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:

Device type	Circuit
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:

Outline letter	MIL-M-38510 appendix C case outline
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.

Package	Case outline	Maximum allowable power dissipation	Maximum θJ-C	Maximum θJ-A
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 1.2.3 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 $-55°C \leq T_A \leq 125°C$ 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 Min.	Limits Max.	Units
Input offset voltage	V_{IO}	$\pm V_{CC} = \pm 5$ V, $V_{CM} = 0$ V	$T_A = 25°C$	01, 02, 03	-5	5	mV
				04, 05, 06	-2	2	
		$\pm V_{CC} = \pm 20$ V, $V_{CM} = \pm 15$ V, 0 V	$-55°C \le T_A \le +125°C$	01, 02, 03	-7	7	
				04, 05, 06	-2.5	+2.5	
Input offset voltage temperature sensitivity	$\frac{\Delta V_{IO}}{\Delta T}$	$\pm V_{CC} = \pm 20$ V, $V_{CM} = 0$ V		01, 02, 03	-30	30	µV/°C
				04, 05, 06	-10	10	
Input offset current	I_{IO}	$\pm V_{CC} = \pm 20$ V, $V_{CM} = 0$ V	$T_J = 25°C$	All	-20	20	pA
			$T_J = 125°C$		-20	20	nA
Input bias current	$+I_{IB}$	$\pm V_{CC} = \pm 20$ V, $V_{CM} = +15$ V, $t \le 25$ ms	$T_J = 25°C$		-100	3500	pA
			$T_J = 125°C$		-10	60	nA
	$-I_{IB}$ 1/	$\pm V_{CC} = \pm 15$ V, $V_{CM} = +10$ V, $t \le 25$ ms	$T_J = 25°C$		-100	300	pA
			$T_J = 125°C$		-10	50	nA
	2/ 3/	$\pm V_{CC} = \pm 20$ V, -15 V $\le V_{CM} \le 0$ V, $t \le 25$ ms	$T_J = 25°C$		-100	100	pA
			$T_J = 125°C$		-10	50	nA
Power supply rejection ratio	+PSRR	$+V_{CC} = 10$ V, $-V_{CC} = -20$ V			85	---	dB
	-PSRR	$+V_{CC} = 20$ V, $-V_{CC} = -10$ V			85	---	dB
Input voltage common mode rejection 4/	CMR	$\pm V_{CC} = \pm 20$ V, $V_{IN} = \pm 15$ V			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 Min.	Limits Max.	Units
Adjustment for input offset voltage	$V_{IO\ ADJ(+)}$	$\pm V_{CC} = \pm 20$ V	All	+8	---	mV
	$V_{IO\ ADJ(-)}$	$\pm V_{CC} = \pm 20$ V		---	-8	mV
Output short circuit current (for positive output) 5/	$I_{OS(+)}$	$\pm V_{CC} = \pm 15$ V, $t < 25$ mS (Short circuit to ground)		-50	---	mA
Output short circuit current (for negative output) 5/	$I_{OS(-)}$	$\pm V_{CC} = \pm 15$ V, $t < 25$ mS (Short circuit to ground)		---	50	mA
Supply current	I_{CC}	$\pm V_{CC} = \pm 15$ V, $T_A = -55°C$	01, 04	---	6	mA
			02, 03, 05, 06	---	11	
		$T_A = +25°C$	01, 04	---	4	
			02, 03, 05, 06	---	7	
		$T_A = +125°C$	01, 04	---	4	
			02, 03, 05, 06	---	7	
Output voltage swing (maximum)	V_{OP}	$\pm V_{CC} = \pm 20$ V, $R_L = 10$ KΩ	All	± 16	---	V
		$\pm V_{CC} = \pm 20$ V, $R_L = 2$ KΩ		± 15	---	
Open loop voltage gain (single ended) 6/	$A_{VS(+)}$	$\pm V_{CC} = \pm 20$ V, $R_L = 2$ KΩ, $V_{OUT} = \pm 15$ V, $T_A = 25°C$		50	---	V/mV
	$A_{VS(-)}$	$-55°C \leq T_A \leq +125°C$		25	---	
Open loop voltage gain (single ended) 6/	A_{VS}	$\pm V_{CC} = \pm 5$ V, $R_L = 2$ KΩ, $V_{OUT} = \pm 2$ V		10	---	V/mV

See footnotes at end of table.

TABLE I. Electrical performance characteristics - Continued.

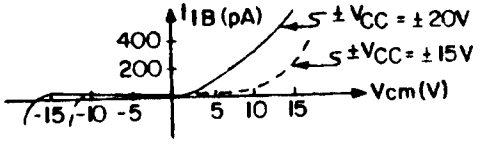
Characteristics	Symbol	Conditions (3.4 and figure 7, unless otherwise specified)		Device Type	Limits		Units
					Min.	Max.	
Transient response Rise time	$TR_{(tr)}$	$\pm V_{CC} = \pm 15$ $R_L = 2k\Omega$ $C_L = 100$ pf see figure 8 V_{IN} 50 mV	AV = 1	01, 04	---	150	ns
				02, 05	---	100	
			AV = 5	03, 06	---	450	
Transient response Overshoot	$TR_{(os)}$		AV = 1	01, 02, 04, 05	---	40	%
			AV = 5	03, 06	---	25	
Slew rate	SR(+) and SR(-)	$V_{IN} = \pm 5$ V $\pm V_{CC} = \pm 15$ V AV = 1 see figure 8	T_A = 25°C	01	2	---	V/us
				02	7.5	---	
				04	3	---	
				05	10	---	
			T_A = -55°C, 125°C	01	1	---	
				02	5	---	
				04	1.5	---	
				05	7	---	
		$V_{IN} = \pm 5$ V; AV = 5 $\pm V_{CC} = \pm 15$ V see figure 8	T_A = 25°C	03	30	---	
				06	40	---	
			T_A = -55°C, 125°C	03	20	---	
				06	25	---	
Settling time	ts(+) and ts(-)	$\pm V_{CC} = \pm 15$ V (0.1% error) T_A = 25°C see figure 9	AV = -1	01, 02, 04, 05	---	1500	ns
			AV = -5	03, 06	---	800	
Noise (referred to input) broad-band	N_I(BB)	$\pm V_{CC} = 20$ V; Bandwidth = 5KHz	T_A = 25°C	All	---	10	μV_{rms}
Noise (referred to input) popcorn	N_I(PC)		T_A = 25°C	All	---	80	μV_{pk}

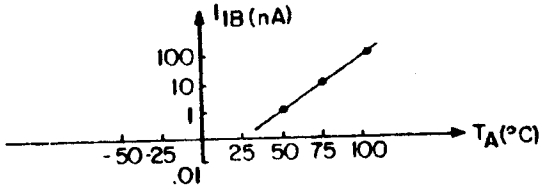
NOTES:

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_{IO} 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 $T_J(max) \leq 175°C$.

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:

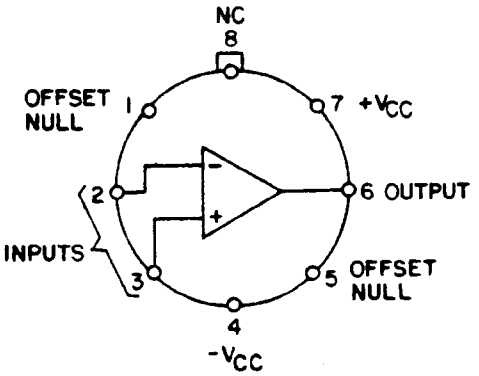
a. Subgroups 9, 10 and 11 shall be omitted.
b. Tests shall be as specified in table II herein.
c. Subgroup 12 shall be added to group A inspection as shown in table III herein. The LTPD for subgroup 12 shall be 5 for all classes.

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:

a. End point electrical parameters shall be as specified in table II herein.
b. 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)

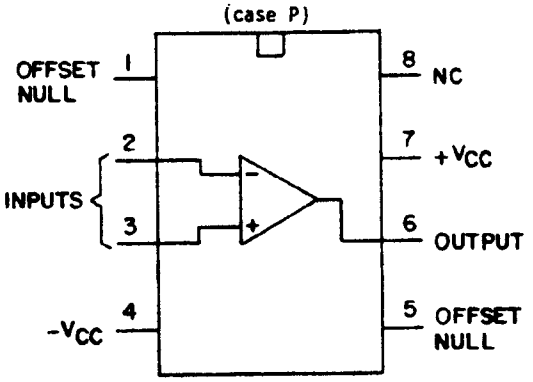


(Pin 4 connected to case)

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.

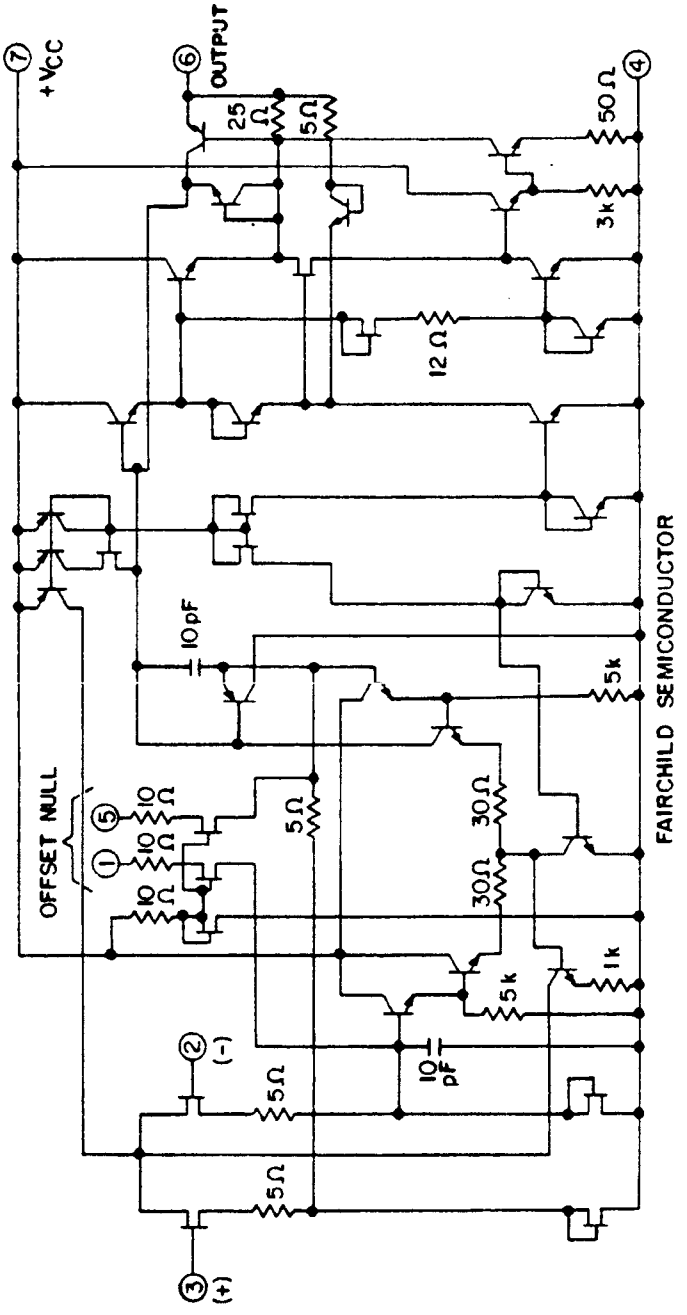
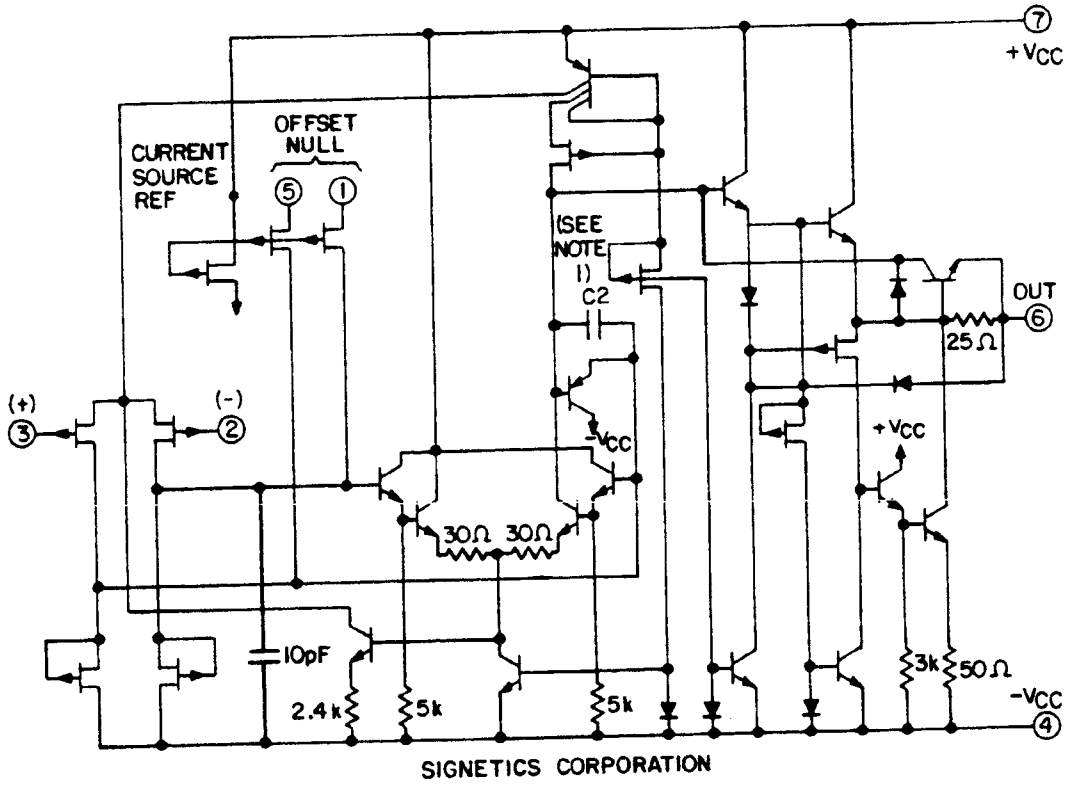


FIGURE 2. Schematic circuits.

Circuit B
Device 01, 02, 03

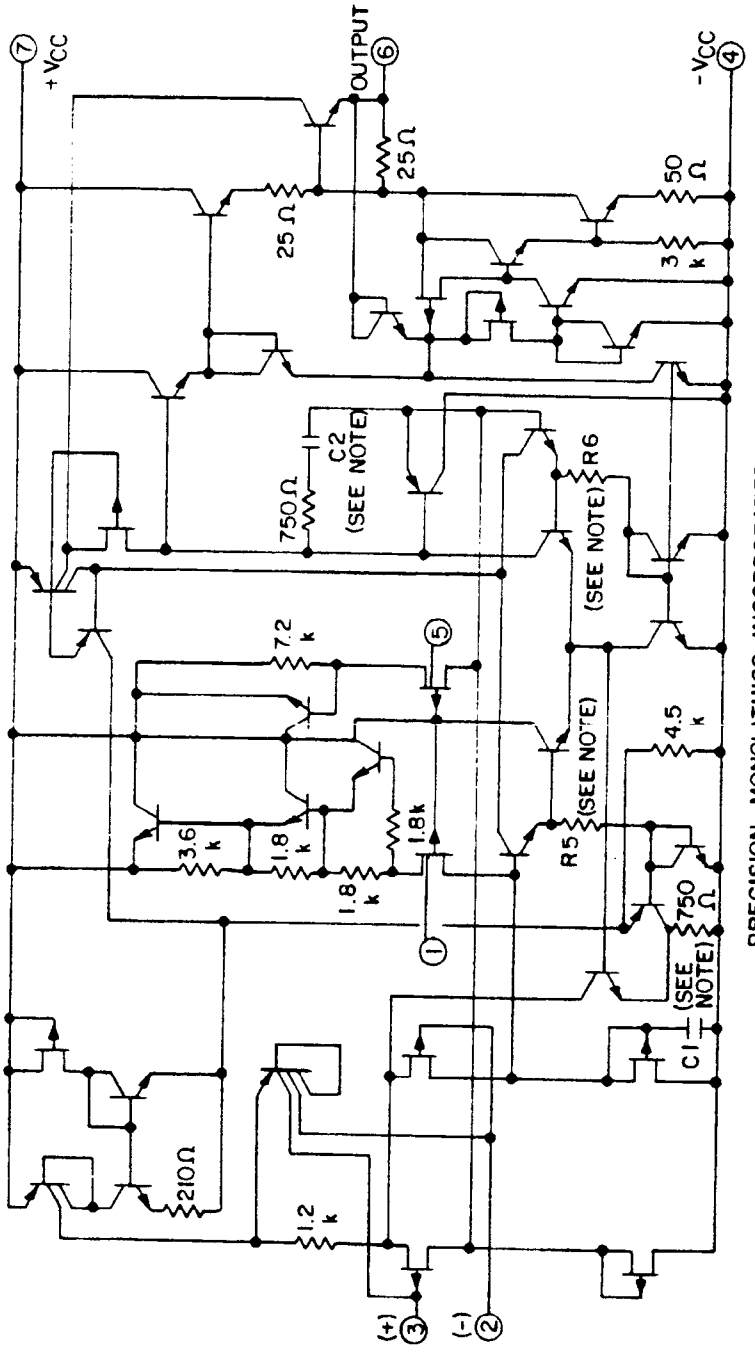


1/ For device 01 and 02, C2 = 10 pF.
For device 03, C2 = 2 pF.

FIGURE 2. Schematic circuits - Continued.

Circuit C

Device 01, 02, 03



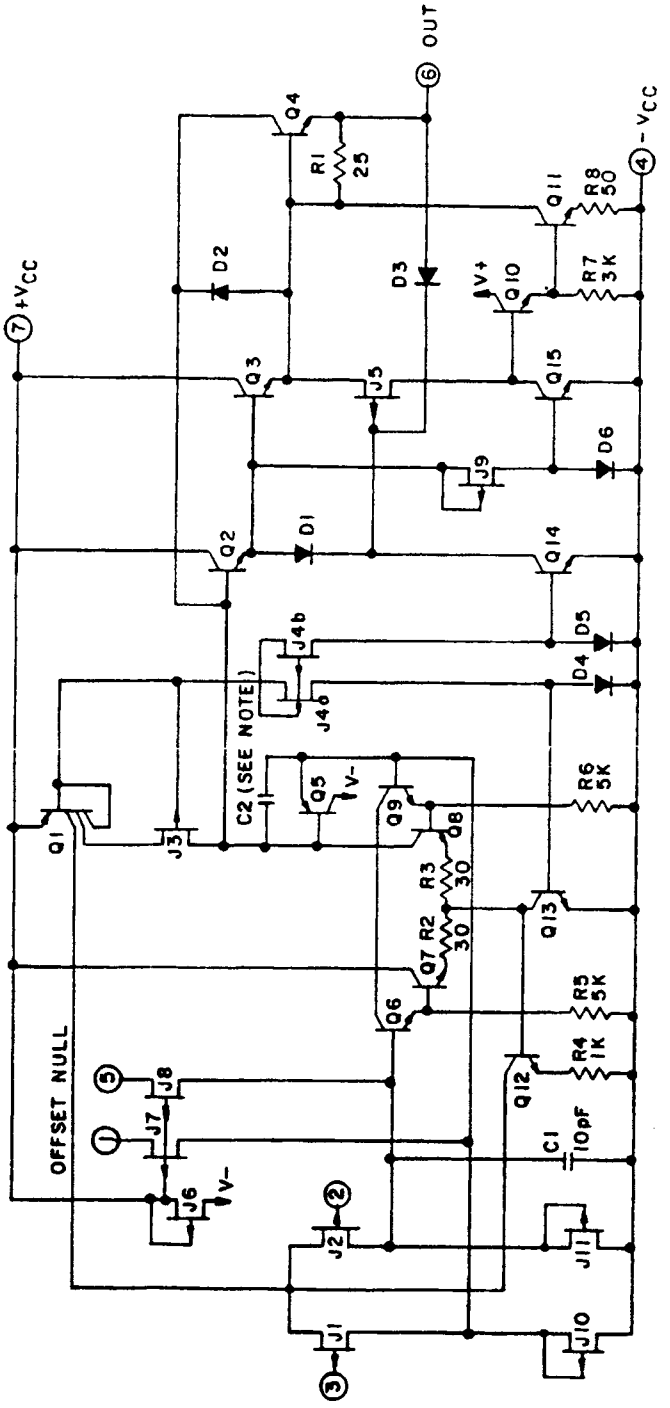
	Dev. 01	Dev. 02	Dev. 03
C1	7pf	5pf	1.7pf
C2	7pf	5pf	1.7pf
R5	7.2K	3.6k	3.6k
R6	7.2k	3.6k	3.6k

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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All resistance values in ohms unless otherwise specified.

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

FIGURE 2. Schematic circuits - Continued.

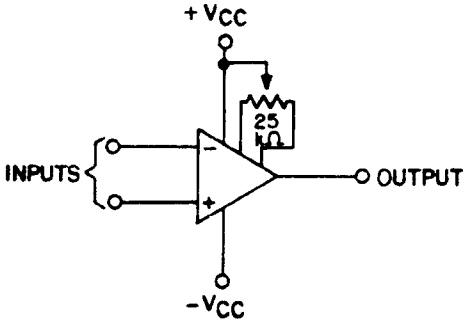
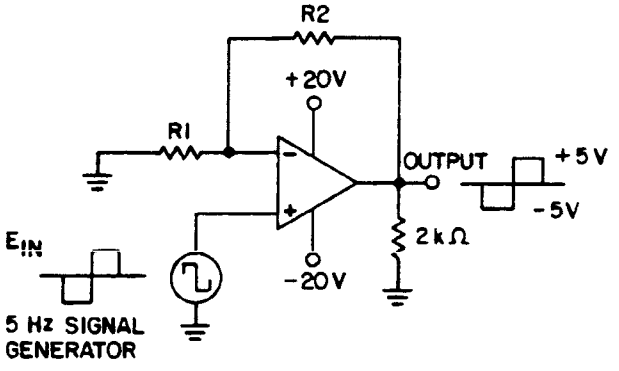


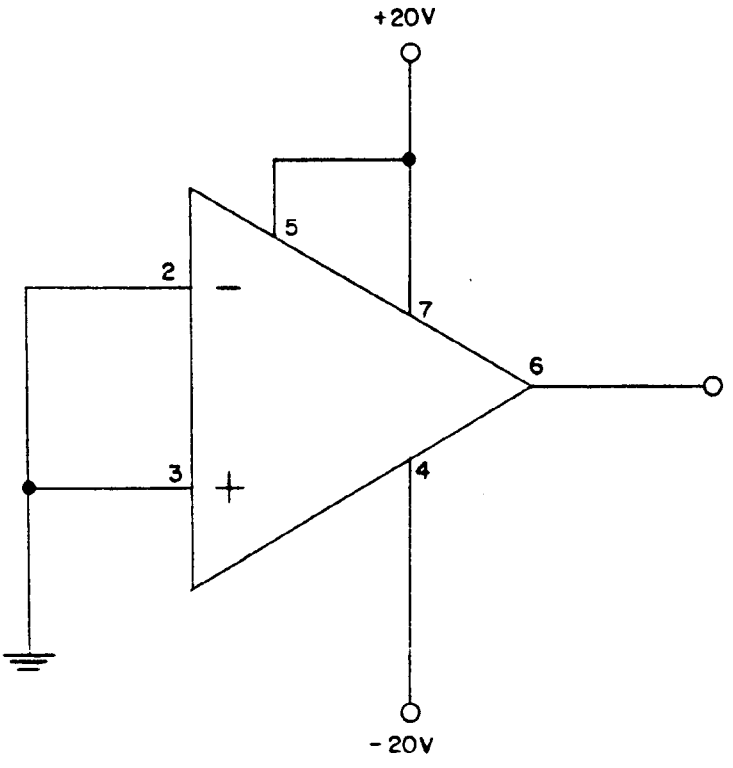
FIGURE 3. Offset null circuit.



Conditions @ T_A = 125°C			
Device type	E_{IN}	R_1	R_2
01, 02, 04, 05	+5/-5 V	∞	0
03, 06	+1/-1 V	20 kΩ	82 kΩ

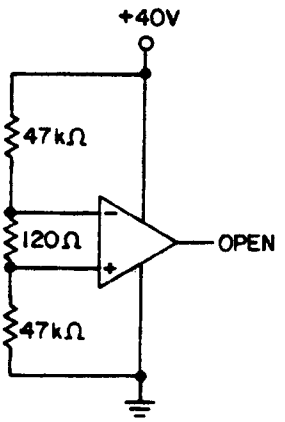
NOTE: All resistor tolerances are ±5%.

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



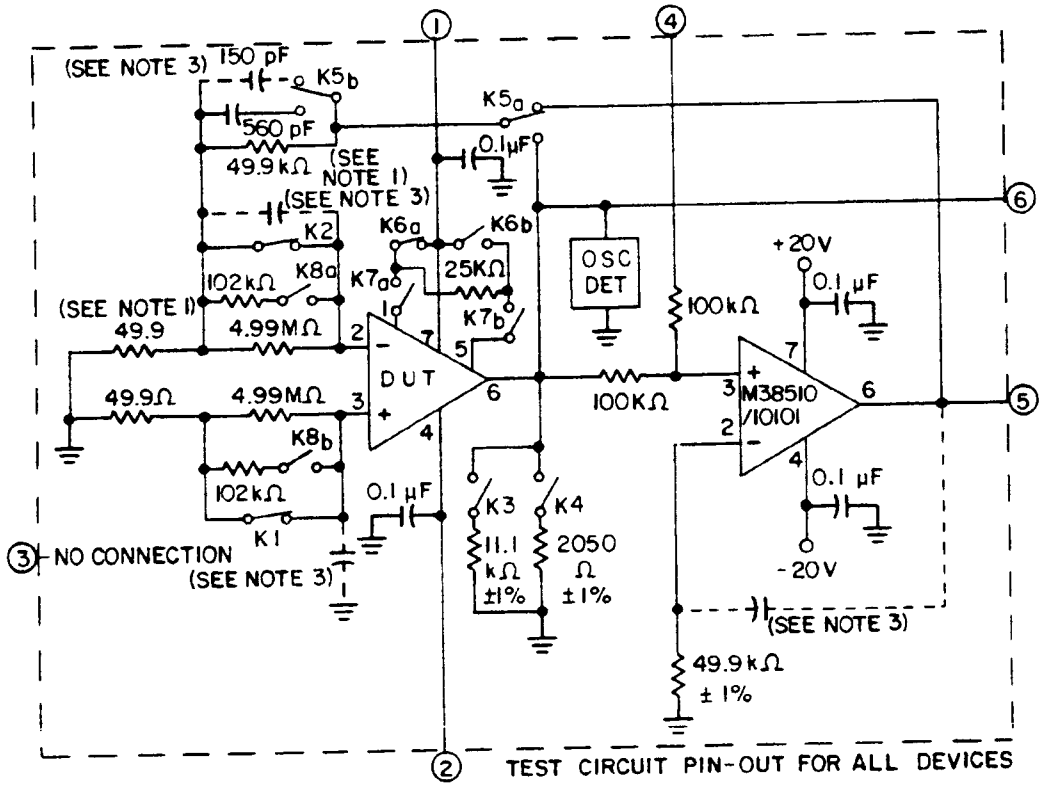
T_A = 125° C

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



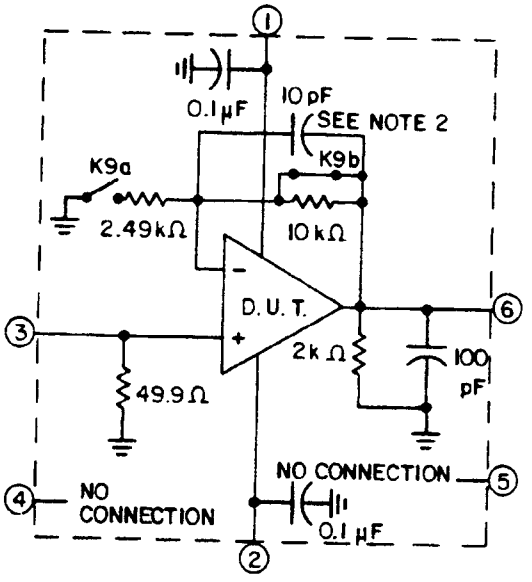
NOTE: All resistors are ±20%.

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



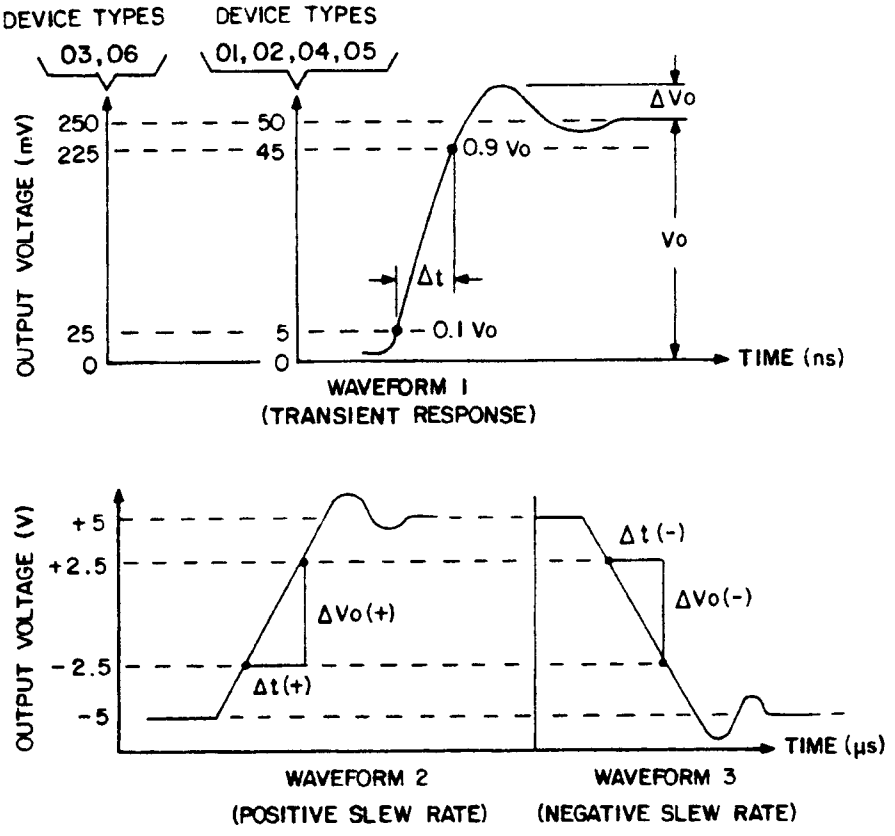
NOTES:
1. All resistors are ±0.1% tolerance and all capacitors are ±10% tolerance unless otherwise specified.
2. Precautions shall be taken to prevent damage to the D.U.T. during insertion into socket and change of state of relays (i.e. disable voltage supplies, current limit ± V_{cc}, etc).
3. Compensation 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 kΩ 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 kΩ yield effective load resistances of 2 kΩ and 10 kΩ 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.



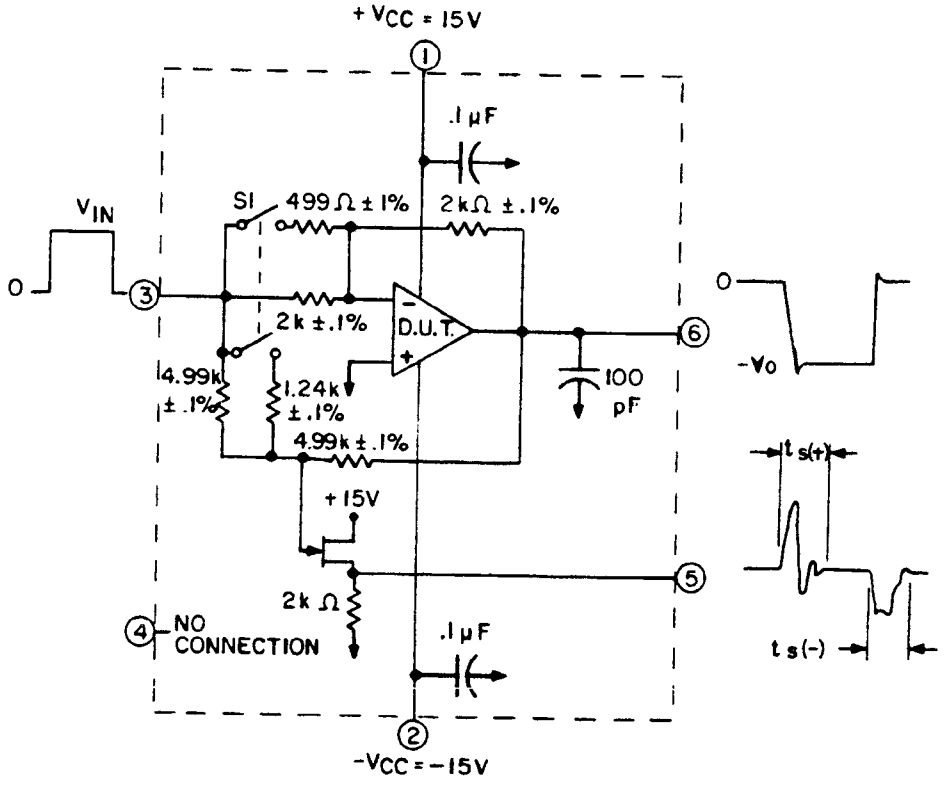
NOTES:
1. Resistors are ±1.0% tolerance and capacitors are ±10% tolerance.
2. This capacitance includes the actual measured value with stray and wire capacitance.
3. Precautions shall be taken to prevent damage to the D.U.T. during insertion into socket and in applying power.
4. Pulse input and output 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 (o_s)	all	+50 mV	Waveform 1	$TR_{(o_s)} = 100\ (^{\Delta Vo}/Vo)$ %
SR (+)	01, 02, 04, 05	-5 V to +5 V step	Waveform 2	$SR(+) = {}^{\Delta Vo(+)}/\Delta t(+)$
	03, 06	-1 V to +1 V step	Waveform 2	
SR (-)	01, 02, 04, 05	+5 V to -5 V step	Waveform 3	$SR(-) = {}^{\Delta Vo(-)}/\Delta t(-)$
	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 ±1.0% and capacitors are ±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} = 10 V.
4. For device types 03 and 06, S1 is closed, AV = -5 and V_{IN} = 2 V.
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 1	2	3	4	Energized relays	Measured pin No.	Value	Units	Equation 1/	Device type	Limits Min.	Max.	Units
1 (T_A = 25°C)	V_{IO}	4001	1	2/	35 V	-5 V	Open	-15 V	None	5	E_1	V	$V_{IO} = E_1$	01, 02, 03	-5	5	mV
			2		5 V	-35 V		15 V			E_2		$V_{IO} = E_2$				
			3		20 V	-20 V		0 V			E_3		$V_{IO} = E_3$	04, 05, 06	-2	2	
			4		5 V	-5 V		0 V			E_4		$V_{IO} = E_4$				
	$+I_{IB}$		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	
					5 V	-25 V		10 V	K1		E_7						
			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	
					5 V	-25 V		10 V	K2		E_{12}						
			11		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_{IO}		13		Calculate value using data from tests 3, 7 and 11								$I_{IO} = 200(2E_3 - E_8 - E_{13})$		-20	20	pA
	+PSRR	4003	14		10 V	-20 V	Open	0 V	None	5	E_{15}	V	$+PSRR = 20 \log\lvert 10^4/(E_3 - E_{15})\rvert$		85	--	dB
	-PSRR	4003	15		20 V	-10 V	Open	0 V	None	5	E_{16}	V	$-PSRR = 20 \log\lvert 10^4/(E_3 - E_{16})\rvert$		85	--	dB
	CMR	4003	16	3/	Calculate value using data from tests 1 and 2								$CMR = 20 \log\lvert 3 \times 10^4/(E_1 - E_2)\rvert$		85	--	dB
	$V_{IO\ ADJ(+)}$		17		20 V	-20 V	Open	0 V	K7	5	E_{17}	V	$V_{IO\ ADJ(+)} = E_3 - E_{17}$		8	--	mV
	$V_{IO\ ADJ(-)}$		18		20 V	-20 V		0 V	K6, K7	5	E_{18}	V	$V_{IO\ ADJ(-)} = E_3 - E_{18}$		--	-8	mV
	$I_{OS(+)}$	3011	19	5/	15 V	-15 V		-10 V	None	6	I_1	mA	$I_{OS(+)} = I_1$		-50	--	mA
	$I_{OS(-)}$	3011	20	5/	15 V	-15 V		10 V	None	6	I_2	mA	$I_{OS(-)} = I_2$		--	50	mA
	I_{CC}	3005	21		15 V	-15 V		0 V	None	2	I_3	mA	$I_{CC} = I_3$	01, 04	---	4	mA
														02, 03, 05, 06	---	7	

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 1	2	3	4	Energized relays	Measured pin No.	Value	Units	Equation 1/	Device type	Limits Min.	Max.	Units
(T_A = 125°C) 2/	V_{IO}	4001	22	2/	35 V	-5 V	Open	-15 V	None	5	E_{19}	V	$V_{IO} = E_{19}$	01, 02, 03	-7	7	mV
			23		5 V	-35 V		15 V			E_{20}		$V_{IO} = E_{20}$				
			24		20 V	-20 V		0 V			E_{21}		$V_{IO} = E_{21}$	04, 05, 06	-2.5	2.5	
			25		5 V	-5 V		0 V			E_{22}		$V_{IO} = E_{22}$				
	$\Delta V_{IO}/\Delta T$		26	6/	$\Delta V_{IO}/\Delta T = [V_{IO}(\text{Test 24}) - V_{IO}(\text{Test 3})]/100°C$									01, 02, 03	-30	30	µV/°C
														04, 05, 06	-10	10	
	$+I_{IB}$		27	2/	5 V	-35 V	Open	15 V	K1, K8	5	E_{23}	V	$+I_{IB} = 10(E_{20} - E_{23})$	All	-10	60	nA
			28		5 V	-25 V		10 V	None		E_{24}		$+I_{IB} = 10 (E_{24} - E_{25})$		-10	50	
					5 V	-25 V		10 V	K1, K8		E_{25}						
			29		20 V	-20 V		0 V	K1, K8		E_{26}		$+I_{IB} = 10 (E_{21} - E_{26})$		-10	50	
			30		35 V	-5 V		-15 V	K1, K8		E_{27}		$+I_{IB} = 10 (E_{19} - E_{27})$		-10	50	
	$-I_{IB}$		31		5 V	-35 V		15 V	K2, K8		E_{28}		$-I_{IB} = 10 (E_{28} - E_{20})$		-10	60	
			32		5 V	-25 V		10 V	None		E_{29}		$-I_{IB} = 10 (E_{30} - E_{29})$		-10	50	
					5 V	-25 V		10 V	K2, K8		E_{30}						
			33		20 V	-20 V		0 V	K2, K8		E_{31}		$-I_{IB} = 10 (E_{31} - E_{21})$		-10	50	
			34		35 V	-5 V		-15 V	K2, K8		E_{32}		$-I_{IB} = 10 (E_{32} - E_{19})$		-10	50	
	I_{IO}		35	2/	20 V	-20 V		0 V	K1, K2, K8	5	E_{33}	V	$I_{IO} = 10 (E_{21} - E_{33})$		-20	20	
	+PSRR	4003	36		10 V	-20 V		0 V	None		E_{34}		$+PSRR = 20 \log\lvert 10^4/(E_{21} - E_{34})\rvert$		85	--	dB
	-PSRR	4003	37		20 V	-10 V		0 V	None		E_{35}		$-PSRR = 20 \log\lvert 10^4/(E_{21} - E_{35})\rvert$		85	--	dB
	CMR	4003	38	3/	Calculate value using data from tests 22 and 23								$CMR = 20 \log\lvert 3 \times 10^4/(E_{19} - E_{20})\rvert$		85	--	dB
	V_{IO} ADJ(+)		39		20 V	-20 V	Open	0 V	K7	5	E_{36}	V	V_{IO} ADJ(+) = $(E_{21} - E_{36})$		8	--	mV
	V_{IO} ADJ(-)		40		20 V	-20 V		0 V	K6, K7		E_{37}	V	V_{IO} ADJ(-) = $(E_{21} - E_{37})$		--	-8	mV
	$I_{OS(+)}$	3011	41	5/	15 V	-15 V		-10 V	None	6	I_4	mA	$I_{OS(+)} = I_4$		-50	--	mA
	$I_{OS(-)}$	3011	42	5/	15 V	-15 V		10 V	None		I_5	mA	$I_{OS(-)} = I_5$		--	50	mA
	I_{CC}	3005	43		15 V	-15 V		0 V	None	2	I_6	mA	$I_{CC} = I_6$	01, 04	---	4	mA
														02, 03, 05, 06	---	7	

See notes at end of

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

Subgroup	Symbol	MIL-STD-883 method	Test no.	Notes	Adapter pin numbers 1	2	3	4	Energized relays	Measured pin No.	Value	Units	Equation 1/	Device type	Limits Min.	Max.	Units
$(T_A = -55°C)^3$	V_{IO}	4001	44	2/	35 V	-5 V	Open	-15 V	None	5	E_{38}	V	$V_{IO} = E_{38}$	01, 02, 03	-7	7	mV
			45		5 V	-35 V		15 V			E_{39}		$V_{IO} = E_{39}$				
			46		20 V	-20 V		0 V			E_{40}		$V_{IO} = E_{40}$	04, 05, 06	-2.5	2.5	
			47		5 V	-5 V		0 V			E_{41}		$V_{IO} = E_{41}$				
	$\Delta V_{IO}/\Delta T$		48	6/	$\Delta V_{IO}/\Delta T = [V_{IO}(\text{Test 46}) - V_{IO}(\text{Test 3})]/80°C$									01, 02, 03	-30	30	µV/°C
														04, 05, 06	-10	10	
	+PSRR	4003	49		10 V	-20 V	Open	0 V	None	5	E_{42}	V	$+PSRR = 20 \log\lvert 10^4/(E_{40} - E_{42})\rvert$	A11	85	--	dB
	-PSRR	4003	50		20 V	-10 V	Open	0 V	None	5	E_{43}	V	$-PSRR = 20 \log\lvert 10^4/(E_{40} - E_{43})\rvert$		85	--	dB
	CMR	4003	51	3/	Calculate value using data from tests 44 and 45								$CMR = 20 \log\lvert 3X10^4/(E_{38} - E_{39})\rvert$		85	--	dB
	$V_{IO\ ADJ(+)}$		52		20 V	-20 V	Open	0 V	K7	5	E_{44}	V	$V_{IO\ ADJ(+)} = (E_{40} - E_{44})$		8	--	mV
	$V_{IO\ ADJ(-)}$		53		20 V	-20 V		0 V	K6, K7	5	E_{45}	V	$V_{IO\ ADJ(-)} = (E_{40} - E_{45})$		--	-8	mV
	$I_{OS(+)}$	3011	54	5/	15 V	-15 V		-10 V	None	6	I_7	mA	$I_{OS(+)} = I_7$		-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
$(T_A = 25°C)^4$	$+V_{OP}$	4004	57		20 V	-20 V	Open	-20 V	K3	6	$(E_o)_1$	V	$+V_{OP} = (E_o)_1$		16	--	V
	$-V_{OP}$		58					20 V	K3		$(E_o)_2$		$-V_{OP} = (E_o)_2$		--	-16	
	$+V_{OP}$		59					-20 V	K4		$(E_o)_3$		$+V_{OP} = (E_o)_3$		15	--	
	$-V_{OP}$		60					20 V			$(E_o)_4$		$-V_{OP} = (E_o)_4$		--	-15	
	$A_{VS(+)}$		61	4/				-15 V		5	E_{46}		$A_{VS(+)} = 15/(E_3 - E_{46})$		50	--	V/mV
	$A_{VS(-)}$		62	4/				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	--	
					5 V	-5 V		2 V			E_{49}						

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 1	2	3	4	Energized relays	Measured pin No.	Value	Units	Equation 1/	Device type	Limits Min.	Max.	Units
(T_A = 125°C) 5	$+V_{OP}$	4004	64		20 V	-20 V	Open	-20 V	K3	6	$(E_0)_5$	V	$+V_{OP} = (E_0)_5$	All	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	4/				-15 V		5	E_{50}		$A_{VS(+)} = 15/(E_{21} - E_{50})$		25	--	V/mV
	$A_{VS(-)}$		69	4/				15 V			E_{51}		$A_{VS(-)} = 15/(E_{51} - E_{21})$		25	--	
	A_{VS}		70		-5 V	5 V		-2 V			E_{52}		$A_{VS} = 4/(E_{53} - E_{52})$		10	--	
								2 V			E_{53}						
(T_A = -55°C) 6	$+V_{OP}$		71		20 V	-20 V	Open	-20 V	K3	6	$(E_0)_9$		$+V_{OP} = (E_0)_9$		16	--	V
	$-V_{OP}$		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	4/				-15 V		5	E_{54}		$A_{VS(+)} = 15/(E_{40} - E_{54})$		25	--	V/mV
	$A_{VS(-)}$		76	4/				15 V			E_{55}		$A_{VS(-)} = 15/(E_{55} - E_{40})$		25	--	
	A_{VS}		77		5 V	-5 V		-2 V			E_{56}		$A_{VS} = 4/(E_{57} - E_{56})$		10	--	
								2 V			E_{57}						
(T_A = 25°C) 7	TR(tr)		78		15 V	-15 V	+50 mV	Open	None	6	Δtr	ns	TR(tr) = Δt_1 (see figure 8)	01, 04	---	150	ns
									K9		Δtr	ns		02, 05	---	100	
														03, 06	---	450	
	TR(os)		79						None		V_{01}	mV	TR(os) = 100 ($\Delta V_{01}/V_{01}$) (See figure 8)	01, 02, 04, 05	---	40	%
									K9		ΔV_{01}	mV		03, 06	---	25	
	SR(+)	4002	80	8/			See notes		None		$\Delta V_{01}(+)$	V	SR(+) = $\Delta V_{01}(+)/\Delta t_1(+)$	01	2	---	V/µs
														02	7.5	---	
														04	3	---	
														05	10	---	
				9/					K9		$\Delta t_1(+)$	µs	(see figure 8)	03	30	---	
														06	40	---	

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 1	2	3	4	Energized relays	Measured pin No.	Value	Units	Equation 1/	Device type	Limit Min.	Max.	Units
$T_A = 25°C$ [7]	SR(-)	4002	81	8/	15 V	-15 V	See notes	Open	None	6	$\Delta V_{01}(-)$	V	$SR(-) = \Delta V_{01}(-)/\Delta t_1(-)$	01	2	---	$V/\mu s$
														02	7.5	---	
														04	3	---	
														05	10	---	
				9/					K9		$\Delta t_1(-)$	μs	(see figure 8)	03	30	---	
														06	40	---	
$(T_A = 25°C)$ [7]	NI(BB)		82	7/	20 V	-20 V	Open	0 V	K5	6	$(E_0)_{13}$	mVrms	$NI(BB) = (E_0)_{13}/1000$	All	---	10	$\mu Vrms$
	NI(PC)		83	7/	20 V	-20 V	Open	0 V	K1,K2,K5,K8		$(E_0)_{14}$	mVpk	$NI(PC) = (E_0)_{14}/1000$	All	---	40	μVpk
$(T_A = 125°C)$ [8]	TR(tr)		84		15 V	-15 V	+50 mV	Open	None		Δt_2	ns	$TR(tr) = \Delta t_2$	01, 04	---	150	ns
														02, 05	---	100	
									K9				(See figure 8)	03, 06	---	450	
	TR(os)		85						None		V_{02},	mV	$TR(os) = 100\ (\Delta V_{02}/V_{02})$	01, 02, 04, 05	---	40	%
									K9		ΔV_{02}	mV	(See figure 8)	03, 06	---	25	
	SR(+)	4002	86	8/			See		None		$\Delta V_{02}(+)$	V,	$SR(+) = \Delta V_{02}(+)/\Delta t_2(+)$	01	1	---	$V/\mu s$
				9/			notes		K9		$\Delta t_2(+)$	μs	(See figure 8)	02	5	---	
														04	1.5	---	
														05	7	---	
														03	20	---	
														06	25	---	
	SR(-)		87	8/					None		$\Delta V_{02}(-)$	V,	$SR(-) = \Delta V_{02}(-)/\Delta t_2(-)$	01	1	---	
				9/					K9		$\Delta t_2(-)$	μs	(See figure 8)	02	5	---	
														04	1.5	---	
														05	7	---	
														03	20	---	
														06	25	---	
$(T_A = -55°C)$ [8]	TR(tr)		88		-15 V	-15 V	+50 mV	Open	None	6	Δt_3	ns	$TR(tr) = \Delta t_3$	01, 04	---	150	ns
														02, 05	---	100	
									K9		Δt_3	ns	(See figure 8)	03, 06	---	450	
	TR(os)		89						None		V_{03},	mV	$TR(os) = 100\ (\Delta V_{03}/V_{03})$	01, 02, 04, 05	---	40	%
									K9		ΔV_{03}		(See figure 8)	03, 06	---	25	
	SR(+)	4002	90	8/			See		None		$\Delta V_{C3}(+)$	V,	$SR(+) = \Delta V_{03}(+)/\Delta t_3(+)$	01	1	---	$V/\mu s$
				9/			notes		K9		$\Delta t_3(+)$	μs	(See figure 8)	02	5	---	
														04	1.5	---	
														05	7	---	
														03	20	---	
														06	25	---	
	SR(-)		91	8/					None		$\Delta V_{C3}(-)$	V,	$SR(-) = \Delta V_{03}(-)/\Delta t_3(-)$	01	1	---	
				9/					K9		$\Delta t_3(-)$	μs	(See figure 8)	02	5	---	
														04	1.5	---	
														05	7	---	
														03	20	---	
														06	25	---	
$(T_A = 25°C)$ [12]	$t_s(+)$	4002	92		15 V	-15 V		Open	None	5	$t_s(+)$	ns	(See figure 9)	01, 02, 04, 05	---	1500	ns
														03, 06	---	800	
	$t_s(-)$		93		15 V	-15 V				5	$t_s(-)$	ns	(See figure 9)	01, 02, 04, 05	---	1500	
														03, 06	---	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°C, $\pm V_{CC}$ = $\pm$20 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.