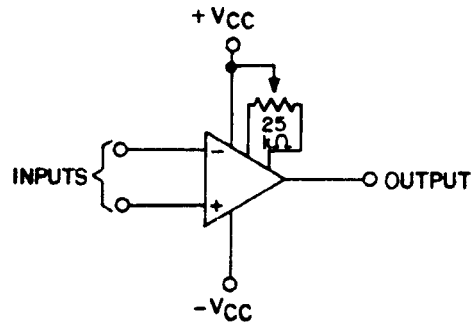
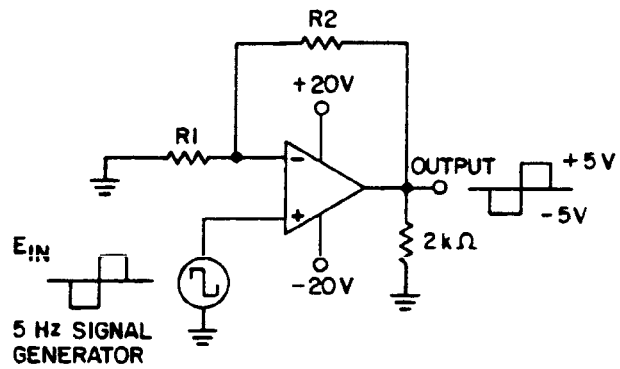


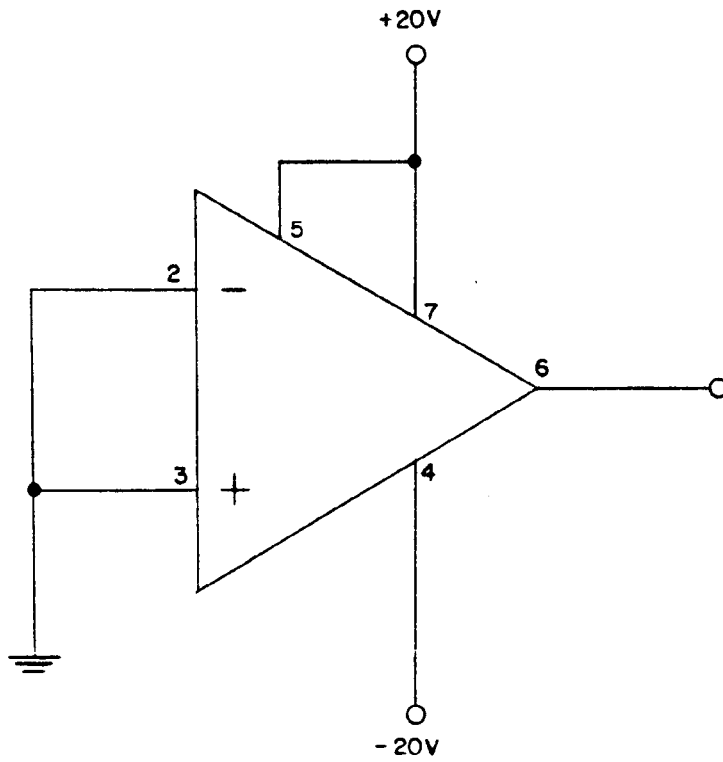
FIGURE 3. Offset null circuit.



Conditions @ $T_A = 125^{\circ}\text{C}$			
Device type	E_{IN}	R_1	R_2
01, 02, 04, 05	+5/-5 V	∞	0
03, 06	+1/-1 V	20 k Ω	82 k Ω

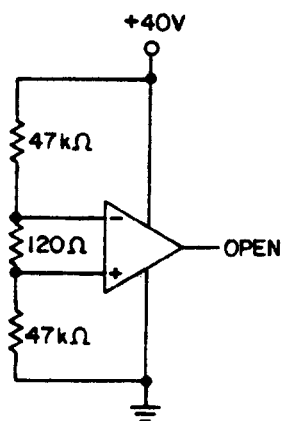
NOTE: All resistor tolerances are $\pm 5\%$.

FIGURE 4. Test circuit for burn-in and operating life tests.



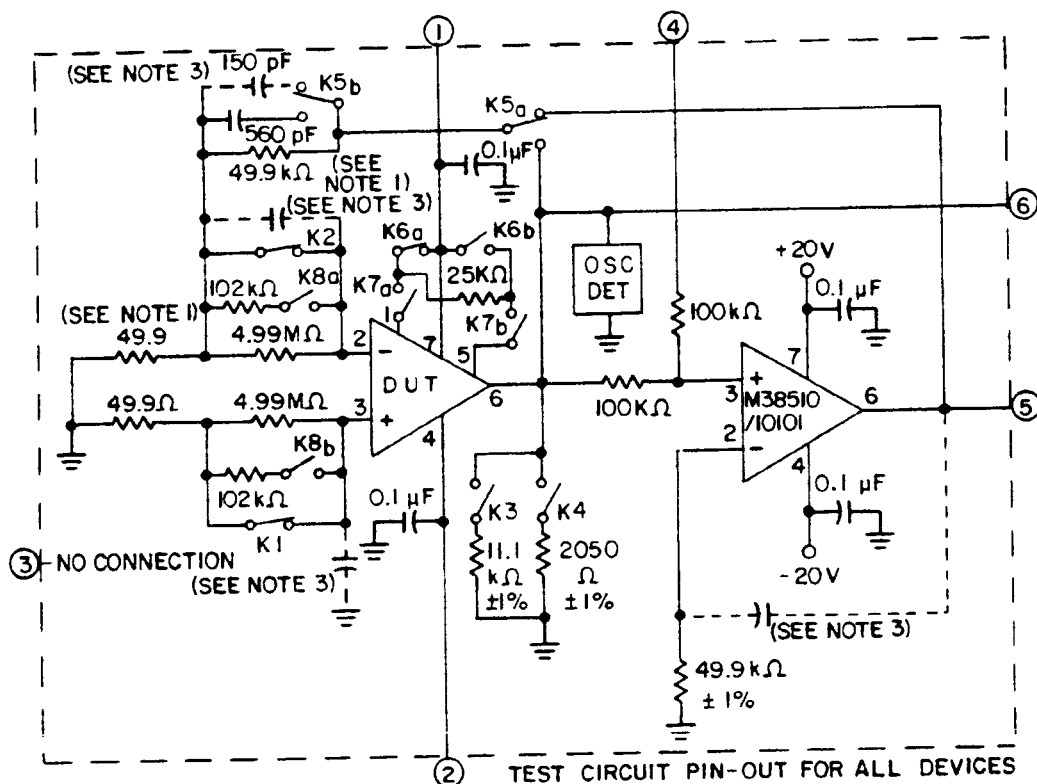
$T_A = 125^\circ C$

FIGURE 5. Test circuit, burn-in (steady state power and reverse bias) and operating life test.



NOTE: All resistors are $\pm 20\%$.

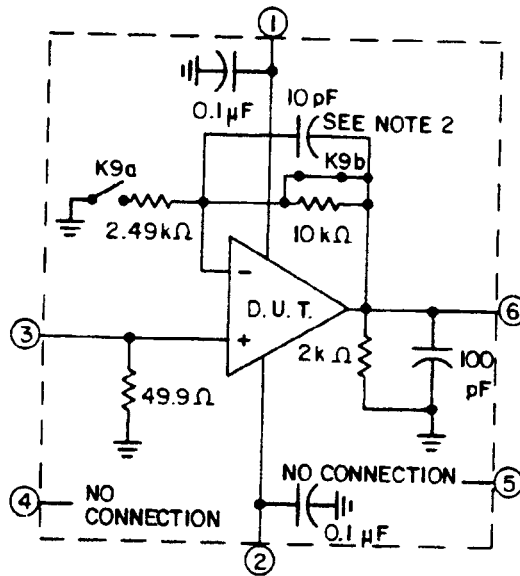
FIGURE 6. Accelerated burn-in and life test circuit.



NOTES:

1. All resistors are $\pm 0.1\%$ tolerance and all capacitors are $\pm 10\%$ tolerance unless otherwise specified.
2. Precautions shall be taken to prevent damage to the D.U.T. during insertion into socket and change of state of relays (i.e. disable voltage supplies, current limit $\pm V_{CC}$, etc).
3. Compensation capacitors should be added as required for test circuit stability. Two general methods for stability compensation exist. One method is with a capacitor for nulling amp feed back. The other method is with a capacitor in parallel with the $49.9\text{ k}\Omega$ closed loop feedback resistor. Both methods should not be used simultaneously. Proper wiring procedures shall be followed to prevent unwanted coupling and oscillations, etc. Loop response and settling time shall be consistent with the test rate such that any value has settled for at least 5 loop time constants before the value is measured.
4. Adequate settling time should be allowed such that each parameter has settled to within 5% of its final value.
5. All relays are shown in the normal de-energized state.
6. The nulling amplifier shall be a M38510/10101XXX. Saturation of the nulling amplifier is not allowed on tests where the E (pin 5) value is measured.
7. The load resistors 2050Ω and $11.1\text{ k}\Omega$ yield effective load resistances of $2\text{ k}\Omega$ and $10\text{ k}\Omega$ respectively.
8. Any oscillation greater than 300 mV in amplitude (peak-to-peak) shall be cause for device failure.

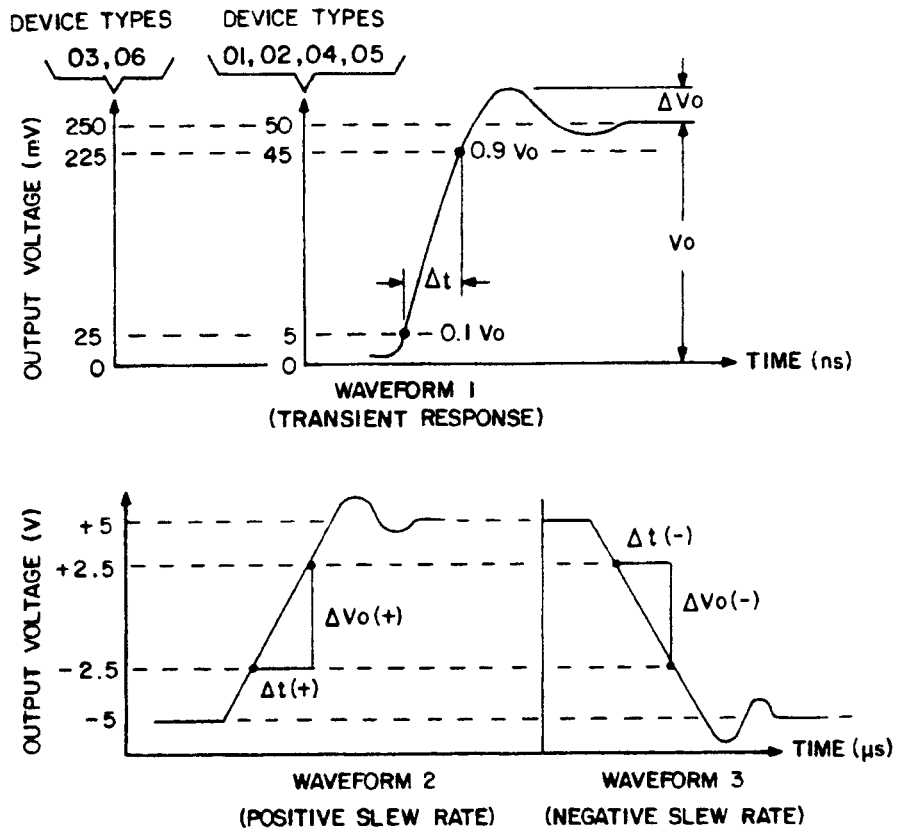
FIGURE 7. Test circuit for static tests.



NOTES:

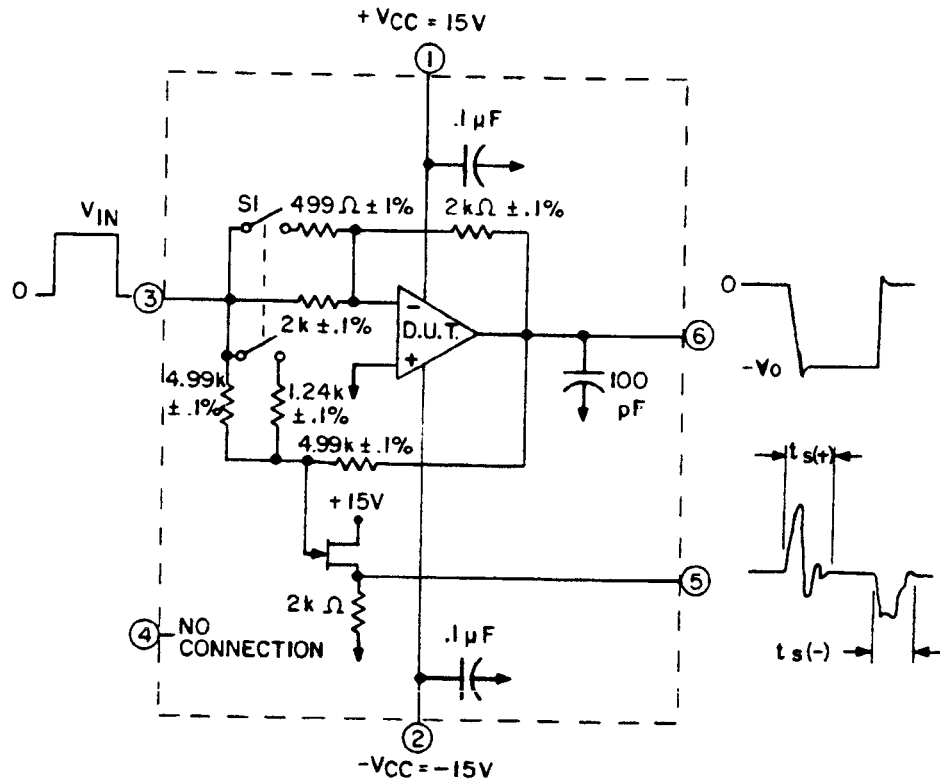
1. Resistors are $\pm 1.0\%$ tolerance and capacitors are $\pm 10\%$ tolerance.
2. This capacitance includes the actual measured value with stray and wire capacitance.
3. Precautions shall be taken to prevent damage to the D.U.T. during insertion into socket and in applying power.
4. Pulse input and output characteristics are shown on the next page.

FIGURE 8. Test circuit for transient response and slew rate.



Parameter symbol	Device type	Input pulse signal @ $t_r \leq 50$ ns	Output pulse signal	Equation
TR (t_r)	all	+50 mV	Waveform 1	TR (t_r) = Δt
TR (σ_s)	all	+50 mV	Waveform 1	TR (σ_s) = $100 (\Delta V_o / V_o) \%$
SR (+)	01, 02, 04, 05	-5 V to +5 V step	Waveform 2	SR (+) = $\Delta V_o(+)/\Delta t(+)$
	03, 06	-1 V to +1 V step	Waveform 2	
SR (-)	01, 02, 04, 05	+5 V to -5 V step	Waveform 3	SR (-) = $\Delta V_o(-)/\Delta t(-)$
	03, 06	-1 V to +1 V step	Waveform 3	

FIGURE 8. Test circuit for transient response and slew rate - Continued.



NOTES:

1. Resistors are $\pm 1.0\%$ and capacitors are $\pm 10\%$ unless otherwise specified.
2. Precaution shall be taken to prevent damage to the D.U.T. during insertion into socket and in applying power.
3. For device types 01, 02, 04 and 05, $S1$ is open, $AV = -1$ and $V_{IN} = 10V$.
4. For device types 03 and 06, $S1$ is closed, $AV = -5$ and $V_{IN} = 2V$.
5. Settling time, t_s , measured on pin 5, is the interval during which the summing node is not nulled within the specified accuracy referred to the output.

FIGURE 9. Test circuit for settling time.

TABLE III. Group A inspection for all device types.

Subgroup	Symbol	MIL-STD-883 method	Test no.	Notes	Adapter pin numbers				Energized relays	Measured pin		Equation	Device type	Limits		Units
					1	2	3	4		No.	Value			Min.	Max.	
(T _A = 25°C)	V _{I0}	4001	1	2/	35 V	-5 V	Open	-15 V	None	5	E ₁	V _{I0} = E ₁	01, 02, 03	-5	5	mV
			2		5 V	-35 V		15 V			E ₂	V _{I0} = E ₂				
			3		20 V	-20 V		0 V			E ₃	V _{I0} = E ₃				
			4		5 V	-5 V		0 V			E ₄	V _{I0} = E ₄				
		+I _{IB}		5		5 V	-35 V		15 V	K1, K8	E ₅	+I _{IB} = 10,000 (E ₂ - E ₅)	All	-100	3500	pA
				6		5 V	-25 V		10 V	None	E ₆	+I _{IB} = 200(E ₆ - E ₇)		-100	300	
				7		20 V	-20 V		0 V	K1	E ₈	+I _{IB} = 200(E ₃ - E ₈)		-100	100	
				8		35 V	-5 V		-15 V	K1	E ₉	+I _{IB} = 200(E ₁ - E ₉)		-100	100	
		-I _{IB}		9		5 V	-35 V		15 V	K2, K8	E ₁₀	-I _{IB} = 10,000 (E ₁₀ - E ₂)		-100	3500	
				10		5 V	-25 V		10 V	None	E ₁₁	-I _{IB} = 200(E ₁₂ - E ₁₁)		-100	300	
				11		5 V	-25 V		10 V	K2	E ₁₂					
				12		20 V	-20 V		0 V	K2	E ₁₃	-I _{IB} = 200(E ₁₃ - E ₃)		-100	100	
			12		35 V	-5 V		-15 V	K2	E ₁₄	-I _{IB} = 200(E ₁₄ - E ₁)		-100	100		
	I _{I0}		13		Calculate value using data from tests 3, 7 and 11						I _{I0} = 200(2E ₃ - E ₈ - E ₁₃)		-20	20	pA	
	+PSRR	4003	14		10 V	-20 V	Open	0 V	None	E ₁₅	+PSRR = 20 log 10 ⁶ / (E ₃ - E ₁₅)		85	--	dB	
	-PSRR	4003	15		20 V	-10 V	Open	0 V	None	E ₁₆	-PSRR = 20 log 10 ⁶ / (E ₃ - E ₁₆)		85	--	dB	
	CNR	4003	16	3/	Calculate value using data from tests 1 and 2						CNR = 20 log 3 x 10 ⁶ / (E ₁ - E ₂)		85	--	dB	
	V _{I0} ADJ(+)		17		20 V	-20 V	Open	0 V	K7	E ₁₇	V _{I0} ADJ(+) = E ₃ - E ₁₇		8	--	mV	
	V _{I0} ADJ(-)		18		20 V	-20 V		0 V	K6, K7	E ₁₈	V _{I0} ADJ(-) = E ₃ - E ₁₈		--	-8	mV	
	I _{OS(+)}	3011	19	5/	15 V	-15 V		-10 V	None	I ₁	I _{OS(+)} = I ₁		-50	--	mA	
	I _{OS(-)}	3011	20	5/	15 V	-15 V		10 V	None	I ₂	I _{OS(-)} = I ₂		--	50	mA	
	I _{CC}	3005	21		15 V	-15 V		0 V	None	I ₃	I _{CC} = I ₃		--	4	mA	
												01, 04	--	7		
												02, 03, 05, 06	--			

See notes at end of table.

TABLE III. Group A inspection for all device types - Continued.

Subgroup	Symbol	MIL-STD-883 method	Test no.	Notes	Adapter pin numbers				Energized relays		Measured pin		Equation	Device type	Limits		Units	
					1	2	3	4	No.	Value	Units	Min.			Max.			
$(T_A = 125^\circ\text{C})$	V_{10}	4001	22	2/	35 V	-5 V	Open	-15 V	None	5	E_{19}	V	$V_{10} = E_{19}$	01, 02, 03	-7	7	mV	
			23		5 V	-35 V		15 V				E_{20}	V		$V_{10} = E_{20}$			
			24		20 V	-20 V		0 V				E_{21}	V		$V_{10} = E_{21}$			
			25		5 V	-5 V		0 V				E_{22}	V		$V_{10} = E_{22}$			
			26	5/	$\Delta V_{10} = [V_{10}(\text{Test 24}) - V_{10}(\text{Test 3})]/100^\circ\text{C}$											01, 02, 03 04, 05, 06		-30 -10
	$+I_{1B}$			27	2/	5 V	-35 V	Open	15 V	K1, K8	5	E_{23}	V	$+I_{1B} = 10(E_{20} - E_{23})$	A11	-10	60	nA
				28		5 V	-25 V		10 V	None			E_{24}	V				
						5 V	-25 V		10 V	K1, K8			E_{25}	V		$+I_{1B} = 10(E_{24} - E_{25})$		
				29		20 V	-20 V		0 V	K1, K8			E_{26}	V		$+I_{1B} = 10(E_{21} - E_{26})$		
				30		35 V	-5 V		-15 V	K1, K8			E_{27}	V		$+I_{1B} = 10(E_{19} - E_{27})$		
				31		5 V	-35 V		15 V	K2, K8			E_{28}	V		$-I_{1B} = 10(E_{28} - E_{20})$		
				32		5 V	-25 V		10 V	None			E_{29}	V		$-I_{1B} = 10(E_{30} - E_{29})$		
						5 V	-25 V		10 V	K2, K8			E_{30}	V				
				33		20 V	-20 V		0 V	K2, K8			E_{31}	V		$-I_{1B} = 10(E_{31} - E_{21})$		
				34		35 V	-5 V		-15 V	K2, K8			E_{32}	V		$-I_{1B} = 10(E_{32} - E_{19})$		
	I_{10}			35	2/	20 V	-20 V		0 V	K1, K2, K8	5	E_{33}	V	$I_{10} = 10(E_{21} - E_{33})$		-20	20	dB
				36		10 V	-20 V		0 V	None			E_{34}	V		$+PSRR = 20 \log 10^4 / (E_{21} - E_{34}) $		
				37		20 V	-10 V		0 V	None			E_{35}	V		$-PSRR = 20 \log 10^4 / (E_{21} - E_{35}) $		
	CHR		4003	38	3/	Calculate value using data from tests 22 and 23									85	--	dB	
						20 V	-20 V	Open	0 V	K7	5	E_{36}	V	$V_{10} \text{ ADJ}(+) = (E_{21} - E_{36})$	01, 04 02, 03, 05, 06	8	--	mV
	$V_{10} \text{ ADJ}(-)$			40		20 V	-20 V		0 V	K6, K7							--	-8
						15 V	-15 V		-10 V	None			I_4	mA	$I_{OS}(+) = I_4$			
	$I_{OS}(-)$		3011	41	5/	15 V	-15 V		10 V	None	6	I_5	mA	$I_{OS}(-) = I_5$		-50	--	mA
				42	5/	15 V	-15 V		10 V	None			I_6	mA		$I_{CC} = I_6$		
	I_{CC}		3005	43		15 V	-15 V		0 V	None	2	I_6	mA			--	4	mA

TABLE III. Group A inspection for all device types - Continued.

Subgroup	Symbol	MIL-STD-883 method	Test no.	Notes	Adapter pin numbers				Energized relays	Measured pin		Equation	Device type	Limits		Units			
					1	2	3	4		No.	Value			Min.	Max.				
3 (T _A = -55°C)	V _{I0}	4001	44	2/	35 V	-5 V	Open	-15 V	None	5	E ₃₈	V _{I0} = E ₃₈	01, 02, 03	-7	7	mV			
			45		5 V	-35 V		15 V			E ₃₉	V _{I0} = E ₃₉							
			46		20 V	-20 V		0 V			E ₄₀	V _{I0} = E ₄₀							
			47		5 V	-5 V		0 V			E ₄₁	V _{I0} = E ₄₁							
		$\Delta V_{I0}/\Delta T$		48	5/	$\Delta V_{I0}/\Delta T = [V_{I0}(\text{Test 46}) - V_{I0}(\text{Test 3})]/80^\circ\text{C}$							01, 02, 03 04, 05, 06	-30 -10	30 10	$\mu\text{V}/^\circ\text{C}$			
		+PSRR	4003	49		10 V	-20 V	Open	0 V	None	5	E ₄₂	$+PSRR = 20 \log 10^4 / (E_{40} - E_{42}) $	A11	85	--	dB		
		-PSRR	4003	50		20 V	-10 V	Open	0 V	None	5	E ₄₃	$-PSRR = 20 \log 10^4 / (E_{40} - E_{43}) $		85	--		dB	
		CRR	4003	51	3/	Calculate value using data from tests 44 and 45											85	--	dB
		V _{I0} ADJ(+)		52		20 V	-20 V	Open	0 V	K7	5	E ₄₄	$V_{I0} \text{ ADJ}(+) = (E_{40} - E_{44})$				8	--	mV
		V _{I0} ADJ(-)		53		20 V	-20 V		0 V	K6, K7	5	E ₄₅	$V_{I0} \text{ ADJ}(-) = (E_{40} - E_{45})$				--	-8	mV
	I _{OS(+)}	3011	54	5/	15 V	-15 V		-10 V	None	6	I ₇	$I_{OS(+)} = I_7$				-50	--	mA	
	I _{OS(-)}		55	5/	15 V	-15 V		10 V			I ₈	$I_{OS(-)} = I_8$				--	50	mA	
	I _{CC}	3005	56		15 V	-15 V		0 V			I ₉	$I_{CC} = I_9$				--	11	mA	
4 (T _A = 25°C)	+V _{OP}	4004	57		20 V	-20 V	Open	-20 V	K3	6	(E ₀) ₁	$+V_{OP} = (E_0)_1$				16	--	V	
	-V _{OP}		58					20 V	K3		(E ₀) ₂	$-V_{OP} = (E_0)_2$				--	-16		
	+V _{OP}		59					-20 V	K4		(E ₀) ₃	$+V_{OP} = (E_0)_3$				15	--		
	-V _{OP}		60					20 V			(E ₀) ₄	$-V_{OP} = (E_0)_4$				--	-15		
	A _{VS(+)}		61	5/				-15 V		5	E ₄₆	$A_{VS(+)} = 15 / (E_3 - E_{46})$				50	--	V/mV	
	A _{VS(-)}		62	5/				15 V			E ₄₇	$A_{VS(-)} = 15 / (E_{47} - E_3)$				50	--		
	A _{VS}		63			5 V	-5 V		-2 V			E ₄₈	$A_{VS} = 4 / (E_{49} - E_{48})$				10	--	

See notes at end of table.

TABLE III. Group A inspection for all device types - Continued.

Subgroup	Symbol	MIL-STD-883 method	Test no.	Notes	Adapter pin numbers				Energized relays	Measured pin		Equation	Device type	Limits		Units	
					1	2	3	4		No.	Value			Min.	Max.		
5 (T _A = 125°C)	+V _{OP}	4004	64		20 V	-20 V	Open	-20 V	K3	6	(E ₀) ₅	+V _{OP} = (E ₀) ₅	A11	16	--	V	
	-V _{OP}		65				20 V	K3			(E ₀) ₆	-V _{OP} = (E ₀) ₆		--	-16		
	+V _{OP}		66				-20 V	K4			(E ₀) ₇	+V _{OP} = (E ₀) ₇		15	--		
	-V _{OP}		67				20 V				(E ₀) ₈	-V _{OP} = (E ₀) ₈		--	-15		
	A _{VS} (+)		68	5/			-15 V			5	E ₅₀	A _{VS} (+) = 15/(E ₂₁ - E ₅₀)		25	--	V/mv	
	A _{VS} (-)		69	5/			15 V				E ₅₁	A _{VS} (-) = 15/(E ₅₁ - E ₂₁)		25	--		
	A _{VS}		70				-5 V	5 V			E ₅₂	A _{VS} = 4/(E ₅₃ - E ₅₂)		10	--		
												E ₅₃					
												(E ₀) ₉		+V _{OP} = (E ₀) ₉	16	--	V
												(E ₀) ₁₀		-V _{OP} = (E ₀) ₁₀	--	-16	
6 (T _A = -55°C)	+V _{OP}		71		20 V	-20 V	Open	-20 V	K3	6	(E ₀) ₉	+V _{OP} = (E ₀) ₉		15	--		
	-V _{OP}		72				20 V	K3			(E ₀) ₁₀	-V _{OP} = (E ₀) ₁₀		--	-16		
	+V _{OP}		73				-20 V	K4			(E ₀) ₁₁	+V _{OP} = (E ₀) ₁₁		15	--		
	-V _{OP}		74				20 V				(E ₀) ₁₂	-V _{OP} = (E ₀) ₁₂		--	-15		
	A _{VS} (+)		75	5/			-15 V			5	E ₅₄	A _{VS} (+) = 15/(E ₄₀ - E ₅₄)		25	--	V/mv	
	A _{VS} (-)		76	5/			15 V				E ₅₅	A _{VS} (-) = 15/(E ₅₅ - E ₄₀)		25	--		
	A _{VS}		77				5 V	-5 V			E ₅₆	A _{VS} = 4/(E ₅₇ - E ₅₆)		10	--		
												E ₅₇					
												TR(tr) = Δt ₁ (see figure 8)		01, 04 02, 05 03, 06	150	---	ns
												TR(os) = 100 (ΔV ₀₁ /V ₀₁) (See figure 8)			100	---	
											SR(+) = ΔV ₀₁ (+)/Δt ₁ (+) (see figure 8)	450	---				
7 (T _A = 25°C)	TR(tr)		78		15 V	-15 V	+50 mV	Open	None K9	6	Δtr Δtr	TR(tr) = Δt ₁ (see figure 8)	01, 04 02, 05 03, 06	40	---	x	
	TR(os)		79					None K9			V ₀₁ ΔV ₀₁	TR(os) = 100 (ΔV ₀₁ /V ₀₁) (See figure 8)		40	---		
	SR(+)		80	8/			See notes	None K9			ΔV ₀₁ (+)	SR(+) = ΔV ₀₁ (+)/Δt ₁ (+) (see figure 8)		25	---	V/μs	
											Δt ₁ (+)			2	---		
														7.5	---		
														10	---		

TABLE III. Group A inspection for all device types - Continued.

Subgroup	Symbol	MIL-STD-883 method	Test no.	Notes	Adapter pin numbers				Energized relays	Measured pin		Equation	Device type	Limit		Units
					1	2	3	4		No.	Value			Min.	Max.	
7 $T_A = 25^\circ\text{C}$	SR(-)	4002	81	8/ 9/	15 V	-15 V	See notes	Open	None	6	$\Delta V_{01}(-)$	$\text{SR}(-) = \Delta V_{01}(-)/\Delta t_1(-)$ (see figure 8)	01 02 04 05 03 06	2	---	V/ μs
					15 V	-15 V	Open	K9	6	$\Delta t_1(-)$	7.5			---		
					20 V	-20 V	Open	K5	6	$(E_0)_{13}$	---			---		
					20 V	-20 V	Open	K1, K2, K5, K8	6	$(E_0)_{14}$	---			---		
					15 V	-15 V	+50 mV	Open	None K9	6	Δt_2			---	---	
					15 V	-15 V	See notes	Open	None K9	6	V_{02} ΔV_{02}			---	---	
8 $(T_A = 125^\circ\text{C})$	TR(tr)	4002	86	8/ 9/	-15 V	-15 V	See notes	Open	None	6	$\Delta V_{02}(+)$ $\Delta t_2(+)$	$\text{TR}(\text{tr}) = \Delta V_{02}(+)/\Delta t_2(+)$ (See figure 8)	01 02 03 04 05 06 01 02 03 04 05 06	5	---	V/ μs
					-15 V	-15 V	Open	K9	6	$\Delta V_{02}(-)$ $\Delta t_2(-)$	5			---		
					15 V	-15 V	Open	None	6	$\Delta V_{03}(+)$ $\Delta t_3(+)$	---			---		
					15 V	-15 V	Open	K9	6	$\Delta V_{03}(-)$ $\Delta t_3(-)$	---			---		
					15 V	-15 V	+50 mV	Open	None K9	6	Δt_3 Δt_3			---	---	
					15 V	-15 V	See notes	Open	None K9	6	V_{03} ΔV_{03}			---	---	
B $(T_A = -55^\circ\text{C})$	TR(tr)	4002	88	8/ 9/	-15 V	-15 V	See notes	Open	None	6	$\Delta V_{03}(+)$ $\Delta t_3(+)$	$\text{TR}(\text{tr}) = \Delta t_3$ (See figure 8) $\text{TR}(\text{os}) = 100 (\Delta V_{03}/V_{03})$ (See figure 8)	01 02 03 04 05 06 01 02 03 04 05 06	5	---	ns
					-15 V	-15 V	Open	K9	6	$\Delta V_{03}(-)$ $\Delta t_3(-)$	5			---		
					15 V	-15 V	Open	None	6	Δt_3 Δt_3	---			---		
					15 V	-15 V	Open	K9	6	V_{03} ΔV_{03}	---			---		
					15 V	-15 V	+50 mV	Open	None K9	6	Δt_3 Δt_3			---	---	
					15 V	-15 V	See notes	Open	None K9	6	V_{03} ΔV_{03}			---	---	
12 $(T_A = 25^\circ\text{C})$	$t_s(+)$ $t_s(-)$	4002	92 93	8/ 9/	15 V	-15 V	Open	Open	None	5	$t_s(+)$	$\text{SR}(+) = \Delta V_{03}(+)/\Delta t_3(+)$ (See figure 8) $\text{SR}(-) = \Delta V_{03}(-)/\Delta t_3(-)$ (See figure 8)	01 02 03 04 05 06 01 02 03 04 05 06	1500	---	ns
					15 V	-15 V	Open	Open	None	5	$t_s(-)$			800	---	
					15 V	-15 V	Open	Open	None	5	$t_s(+)$			1500	---	
					15 V	-15 V	Open	Open	None	5	$t_s(-)$			800	---	
					15 V	-15 V	Open	Open	None	5	$t_s(+)$			1500	---	
					15 V	-15 V	Open	Open	None	5	$t_s(-)$			800	---	

Table III. - Group A inspection - Continued.

NOTES:

- 1/ The equations take into account both the closed loop gain of 1,000 and the scale factor multiplier so that the calculated value is in table I units. The measured value units should, therefore, be used in the equation. (For example: If $E_1 = 2$ V and $V_{IO} = E_1$, then $V_{IO} = 2$ mV.)
- 2/ Each device shall be tested over the common mode range as specified in table III. V_{cm} conditions are achieved by grounding the inputs and algebraically subtracting V_{cm} from each supply. (For example: If $V_{cm} = -15$ V, then $+V_{CC} = +20$ V - (-15) = +35 V and $-V_{CC} = -20$ V - (-15) = -5 V.)
- 3/ Common mode rejection is calculated using the offset voltage values measured at the common mode range end points.
- 4/ To minimize thermal drift the reference voltage for the gain measurement (E_3 , E_{21} and E_{40}) shall be taken immediately prior to or after the reading corresponding to device gain (E_{46} , E_{47} , E_{50} , E_{51} , E_{54} and E_{55}).
- 5/ The output shall be shorted to ground for 25 ms or less.
- 6/ Tests 26 and 48 which require a read and record measurement plus a calculation may be omitted except when subgroups 2 and 3 are being accomplished for group A sampling inspection and groups C and D end point measurements.
- 7/ Broadband noise NI(BB) shall be measured using a true RMS voltmeter with a minimum bandwidth of 10 Hz to 20 kHz. "Popcorn" noise NI(PC) shall be measured for 15 seconds.
- 8/ Device types 01, 02, 04, and 05 are tested with a -5V to +5V step input as shown in figure 8. The circuit gain is 1V/V.
- 9/ Device types 03 and 06 are tested with a -1V to +1V step input as shown in figure 8. The circuit gain is 5V/V.

4.4.3 Group C inspection. Group C inspection shall be in accordance with table III of method 5005 and as follows:

- a. End point electrical parameters shall be as specified in table II herein.
- b. Life test for classes B and C devices (method 1005 of MIL-STD-883). Test condition D using the circuit shown on figure 5 or test condition F using the circuit shown on figure 6 (see note for 4.3a, item 2).
- c. Subgroup 12 shall be added to group C inspection as shown in table III herein. The LTPD for subgroup 12 shall be 5 for all classes."

4.4.4 Group D inspection. Group D inspection shall be in accordance with table IV of method 5005 of MIL-STD-883. End point electrical parameters shall be as specified in table II herein.

4.5 Methods of examination and test. Methods of examination and test shall be as specified in the appropriate tables. Electrical test circuits as prescribed herein or in the referenced test methods of MIL-STD-883 shall be acceptable. Other test circuits shall require the approval of the qualifying activity.

4.5.1 Voltage and current. All voltage values given, except the input offset voltage (or differential voltage) are referenced to the external zero reference level of the supply voltage. Currents given are conventional current and positive when flowing into the referenced terminal.

4.5.2 Life test cooldown procedure. When devices are measured at 25°C following application of the operating life or burn-in test condition, they shall be cooled to room temperature prior to removal of the bias.

4.6 Inspection of preparation for delivery. Inspection of preparation for delivery shall be in accordance with MIL-M-38510.

TABLE IV. Group C end point electrical parameters.
($T_A = 25^\circ\text{C}$, $\pm V_{CC} = \pm 20\text{ V}$ for all device types)

Table III test no.	Test		Limits				Units
			Device type 01, 02, 03		Device type 04, 05, 06		
			min.	max.	min.	max.	
3	V_{IO}	Limit	-5	+5	-2	2	mV
		Delta	-1	+1	-.5	.5	
7	$+I_{IB}$	Limit	-100	+100	-100	+100	pA
		Delta	-50	+50	-50	+50	
11	$-I_{IB}$	Limit	-100	+100	-100	+100	pA
		Delta	-50	+50	-50	+50	

5. PACKAGING

5.1 Packaging requirements. The requirements for packaging shall be in accordance with MIL-M-38510.

6. NOTES

6.1 Notes. The notes specified in MIL-M-38510 are applicable to this specification.

6.2 Intended use. Microcircuits conforming to this specification are intended for use for Government microcircuit applications (original equipment) and logistic purposes.

6.3 Ordering data. The contract or purchase order should specify the following:

- a. Complete part number (see 1.2).
- b. Requirements for delivery of one copy of the quality conformance inspection data pertinent to the device inspection lot to be supplied with each shipment by the device manufacturer, if applicable.
- c. Requirement for certificate of compliance, if applicable.
- d. Requirements for notification of change of product or process to procuring activity in addition to notification to the qualifying activity, if applicable.
- e. Requirements for packaging and packing.
- f. Requirements for failure analysis (including required test condition of method 5003 of MIL-STD-883) corrective action and reporting of results, if applicable.
- g. Requirements for product assurance options.
- h. Requirements for carriers, special lead lengths or lead forming, if applicable. These requirements shall not affect the part number. Unless otherwise specified, these requirements will not apply to direct purchase by or direct shipment to the Government.

6.4 Abbreviations, symbols, and definitions. Abbreviations, symbols, and definitions used herein are defined in MIL-M-38510 and MIL-STD-1331.

6.5 Logistic support. Lead materials and finishes (see 3.3) are interchangeable. Unless otherwise specified, microcircuits procured for Government logistic support will be procured to device class B (see 1.2.2), lead material and finish C (see 3.3). Longer length leads and lead forming shall not affect the part number.

6.6 Substitutability. The cross-reference information below is presented for the convenience of users. Microcircuits covered by this specification will functionally replace the listed Generic-Industry type. Generic-Industry microcircuit types may not have equivalent operational performance characteristics across military temperature ranges or reliability factors equivalent to MIL-M-38510 device types and may have slight physical variations in relation to case size. The presence of this information shall not be deemed as permitting substitution of Generic-Industry types for MIL-M-38510 types or as a waiver of any of the provisions of MIL-M-38510.

Military Device Type	Generic-Industry Type
01	LF 155
02	LF 156
03	LF 157
04	LF 155A
05	LF 156A
06	LF 157A

Custodians:
 Army - ER
 Navy - EC
 Air Force - 17

Preparing activity:
 Air Force - 17

Review activities:
 Army - MI, AR, ER
 Navy - SD
 Air Force - 99
 DLA - ES
 NASA - NS

Agent:
 DLA - ES
 (Project 5962-0311)

User activities:
 Army - SM
 Navy - CG, MC, AS, OS
 Air Force - 19