INCH-POUND
MIL-M-38510/131A
21 October 2003
SUPERSEDING
MIL-M-38510/131
15 July 1982

MILITARY SPECIFICATION

MICROCIRCUITS, LINEAR, LOW NOISE OPERATIONAL AMPLIFIERS, MONOLITHIC SILICON

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

Reactivated after 21 October 2003 and may be used for either new or existing design acquisition.

The requirement for acquiring the product herein shall consist of this specification sheet and MIL-PRF-38535.

1. SCOPE

1.1 Scope. This specification covers the detail requirements for monolithic silicon, low noise operational amplifiers. Two product assurance classes and a choice of case outlines and lead finishes are provided and are reflected in the complete part number. For this product, the requirements of MIL-M-38510 have been superseded by MIL-PRF-38535, (see 6.3)

1.2 Part or identifying Number (PIN). The PIN number should be in accordance with MIL-PRF-38535, and as specified herein.

1.2.1 Device types. The device types should be as follows:

Device type	Circuit
01	Single operational amplifier, low noise, undercompensated
02	Dual operational amplifier, low noise, compensated

1.2.2 Device class. The device class should be the product assurance level as defined in MIL-PRF-38535.

1.2.3 Case outline. The case outline should be as designated in MIL-STD-1835 and as follows:

Outline letter	Descriptive designator	Terminals	Package style
G	MACY1-X8	8	Can
P	GDIP1-T8 or CDIP2-T8	8	Dual-in-line

Comments, suggestions, or questions on this document should be addressed to: Commander, Defense Supply Center Columbus, ATTN: DSCC-VAS, 3990 East Broad St., Columbus, OH 43216-5000, or emailed to linear@dscc.dla.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at www.dodssp.daps.mil.

1.3 Absolute maximum ratings.

Supply voltage (V_{CC}) ..... ±22 V
Input voltage (V_{IN}) ..... $\pm V_{CC}$
Differential input voltage range ..... ±0.5 V
Output short-circuit duration 1/
Lead temperature (soldering, 60 seconds) ..... +300°C
Storage temperature range ..... -65°C to +150°C
Junction temperature (T_J) ..... +175°C

1.4 Recommended operating conditions.

Supply voltage range ..... ±3.0 V dc to ±20.0 V
Ambient operating temperature range (T_A) ..... -55°C to +125°C

1.5 Power and thermal characteristics.

Case outlines	Maximum allowable 2/ power dissipation	Maximum θ_{JC}	Maximum θ_{JA}
G	330 mW at T_A = +125°C	40°C/W	150°C/W
P	400 mW at T_A = +125°C	35°C/W	120°C/W

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, or 5 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, or 5 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications and standards form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-PRF-38535 - Integrated Circuits (Microcircuits) Manufacturing, General Specification for.

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-883 - Test Method Standard for Microelectronics.
MIL-STD-1835 - Interface Standard Electronic Component Case Outlines.

(Copies of these documents are available online at http://assist.daps.dla.mil;quicksearch/ or www.dodssp.daps.mil or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

1/ Output may be shorted to ground indefinitely at V_S = ±15 volts, T_A = 25°C. Temperature and/or supply voltages must be limited to ensure dissipation rating is not exceeded.
2/ All leads welded or soldered to P.C. board.

2.3 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein the text of this document shall takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Qualification. Microcircuits furnished under this specification shall be products that are manufactured by a manufacturer authorized by the qualifying activity for listing on the applicable qualified manufacturers list before contract award (see 4.3 and 6.4).

3.2 Item requirements. The individual item requirements shall be in accordance with MIL-PRF-38535 and as specified herein or as modified in the device manufacturer's Quality Management (QM) plan. The modification in the QM plan shall not affect the form, fit, or function as described herein.

3.3 Design, construction, and physical dimensions. The design, construction, and physical dimensions shall be as specified in MIL-PRF-38535 and herein.

3.3.1 Terminal connections and logic diagram. The terminal connections and logic diagram shall be as specified on figure 1.

3.3.2 Schematic circuits. The schematic circuits shall be maintained by the manufacturer and made available to the qualifying activity and the preparing activity upon request.

3.3.3 Case outlines. The case outlines shall be as specified in 1.2.3.

3.4 Lead material and finish. The lead material and finish shall be in accordance with MIL-PRF-38535 (see 6.6).

3.5 Electrical performance characteristics. The electrical performance characteristics are as specified in table I, and unless otherwise specified, apply over the full recommended ambient operating temperature range for supply voltages from ±3 V dc to ±20 V dc. Unless otherwise specified, source resistance (R_S) shall be 50 ohms for all tests. For dual packages the idle device shall be connected as a ground follower.

3.5.1 Offset null circuits. The nulling inputs shall be capable of being nulled 1 mV beyond the specified offset voltage limits for $-55°C \le T_A \le 125°C$ using the circuit of figure 2.

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

3.6 Electrical test requirements. Electrical test requirements for each device class shall be the subgroups specified in table II. The electrical tests for each subgroup are described in table III.

3.7 Marking. Marking shall be in accordance with MIL-PRF-38535.

3.8 Microcircuit group assignment. The devices covered by this specification shall be in microcircuit group number 49 (see MIL-PRF-38535, appendix A).

TABLE I. Electrical performance characteristics.

Test	Symbol	Conditions $-55°C \le T_A \le +125°C$ $\pm V_{CC} = \pm 15$ V, see figure 3 and paragraph 3.5 unless otherwise specified	Group A subgroups	Device type	Limits		Unit
					Min	Max	
Input offset voltage	V_{IO}	1/	1	01,02	-2	2	mV
			2,3		-3	3	
Input offset voltage temperature sensitivity	$\Delta V_{IO}/\Delta t$		2,3	01,02	-10	10	µV/°C
Input bias current	$+I_{IB}$	1/	1	01,02	-800	800	nA
			2,3		-1500	1500	
	$-I_{IB}$		1		-800	800	
			2,3		-1500	1500	
Input offset current	I_{IO}	1/	1	01,02	-200	200	nA
			2,3		-500	500	
Power supply rejection ratio	+PSRR	$+V_{CC}$ = +20 V to +10 V, $-V_{CC}$ = -15 V	1,2,3	01,02	85		dB
	-PSRR	$+V_{CC}$ = +15 V, $-V_{CC}$ = -20 V to -10 V			85		
Common mode rejection ratio	CMRR	$V_{CM} = \pm 11$ V	1,2,3	01,02	80		dB
Adjustment for input offset	V_{IO} (ADJ+)		1,2,3	01	+4		mV
	V_{IO} (ADJ-)					-4	
Output short circuit current	$I_{OS(+)}$	$t \le 25$ ms 4/	1,2,3	01,02	-95		mA
	$I_{OS(-)}$	$t \le 25$ ms 4/				+95	
Supply current	I_{CC}		1	01		6.5	mA
				02		11.0	
			2,3	01		9.0	
				02		13.0	

See footnotes at end of table.

TABLE I. Electrical performance characteristics – Continued.

Test	Symbol	Conditions $-55°C \le T_A \le +125°C$ $\pm V_{CC} = \pm 15$ V, see figure 3 and paragraph 3.5 unless otherwise specified	Group A subgroups	Device type	Limits		Unit
					Min	Max	
Output voltage swing (maximum)	V_{OP}	$R_L = 600\ \Omega$	4,5,6	01	-10	10	V
		$R_L = 2000\ \Omega$		01,02	-12	12	
Output loop voltage gain (single ended)	$A_{VS(\pm)}$	2/	4	01,02	50		V/mV
			5,6		25		
Output loop voltage gain (single ended)	A_{VS}	3/	4	01,02	50		V/mV
			5,6		25		
Slew rate	SR(+) and SR(-)	$V_{IN} = 10$ V	7,8	01	10		V/µs
				02	3		
Settling time	ts(+) and ts(-)	$A_V = -1$, $R_L = 600\ \Omega$, $C_L = 100$ pF, 0.1 % error, $T_A = +25°C$, see figure 5	12	01,02		4	µs
Transient response (rise time)	$T_{R(tr)}$	$A_V = +1$, $R_L = 600\ \Omega$, $C_L = 100$ pF, see fig. 4	7,8	01,02		40	ns
Transient response (overshoot)	$T_{R(os)}$	$A_V = +1$, $R_L = 600\ \Omega$, $C_L = 100$ pF, see fig. 4	7,8	01,02		40	%
Input noise voltage density	EN	$f_o = 30$ Hz, see fig. 6	4,7	01,02		15	nV/$\sqrt{\text{Hz}}$
		$f_o = 100$ Hz				9	
		$f_o = 1$ kHz				5.5	
		$f_o = 10$ kHz				5.0	
Input noise current density	IN	$f_o = 30$ Hz, see fig. 6	7	01,02		10	pA/Hz
		$f_o = 100$ Hz				5	
		$f_o = 1$ kHz				2	
		$f_o = 10$ kHz				2	

See footnotes at end of table.

TABLE I. Electrical performance characteristics – Continued.

Test	Symbol	Conditions $-55°C \le T_A \le +125°C$ $\pm V_{CC} = \pm 15$ V, see figure 3 and paragraph 3.5 unless otherwise specified	Group A subgroups	Device type	Limits		Unit
					Min	Max	
Broadband input noise voltage	$N_{I(BB)}$	f = 10 Hz – 10 kHz, $R_S = 50\ \Omega$, see fig. 7	7	01,02		500	nV rms
Channel separation	CS	See fig. 8	7	02	80		dB

1/ Tested at a) $V_{CM} = 0$ V, $V_{CC} = \pm 5$ V, b) $V_{CM} = \pm 12$ V, $V_{CC} = \pm 15$ V, c) $V_{CM} = 0$ V, $V_{CC} = \pm 15$ V.

2/ $V_{OUT} = 0$ to +10 for $A_{VS(+)}$ and $V_{OUT} = 0$ to –10 for $A_{VS(-)}$. $R_L = 600\ \Omega$ for device type 01 and $R_L = 2\ k\Omega$ for device type 02.

3/ Tested at a) $V_{CC} = \pm 5$ V, $V_{OUT} = \pm 2$ V, $R_L = 600\ \Omega$ for device type 01, b) $V_{CC} = \pm 5$ V, $V_{OUT} = \pm 2$ V, $R_L = 2000\ \Omega$ for device types 01 and 02.

4/ Continuous short circuit limits are considerably less than the indicated test limits since maximum power dissipation cannot be exceeded.

TABLE II. Electrical test requirements.

MIL-PRF-38535 test requirements	Subgroups (see table III)	
	Class S devices	Class B devices
Interim electrical parameters	1	1
Final electrical test parameters	1*, 2, 3, 4	1*, 2, 3, 4
Group A test requirements	1, 2, 3, 4, 5, 6, 7, 8, 12**	1, 2, 3, 4, 5, 6, 7
Group B electrical test parameters when using the method 5005 QCI option	1, 2, 3 and table IV delta limits	N/A
Group C end-point electrical parameters	1, 2, 3 and table IV delta limits	1 and table IV delta limits
Additional electrical subgroups for group C periodic inspection	N/A	8, 12
Group D end-point electrical parameters	1, 2, 3	1

* PDA applies to subgroup 1.
** See 4.4.1c

4. VERIFICATION.

4.1 Sampling and inspection. Sampling and inspection procedures shall be in accordance with MIL-PRF-38535 or as modified in the device manufacturer's Quality Management (QM) plan. The modification in the QM plan shall not effect the form, fit, or function as function as described herein.

4.2 Screening. Screening shall be in accordance with MIL-PRF-38535, and shall be conducted on all devices prior to qualification and quality conformance inspection. The following additional criteria shall apply:

a. The burn-in test duration, test condition, and test temperature, or approved alternatives shall be as specified in the device manufacturer's QM plan in accordance with MIL-PRF-38535. The burn-in test circuit shall be maintained under document control by the device manufacturer's Technology Review Board (TRB) in accordance with MIL-PRF-38535 and shall be made available to the acquiring or preparing activity upon request. The test circuit shall specify the inputs, outputs, biases, and power dissipation, as applicable, in accordance with the intent specified in test method 1015 of MIL-STD-883.

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.

b. Interim and final electrical test parameters shall be as specified in table II, except interim electrical parameters test prior to burn-in is optional at the discretion of the manufacturer.

c. Additional screening for space level product shall be as specified in MIL-PRF-38535.

d. Reverse bias burn-in shall apply to class S devices only.

4.3 Qualification inspection. Qualification inspection shall be in accordance with MIL-PRF-38535.

4.4 Technology Conformance inspection (TCI). Technology conformance inspection shall be in accordance with MIL-PRF-38535 and herein for groups A, B, C, and D inspections (see 4.4.1 through 4.4.4).

4.4.1 Group A inspection. Group A inspection shall be in accordance with table III of MIL-PRF-38535 and as follows:

a. Tests shall be as specified in table II herein.

b. Subgroups 9, 10, and 11 shall be omitted.

c. A special subgroup shall be added to group A inspection for class S devices only and shall consists of the tests, conditions, and limits of subgroup 12 as shown in table III herein.

4.4.2 Group B inspection. Group B inspection shall be in accordance with table II of MIL-PRF-38535.

4.4.3 Group C inspection. Group C inspection shall be in accordance with table III of MIL-PRF-38535 and as follows:

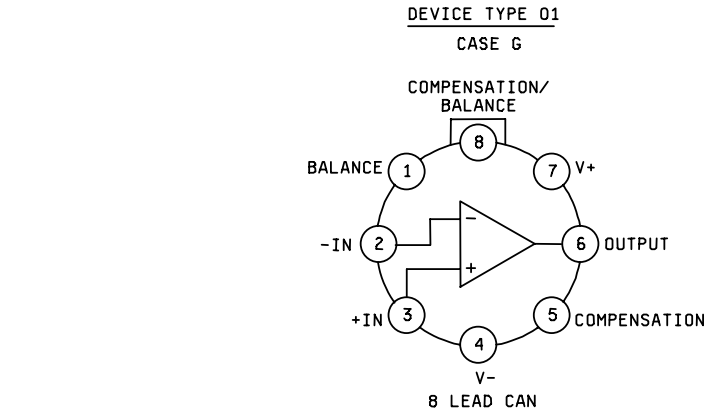
a. End point electrical parameters shall be as specified in table II herein.

b. The steady-state life test duration, test condition, and test temperature, or approved alternatives shall be as specified in the device manufacturer's QM plan in accordance with MIL-PRF-38535. The burn-in test circuit shall be maintained under document control by the device manufacturer's Technology Review Board (TRB) in accordance with MIL-PRF-38535 and shall be made available to the acquiring or preparing activity upon request. The test circuit shall specify the inputs, outputs, biases, and power dissipation, as applicable, in accordance with the intent specified in test method 1005 of MIL-STD-883.

4.4.4 Group D inspection. Group D inspection shall be in accordance with table IV of MIL-PRF-38535. End point electrical parameters shall be as specified in table II herein.

4.5 Methods of inspection. Methods of inspection shall be specified and as follows.

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 and positive when flowing into the referenced terminal.



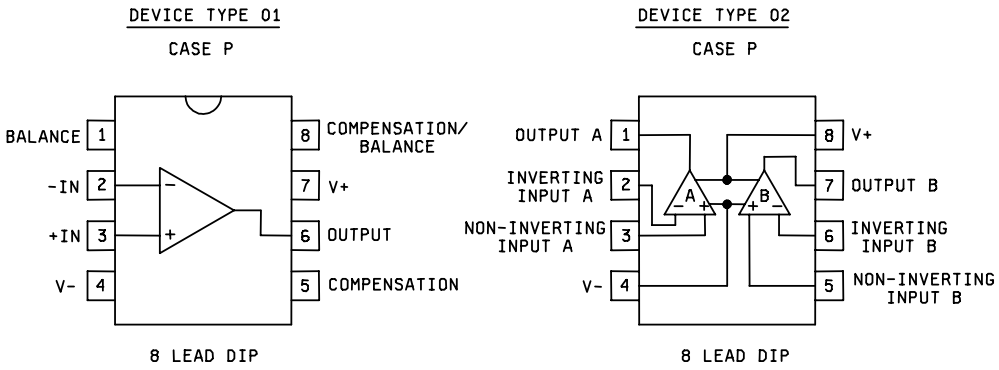


Figure 1. Terminal connections and logic diagram.

DEVICE TYPE 01

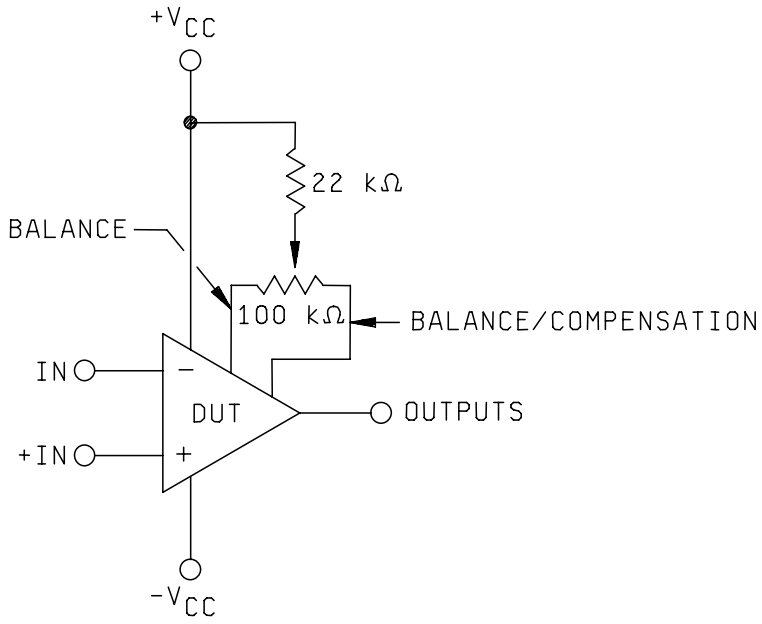
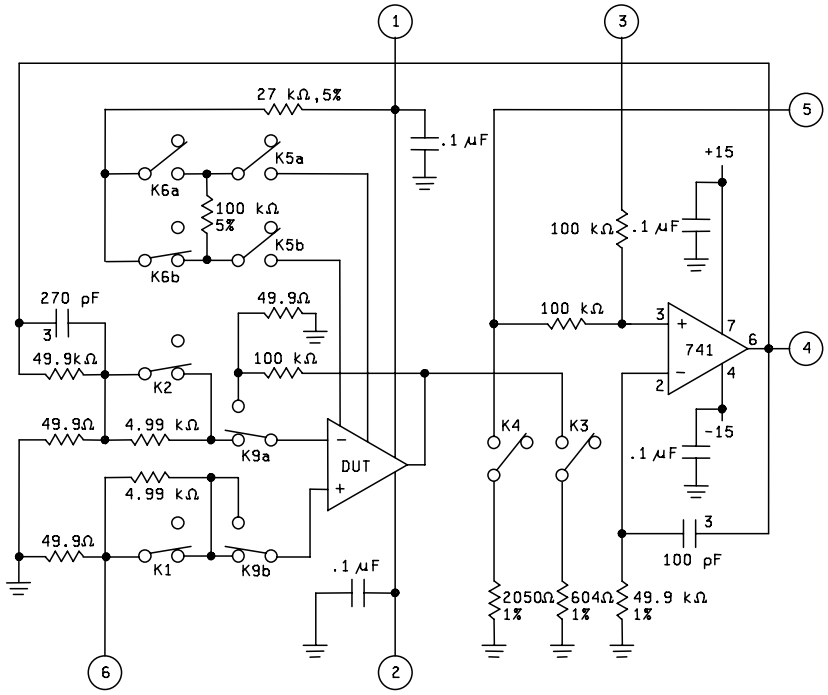


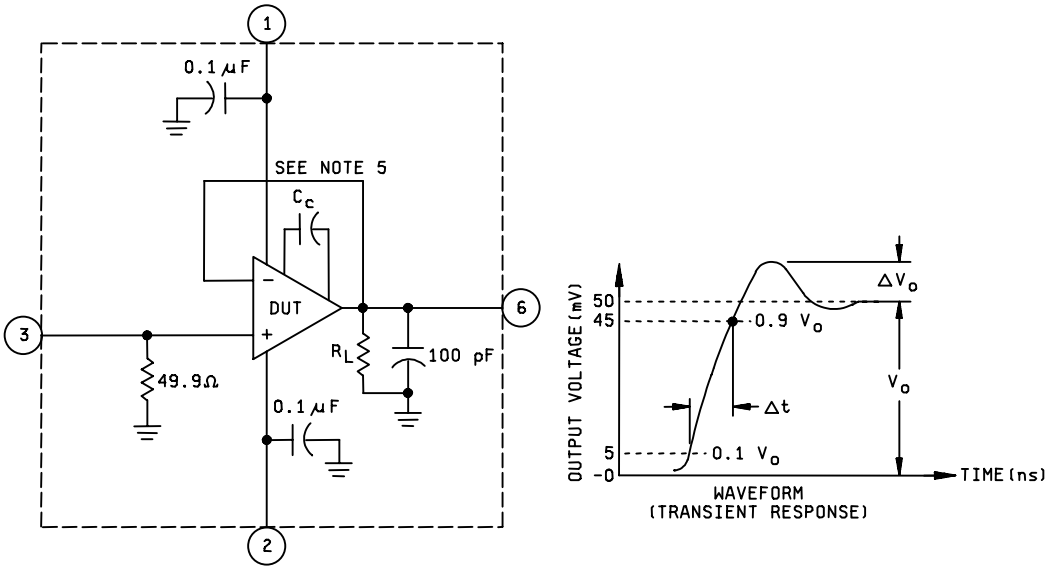
FIGURE 2. Offset null circuit.



NOTES:

1. All resistors are ±0.1 % tolerance and all capacitors are ±10% unless specified otherwise.
2. Precautions shall be taken to prevent damage to the device under test (DUT) during insertion into socket and change of relay state (example: disable voltage supplies, current limit $\pm V_{CC}$, etc.).
3. Compensation capacitors should be added as required for test circuit stability. 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. Saturation of the nulling amp is not allowed on tests where the pin 4 (V-) value is measured.
7. The load resistors 604 Ω and 2050 Ω yield effective load resistances of 600 Ω and 2000 Ω respectively.
8. Any oscillation greater than 300 mV pk-pk is amplitude shall be cause for device failure.
9. Selection relays for dual devices are not shown.

FIGURE 3. Test circuit for static tests and slew rate.

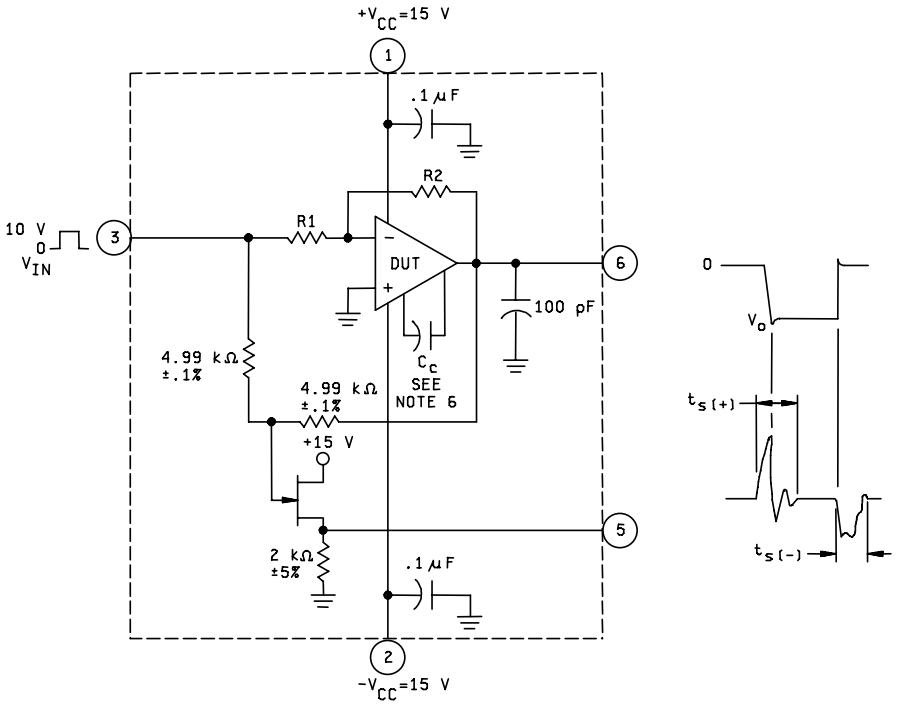


Parameter symbol	Input pulse signal at tr ≤ 50 ns	Equation
TR (tr)	+50 mV	TR (tr) = Δt
TR (os)	+50 mV	TR (os) = 100 (ΔV_O / V_O)

NOTES:

1. Resistors are ±1% tolerance and capacitors are 10% tolerance.
2. Precaution should be taken to prevent damage to the D.U.T. suring insertion into socket and in applying power.
3. R_L = 604 Ω and C_C = 22 pF.
4. Selection circuitry for dual devices is not shown.
5. Device type 01 only.
6. C_L includes scope, probe, and jig capacitance.

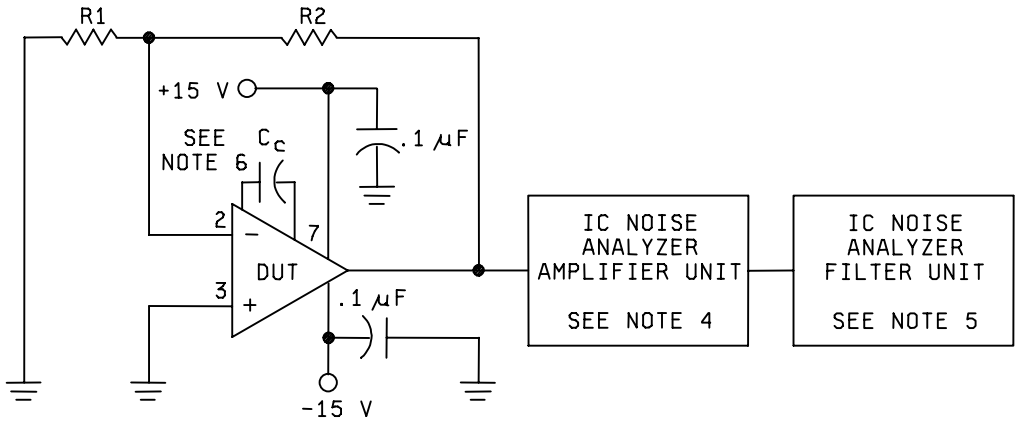
FIGURE 4. Test circuit for transient response.



NOTES:

1. Resistors are ±1% and capacitors are ±10% unless otherwise specified.
2. Precaution should be taken to prevent damage to the D.U.T. during insertion into the socket and in applying power.
3. Selection circuitry for dual devices is not shown.
4. Settling time, as measured on pin 5, is defined as the interval of time during which the summing node is not nulled.
5. R1 = R2 = 604 Ω and C_C = 22 pF.
6. Device type 01 only.
7. C_L includes scope, probe, and jig capacitance.

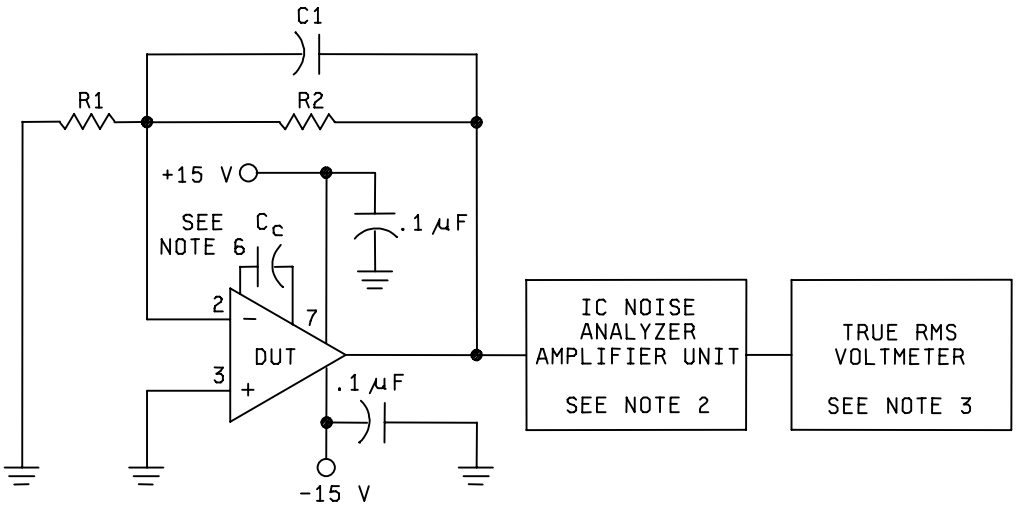
FIGURE 5. Test circuit for settling time.



NOTES:

1. Input noise voltage density (En) test: R1 = 50 Ω, R2 = 10 kΩ.
2. Input noise current density (In) test: R1 = 105 kΩ, R2 = 2.0 MΩ.
3. All resistors are metal film and ±1 % tolerance. Capacitors are ±10 % tolerance.
4. Quan-Tech model 2283 or equivalent.
5. Quan-Tech model 2181 or equivalent.
6. C_C = 20 pF, device type 01 only.

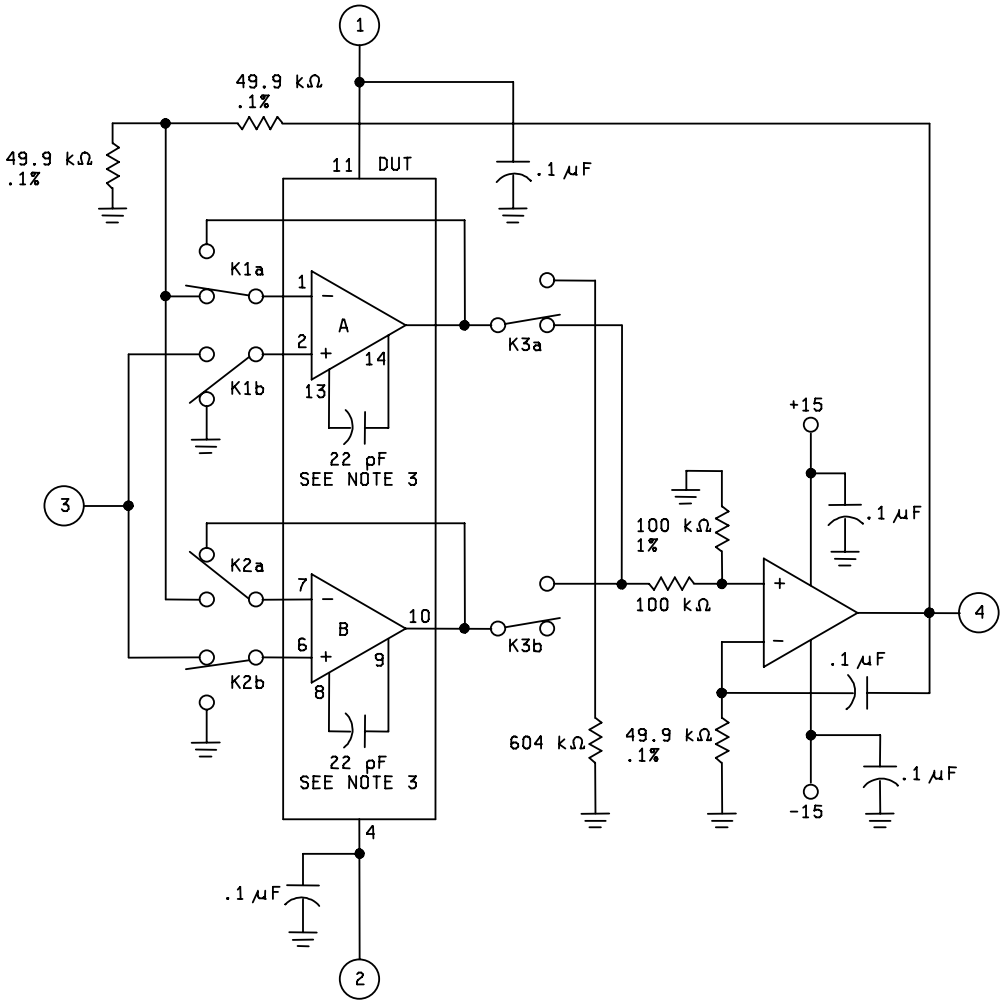
FIGURE 6. Noise density test circuit.



NOTES:

1. All resistors are metal film and ±1 % tolerance. Capacitors are ±10 % tolerance.
2. Quan-Tech model 2283 or equivalent. Bandwidth must be 10 Hz to 20 kHz minimum. Gain = 50
3. Bandwidth must be 10 Hz to 20kHz minimum.
4. Effective circuit noise bandwidth is 10 kHz.
5. R1 = 50 Ω, R2 = 10 kΩ, C1 = 2500 pF.
6. C_C = 22 pF, device type 01 only.

FIGURE 7. Broadband noise test circuit.



NOTES:

1. Capacitors are ±10 % tolerance.
2. All relay contacts are shown in the normal de-energized state.
3. Device type 01 only.

FIGURE 8. Test circuit for channel separation.

TABLE III. Group A inspection for all device types.

Subgroup	Symbol	MIL-STD-883 method	Test no.	Notes	Adapter pin number			Energized relays	Measured pin			Equation	Limits		Unit
					1	2	3		No.	Value	Units		Min	Max	
1 T_A = +25°C	V_{IO}	4001	1	6/	26	-4	-11	None	4	E1	V	V_{IO} = E1	-2	2	mV
		"	2		4	-26	11	"	"	E2	"	V_{IO} = E2	"	"	"
		"	3		15	-15	0	"	"	E3	"	V_{IO} = E3	"	"	"
		"	4		5	-5	0	"	"	E4	"	V_{IO} = E4	"	"	"
	$+I_{IB}$	4001	5		26	-4	-11	K1	"	E5	"	$+I_{IB}$ = 200 (E1 – E5)	-800	800	nA
		"	6		15	-15	0	K1	"	E6	"	$+I_{IB}$ = 200 (E3– E6)	"	"	"
		"	7		4	-26	11	K1	"	E7	"	$+I_{IB}$ = 200 (E2 – E7)	"	"	"
	$-I_{IB}$	"	8		26	-4	-11	K2	"	E8	"	$-I_{IB}$ = 200 (E8 – E1)	-800	800	"
		"	9		15	-15	0	K2	"	E9	"	$-I_{IB}$ = 200 (E9 – E2)	"	"	"
		"	10		4	-26	11	K2	"	E10		$-I_{IB}$ = 200 (E10 – E3)	"	"	"
	I_{IO}	"	11	1/								I_{IO} = 200 (2E3 – E6 –E9)	-200	200	nA
	+PSRR	4003	12		20 10	-15 -15	0 0	None	4	E11 E12	V "	+PSRR = 20 log (10000/(E11 – E12))	85		dB
	-PSRR	4003	13		15 15	-20 -10	0 0	None	4	E13 E14	V "	-PSRR = 20 log (10000/(E13 – E14))	85		dB
	CMRR	4003	14	2/								CMRR = 20 log (24000/(E1 – E2))	80		dB
	V_{IO} ADJ(+)		15	01 only	15	-15	0	K5	4	E15	"	V_{IO} ADJ(+) = E3 – E15	4		mV
	V_{IO} ADJ(-)		16	01 only	15	-15	0	K5,K6	4	E16	"	V_{IO} ADJ(-) = E3 – E16		-4	mV
	$I_{OS(+)}$	3011	17	3/	12	-12	-10	None	5	I1	mA	$I_{OS(+)}$ = I1	-95		mA
	$I_{OS(-)}$	3011	18	3/	12	-12	10	None	5	I2	mA	$I_{OS(-)}$ = I2		95	mA
	I_{CC}	4005	19		15	-15	0	None		I3	mA	I_{CC} = I3 Device 01		6.5	mA
												Device 02		11.0	mA
2 T_A = +125°C	V_{IO}	4001	20		26	-4	-11	None	4	E17	V	V_{IO} = E17	-3	3	mV
		"	21		4	-26	11	"	"	E18	"	V_{IO} = E18	"	"	"
		"	22		15	-15	0	"	"	E19	"	V_{IO} = E19	"	"	"
		"	23		5	-5	0	"	"	E20	"	V_{IO} = E20	"	"	"
	$\Delta V_{IO}/\Delta t$	"	24	4/								$\Delta V_{IO} / \Delta t$ = 10 (E19 – E3)	-10	10	µV/°C
	$+I_{IB}$	4001	25		26	-4	-11	K1	4	E21	"	$+I_{IB}$ = 200 (E17 – E21)	-1500	1500	nA
		"	25		15	-15	0	K1	"	E22	"	$+I_{IB}$ = 200 (E19– E22)	"	"	"
		"	27		4	-26	11	K1	"	E23	"	$+I_{IB}$ = 200 (E18 – E23)	"	"	"
	$-I_{IB}$	"	28		26	-4	-11	K2	"	E24	"	$-I_{IB}$ = 200 (E24 – E17)	-1500	1500	"
		"	29		15	-15	0	K2	"	E25	"	$-I_{IB}$ = 200 (E25 – E19)	"	"	"
		"	30		4	-26	11	K2	"	E26		$-I_{IB}$ = 200 (E26 – E18)	"	"	"
	I_{IO}	"	31	1/								I_{IO} = 200 (2E19 – E22 –E23)	-500	500	nA

See footnotes 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 number			Energized relays	Measured pin			Equation	Limits		Unit
					1	2	3		No.	Value	Units		Min	Max	
2 T_A = +125°C	+PSRR	4003	32		20 10	-15 -15	0 0	None	4	E27 E28	V “	+PSRR = 20 log (10000/(E27 – E28))	85		dB
	-PSRR	4003	33		15 15	-20 -10	0 0	None	4	E29 E30	V “	-PSRR = 20 log (10000/(E29 – E30))	85		dB
	CMRR	4003	34	2/								CMRR = 20 log (24000/(E17 – E18))	80		dB
	V_{IO} ADJ(+)		35	01 only	15	-15	0	K5	4	E31	V	V_{IO} ADJ(+) = E19 – E31	4		mV
	V_{IO} ADJ(-)		36	01 only	15	-15	0	K5,K6	4	E32	“	V_{IO} ADJ(-) = E19 – E32		-4	mV
	$I_{OS(+)}$	3011	37	3/	12	-12	-10	None	5	I4	mA	$I_{OS(+)}$ = I4	-95		mA
	$I_{OS(-)}$	3011	38	3/	12	-12	10	None	5	I5	mA	$I_{OS(-)}$ = I5		95	mA
	I_{CC}	4005	39		15	-15	0	None		I6	mA	I_{CC} = I6 Device 01		9	mA
												Device 02		13.0	mA
3 T_A = -55°C	V_{IO}	4001	40		26	-4	-11	None	4	E33	V	V_{IO} = E33	-3	3	mV
		“	41		4	-26	11	“	“	E34	“	V_{IO} = E34	“	“	“
		“	42		15	-15	0	“	“	E35	“	V_{IO} = E35	“	“	“
		“	43		5	-5	0	“	“	E36	“	V_{IO} = E36	“	“	“
	$\Delta V_{IO}/\Delta t$	“	44	4/								$\Delta V_{IO} / \Delta t$ = 12.5 (E35 – E3)	-10	10	µV/°C
	$+I_{IB}$	4001	45		26	-4	-11	K1	4	E37	“	$+I_{IB}$ = 200 (E33 – E37)	-1500	1500	nA
		“	46		15	-15	0	K1	“	E38	“	$+I_{IB}$ = 200 (E34 – E38)	“	“	“
		“	47		4	-26	11	K1	“	E39	“	$+I_{IB}$ = 200 (E35 – E39)	“	“	“
	$-I_{IB}$	“	48		26	-4	-11	K2	“	E40	“	$-I_{IB}$ = 200 (E40 – E33)	-1500	1500	“
		“	49		15	-15	0	K2	“	E41	“	$-I_{IB}$ = 200 (E41 – E34)	“	“	“
		“	50		4	-26	11	K2	“	E42		$-I_{IB}$ = 200 (E42 – E35)	“	“	“
	I_{IO}	“	51	1/								I_{IO} = 200 (2E35 – E38 –E41)	-500	500	nA
	+PSRR	4003	52		20 10	-15 -15	0 0	None	4	E43 E44	V “	+PSRR = 20 log (10000/(E43 – E44))	85		dB
	-PSRR	4003	53		15 15	-20 -10	0 0	None	4	E45 E46	V “	-PSRR = 20 log (10000/(E45 – E46))	85		dB
	CMRR	4003	54	2/								CMRR = 20 log (24000/(E33 – E34))	80		dB
	V_{IO} ADJ(+)		55	01 only	15	-15	0	K5	4	E47	V	V_{IO} ADJ(+) = E35 – E47	4		mV
	V_{IO} ADJ(-)		56	01 only	15	-15	0	K5,K6	4	E48	“	V_{IO} ADJ(-) = E35 – E48		-4	mV
	$I_{OS(+)}$	3011	57	3/	12	-12	-10	None	5	I7	mA	$I_{OS(+)}$ = I7	-95		mA
	$I_{OS(-)}$	3011	58	3/	12	-12	-10	None	5	I8	mA	$I_{OS(-)}$ = I8		95	mA
	I_{CC}	4005	59		15	-15	0	None		I9	mA	I_{CC} = I9 Device 01		9	mA
												Device 02		13.0	mA

See footnotes 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 nunbers			Energized relays	Measured pin			Equation	Limits		Unit
					1	2	3		No.	Value	Units		Min	Max	
4	$+V_{OP}$	4004	60	01	15	-15	-15	K3	5	E49	V	$+V_{OP}$ = E49 Device 01 only	10		V
		"	61	only				K4	"	E50	"	$+V_{OP}$ = E50	12		
T_A = +25°C	$-V_{OP}$	"	62	01	15	-15	15	K3	"	E51	"	$+V_{OP}$ = E51 Device 01 only		-10	V
		"	63	only				K4	"	E52	"	$+V_{OP}$ = E52		-12	
	$A_{VS(+)}$	"	64	01	15	-15	-10	K3	4	E53	"	$A_{VS(+)}$ = 10 / (E3 – E53)	50		V/mV
		"	65	only				K4	"	E54	"	$A_{VS(+)}$ = 10 / (E3 – E54)	50		"
	$A_{VS(-)}$	"	66	01	15	-15	10	K3	4	E55	"	$A_{VS(-)}$ = 10 / (E55 – E3)	50		V/mV
		"	67	only				K4	"	E56	"	$A_{VS(-)}$ = 10 / (E56 – E3)	50		"
	A_{VS}	"	68	01	5	-5	2	K3	"	E57	"	A_{VS} = 4 / (E58 – E57)	50		V/mV
		"		only			-2	K3	"	E58	"		50		"
		"	69				2	K4	"	E59	"	A_{VS} = 4 / (E60 – E59)	50		"
		"					-2	K4	"	E60	"		50		"
	EN		70	f = 30 Hz						E61	nV	EN = $((E61)^2 - .882) \times .5$		15	nV/ $\sqrt{Hz}$
			71	f = 1 kHz						E62	"	EN = $((E62)^2 - .882) \times .5$		5.5	nV/ $\sqrt{Hz}$
5	$+V_{OP}$	4004	72	01	15	-15	-15	K3	5	E63	V	$+V_{OP}$ = E63 Device 01 only	10		V
		"	73	only				K4	"	E64	"	$+V_{OP}$ = E64	12		
T_A = +125°C	$-V_{OP}$	"	74	01	15	-15	15	K3	"	E65	"	$-V_{OP}$ = E65 Device 01 only		-10	V
		"	75	only				K4	"	E66	"	$-V_{OP}$ = E66		-12	
	$A_{VS(+)}$	"	76	01	15	-15	-10	K3	4	E67	"	$A_{VS(+)}$ = 10 / (E19 – E67)	25		V/mV
		"	77	only				K4	"	E68	"	$A_{VS(+)}$ = 10 / (E19 – E68)	25		"
	$A_{VS(-)}$	"	78	01	15	-15	10	K3	4	E69	"	$A_{VS(+)}$ = 10 / (E69 – E19)	25		V/mV
		"	79	only				K4	4	E70	"	$A_{VS(+)}$ = 10 / (E70 – E19)	25		"
	A_{VS}	"	80	01	5	-5	2	K3	"	E71	"	A_{VS} = 4 / (E72 – E71)	25		V/mV
		"		only			-2	K3	"	E72	"		25		"
		"	81				2	K4	"	E73	"	A_{VS} = 4 / (E74 – E73)	25		"
		"					-2	K4	"	E74	"		25		"
6	$+V_{OP}$	4004	82	01	15	-15	-15	K3	5	E75	V	$+V_{OP}$ = E75 Device 01 only	10		V
		"	83	only				K4	"	E76	"	$+V_{OP}$ = E76	12		
T_A = -55°C	$-V_{OP}$	"	84	01	15	-15	15	K3	"	E77	"	$-V_{OP}$ = E77 Device 01 only		-10	V
		"	85	only				K4	"	E78	"	$-V_{OP}$ = E78		-12	
	$A_{VS(+)}$	"	86	01	15	-15	-10	K3	4	E79	"	$A_{VS(+)}$ = 10 / (E35 – E79)	25		V/mV
		"	87	only				K4	"	E80	"	$A_{VS(+)}$ = 10 / (E35 – E80)	25		"
	$A_{VS(-)}$	"	88	01	15	-15	10	K3	4	E81	"	$A_{VS(+)}$ = 10 / (E81 – E35)	25		V/mV
		"	89	only				K3	4	E82	"	$A_{VS(+)}$ = 10 / (E82 – E35)	25		"
	A_{VS}	"	90	01	5	-5	2	K3	"	E83	"	A_{VS} = 4 / (E84 – E83)	25		V/mV
		"		only			-2	K3	"	E84	"		25		"
		"	91				2	K4	"	E85	"	A_{VS} = 4 / (E86 – E85)	25		"
		"					-2	K4	"	E86	"		25		"

See footnotes 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 number			Energized relays	Measured pin			Equation	Limits		Unit
					1	2	3		No.	Value	Units		Min	Max	
7	$T_{R(tr)}$		92	Fig. 4	15	-15	50 mV	None	4	E87	mV	TR(tr) = E87		40	ns
	$T_{R(os)}$		93	Fig. 4	15	-15	50 mV	None	4	E88	mV	TR(tr) = E87		40	%
T_A =	EN		94	f = 100 Hz						E89	nV	$EN = ((E89)^2 - .882) \times .5$		9	nV/ $\sqrt{Hz}$
+25°C			95	f = 10 kHz Fig. 6						E90	"	$EN = ((E90)^2 - .882) \times .5$		5.0	
	IN		96	f = 30 Hz						E91	"	$IN = (((E91)^2 - (E61)^2 - 1644)/10000) \times .5$		10	pA/Hz
			97	f = 100 Hz						E92	"	$IN = (((E92)^2 - (E89)^2 - 1644)/10000) \times .5$		5	"
			98	f = 1 kHz						E93	"	$IN = (((E93)^2 - (E62)^2 - 1644)/10000) \times .5$		2	"
			99	f = 10 kHz Fig. 6						E94	"	$IN = (((E94)^2 - (E90)^2 - 1644)/10000) \times .5$		2	"
	$S_{R(+)}$	4002	100		15	-15	0	K4, K9	5	E95	V	$S_{R(+)}$ = E95 Device 01	10		V/µs
												Device 02	3		
	$S_{R(-)}$	4002	101		15	-15	0	K4, K9	5	E96	V	$S_{R(-)}$ = E96 Device 01	10		V/µs
												Device 02	3		
	$N_{I(BB)}$		102	Fig. 7	15	-15	0	None	4	E97	µV	$N_{I(BB)}$ = E97/10		500	nVrms
	$C_{S(A)}$		103	Fig. 8 5/	15	-15	10 -10	None		E98 E99	V	$C_{S(A)} = 20 \log(20000/(E98 - E99)$	80		dB
	$C_{S(B)}$		104	Fig. 8 5/	15	-15	10 -10	K1,K2,K3		E100 E101	V	$C_{S(A)} = 20 \log(20000/(E100 - E101)$	80		dB
8	$T_{R(tr)}$		105	Fig. 4	15	-15	50 mV	None	4	E102	mV	TR(tr) = E102		40	ns
	$T_{R(os)}$		106	Fig. 4	15	-15	50 mV	None	4	E103	mV	TR(os) = E103		40	%
T_A =	$S_{R(+)}$	4002	107		15	-15	0	K4, K9	5	E104	V	$S_{R(+)}$ = E104 Device 01	10		V/µs
												Device 02	3		
+125°C	$S_{R(-)}$	4002	108		15	-15	0	K4, K9	5	E105	V	$S_{R(-)}$ = E105 Device 01	10		V/µs
												Device 02	3		
8	$T_{R(tr)}$		109	Fig. 4	15	-15	50 mV	None	4	E106	mV	TR(tr) = E106		40	ns
	$T_{R(os)}$		110	Fig.4	15	-15	50 mV	None	4	E107	mV	TR(os) = E107		40	%
T_A =	$S_{R(+)}$	4002	111		15	-15	0	K4, K9	5	E108	V	$S_{R(+)}$ = E108 Device 01	10		V/µs
												Device 02	3		
-55°C	$S_{R(-)}$	4002	112		15	-15	0	K4, K9	5	E109	V	$S_{R(-)}$ = E109 Device 01	10		V/µs
												Device 02	3		
12	$t_{S(+)}$		113	Fig. 5	15	-15	10	None	5	E110	mV	$t_{S(+)}$ = E110		4	µs
T_A = 25°C	$t_{S(-)}$		114	Fig. 5	15	-15	0	None	5	E111	mV	$t_{S(-)}$ = E111		4	µs

1/ I_{IO} is calculated using data from previous tests.
2/ CMRR is calculated using data from previous tests.
3/ $I_{OS(+)}$ and $I_{OS(-)}$ are measured with the output shorted to ground for less than 25 milliseconds.
4/ $\Delta V_{IO} / \Delta t$ is calculated using data from previous tests. These read-and-record tests may be omitted except when subgroups 2 and 3 are being accomplished for group A sampling inspection and for groups C and D endpoint measurements.
5/ Device type 02 only.
6/ All tests apply to figure 3 unless otherwise specified.

TABLE IV. Group C endpoint electrical parameters.

(T_A = 25°C, $\pm V_{CC}$ = ±15 V for all device types)

Table III test no.	Test	Limits		Delta limits		Units
		Min	Max	Min	Max	
103	V_{IO}	-2	2	-1	1	mV
106	$+I_{IB}$	-800	800	-400	400	nA
109	$-I_{IB}$	-800	800	-400	400	nA
111	I_{IO}	-200	200	-200	200	nA

5. PACKAGING

5.1 Packaging requirements. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When actual packaging of materiel is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activity within the Military Service, or Defense Agency, or within the military service's system command. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6.0 NOTES

6.1 Intended use. Microcircuits conforming to this specification are intended for original equipment design applications and logistic support of existing equipment.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number, and date of the specification.

b. PIN and compliance identifier, if applicable (see 1.2).

c. 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.

d. Requirements for certificate of compliance, if applicable.

e. Requirements for notification of change of product or process to contracting activity in addition to notification to the qualifying activity, if applicable.

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 special carriers, lead lengths, or lead forming, if applicable. These requirements should not affect the part number. Unless otherwise specified, these requirements will not apply to direct purchase by or direct shipment to the Government.

i. Requirements for "JAN" marking.

j. Packaging requirements (see 5.1)

6.3 Superseding information. The requirements of MIL-M-38510 have been superseded to take advantage of the available Qualified Manufacturer Listing (QML) system provided by MIL-PRF-38535. Previous references to MIL-M-38510 in this document have been replaced by appropriate references to MIL-PRF-38535. All technical requirements now consist of this specification and MIL-PRF-38535. The MIL-M-38510 specification sheet number and PIN have been retained to avoid adversely impacting existing government logistics systems and contractor's parts lists.

6.4 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Manufacturers List QML-38535 whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or purchase orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from DSCC-VQ, 3990 E. Broad Street, Columbus, Ohio 43123-1199.

6.5 Abbreviations, symbols, and definitions. The abbreviations, symbols, and definitions used herein are defined in MIL-PRF-38535, and MIL-HDBK-1331.

6.6 Logistic support. Lead materials and finishes (see 3.3) are interchangeable. Unless otherwise specified, microcircuits acquired for Government logistic support will be acquired to device class B (see 1.2.2), lead material and finish A (see 3.4). Longer length leads and lead forming should not affect the part number.

6.7 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 should 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-PRF-38535.

Military device type	Generic-industry type
01	5534A
02	5532A

6.8 Changes from previous issue. Asterisks are not used in this revision to identify changes with respect to the previous issue, due to the extensiveness of the changes.

Custodians:
Army – CR
Navy - EC
Air Force - 11
NASA - NA
DLA – CC

Review activities:
Army - MI, SM
Navy - AS, CG, MC, SH, TD
Air Force – 03, 19, 99

Preparing activity:
DLA - CC

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