INCH-POUND
MIL-M-38510/148B
23 March 2004
SUPERSEDING
MIL-M-38510/148A
5 September 1989

MILITARY SPECIFICATION

MICROCIRCUITS, LINEAR, ADJUSTABLE, PRECISION VOLTAGE REFERENCE, SHUNT REGULATOR, MONOLITHIC SILICON

Reactivated after 23 March 2004 and may be used for either new or existing design acquisitions.

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

The requirements 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, precision voltage reference. 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 For this product, the requirements of MIL-M-38510 have been superseded by MIL-PRF-38535, (see 6.3)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 is in accordance with MIL-PRF-38535, and as specified herein.

1.2.1 Device types. The device types are internally compensated and are as follows:

Device type	Circuit
01	Adjustable voltage reference, shunt regulator
02	2.5 V voltage reference, shunt regulator

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

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

Outline letter	Descriptive designator	Terminals	Package style
P	GDIP1-T8 or CDIP2-T8	8	Dual-in-line
X	See figure 1	3	Can

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.

Cathode to anode voltage (device type 01)	37 V dc
Continuous cathode current range (device type 01)	-100 to +150 mA
Reference input current (device type 01)	-0.05 to 10 mA
Maximum power dissipation (P_D) ambient (device type 01)	1,050 mW 1/
Reverse current (device type 02)	20 mA
Forward current (device type 02)	10 mA
Storage temperature range	-65°C to +150°C
Junction operating temperature (T_J)	+150°C
Lead temperature (soldering, 10 seconds)	+300°C

1.4 Recommended operating conditions.

Cathode to anode voltage (device type 01)	36 V
Cathode current (device type 01)	100 mA
Reverse current (device type 02)	18 mA
Forward current (device type 02)	8 mA
Ambient operating temperature range (T_A)	-55°C to +125°C

1.5 Power and thermal characteristics.

Package	Case outlines	Maximum θ_{JC}	Maximum θ_{JA}
8 pin DIP	P	38°C/W	100°C/W
4 pin can	X	80°C/W	440°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/ Derate 8.4 mW/°C above T_A = +25°C.

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 take 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 Functional diagrams and terminal connections. The functional diagram and terminal connections shall be as specified on figure 2.

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.

3.3.4 Package and sealing material. Packaging and sealing material shall be in accordance with MIL-PRF-38510.

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 apply over the full recommended operating ambient temperature range, unless otherwise specified.

3.6 Electrical test requirements. The 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.

3.7.1 Serialization. All class S devices shall be serialized in accordance with MIL-PRF-38510.

3.7.2 Correctness of indexing and markings. All devices shall be subjected to the final electrical tests specified in table II after part marking to verify that they are correctly indexed and identified by part number. Optionally, an approved electrical test may be devised especially for this requirement.

3.8 Microcircuit group assignment. The devices covered by this specification shall be in microcircuit group number 59 (see MIL-PRF-38535, appendix A).

TABLE I. Electrical performance characteristics for device type 01. 1/

Characteristic	Symbol	Conditions R_1 = 10 kΩ, I_K = 10 mA see 3.5 unless otherwise specified	Device type	Limits		Unit
				Min	Max	
Reference input	V_{REF}	$V_{KA} = V_{REF}$, see figure 3, T_A = -55°C, +125°C	01	2.42	2.57	V
		$V_{KA} = V_{REF}$, see figure 3, T_A = +25°C		2.44	2.55	
Cathode voltage	V_{KA10}	$V_{KA10} = V_{KA}$, R_2 = 3.33 kΩ, see figure 4	01	8.00	12.00	V
Cathode voltage	V_{KA36}	$V_{KA36} = V_{KA}$, R_2 = 746 Ω, see figure 4	01	31.00	36.00	V
Ratio of change in V_{REF} to change in V_{KA}	ΔV_R / ΔV_K(1)	$V_{REF} = V_{R2} - V_{R1}$, $V_{KA} = V_{KA10} - V_{R1}$, R_2 = 3.33 kΩ, see figure 4	01		-2.70	mV/V
Ratio of change in V_{REF} to change in V_{KA}	ΔV_R / ΔV_K(2)	$V_{REF} = V_{R3} - V_{R1}$, $V_{KA} = V_{KA36} - V_{R1}$, R_2 = 746 Ω, see figure 4	01		-2.00	mV/V
Reference input current	I_{REF}	$I_R = I_{REF}$, see figure 4, T_A = +25°C	01	-0.1	4.00	μA
		$I_R = I_{REF}$, see figure 4, T_A = -55°C, +125°C		-0.1	7.00	
Minimum cathode current for regulation	I_{MIN}	$V_{KA} = V_{REF}$, I_K = 1 mA, R_2 = ∞, see figure 3	01	2.40	2.60	V
Off state cathode	I_{OFF}	V_{KA} = 36 V, V_{REF} = 0 V, see figure 5	01	-0.1	1.00	μA
Input impedance	Z_{KA}	$V_{KA} = V_{REF}$, I_K = 1.0 mA to 100 mA, see figure 3	01		0.50	Ω
Noise	N_O	I_K = 10 mA, BW = 0.1 Hz to 10 Hz, see figure 6, T_A = +25°C	01		20.0	μVp-p

See footnote at end of table.

TABLE I. Electrical performance characteristics for device type 02. 1/

Test	Symbol	Conditions $-55°C \le T_A \le +125°C$ V_{REF} = 15 V, unless otherwise specified	Device type	Limits		Unit
				Min	Max	
Minimum operating current	I_{MIN}	V_Z = 2.48 V, T_A = +25°C	02		260	µA
		V_Z = 2.465 V, T_A = +125°C			340	
		V_Z = 2.465 V, T_A = -55°C			200	
Voltage reference	V_Z	I_R = 400 µA, T_A = +25°C	02	2.495	2.505	V
		I_R = 400 µA, T_A = -55°C, +125°C		2.480	2.520	
		I_R = 1 mA, T_A = +25°C		2.495	2.505	
		I_R = 1 mA, T_A = -55°C, +125°C		2.480	2.520	
		I_R = 10 mA, T_A = +25°C		2.490	2.510	
		I_R = 10 mA, T_A = -55°C, +125°C		2.480	2.520	
Load regulation	$V_Z$load	I_R = 400 µA, 10 mA	02	-10.0	10.0	mV
Voltage adjust reference	V_{ADJ}	ADJ = 600 mV	02		2.500	V
		ADJ = V_{REF} – 600 mV		2.500		
Reference adjustment	V_ZADJ		02	100.0		mV
Impedance	V_Z / I_Z	400 µA < I_Z < 10 mA	02		1.0	Ohms
Delta voltage / delta temperature	V_Z / dT	I_R = 1 mA, from –55°C to +25°C	02		15	mV
		I_R = 1 mA, from +25°C to +125°C			15	
Noise	N_O	I_R = 1 mA, BW = 0.1 Hz to 10 Hz	02		30	µVp-p

1/ For devices marked with the “Q” certification mark, the parameters listed herein may be guaranteed if not tested to the limits specified herein in accordance with the manufacturer’s QM plan.

TABLE II. Electrical test requirements.

MIL-PRF-38535 test requirements	Subgroups (see table III)	
	Class S devices	Class B 2/ devices
Interim electrical parameters	1	1
Final electrical test parameters 1/	1*, 2, 3	1*, 2, 3
Group A test requirements	1, 2, 3, 4, 5, 6	1, 2, 3, 4, 5, 6
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
Group D end-point electrical parameters	1, 2, 3	1

1/ * PDA applies to subgroup 1 (see 4.2).

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.

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.

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 7, 8, 9, 10, and 11 shall be omitted.

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 IV 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 V 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 are referenced to the external zero reference level of the supply voltage. Currents given are conventional and positive when flowing into the referenced terminal.

4.5.2 Life test and burn-in cooldown procedure. When devices are measured at +25°C following application of the steady state life or burn-in test condition, they shall be cooled within 10°C of their power stable condition prior to removal of the bias.

4.6 Data reporting. When specified in the acquisition document, a copy of the following data, as applicable, shall be applied:

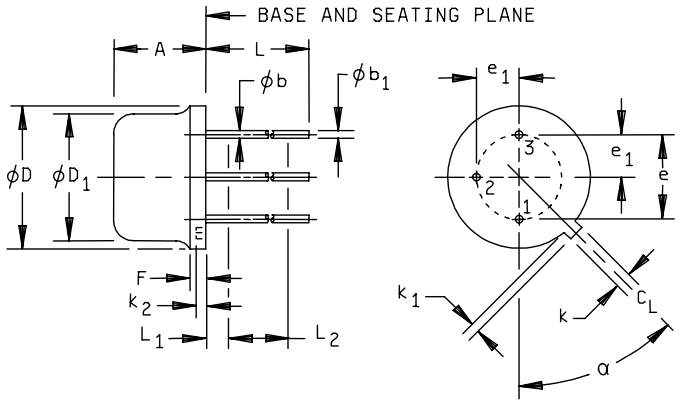
a. Attributes data for all screening tests (see 4.2) and variables data for all static burn-in, dynamic burn-in, and operating life tests.

b. A copy of each radiograph.

c. The quality conformance inspection data (see 4.4).

d. Parameter distribution data on parameters evaluated during burn-in (see 3.5).

e. Final electrical parameter data (see 4.2).



Dimensions					
Symbol	Inches		Millimeters		Notes
	Min	Max	Min	Max	
A	.085	.105	2.159	2.667	
ϕb	.016	.019	0.406	0.483	3
ϕb_1					3
ϕD	.209	.219	5.31	5.563	
ϕD_1	.178	.195	4.521	4.953	
e	.100	T.P.	2.540	T.P.	5
e_1	.050	T.P.	1.270	T.P.	5
F	---	.030	---	0.762	
k	.036	.046	.914	1.168	
k_1	.028	.048	.711	1.219	4
k_2					
L	.500	---	12.700	---	
L_1	---	.050	---	1.27	
L_2	.250	---	6.35	---	
α	45°	T.P.	45°	T.P.	5

NOTES:
1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. (Three leads) ϕb applies between L_1 and L_2, ϕb_1 applies between L_2 and .500 (12.70 mm) from the reference plane. Diameter is uncontrolled in L_1 and beyond .500 (12.70 mm) from the reference plane.
4. Three leads.
5. Measured from the maximum diameter of the product.
6. Leads having a maximum diameter .019 (0.48 mm) measured in gauging plane .054 (1.37 mm) + .001 (0.03 mm) - .000 (0.00 mm) below the base plane of the product shall be within .007 (0.18 mm) of their true position relative to a maximum width tab.
7. The product may be measured by direct methods or by gauge.

FIGURE 1. Case outline X (device type 02).

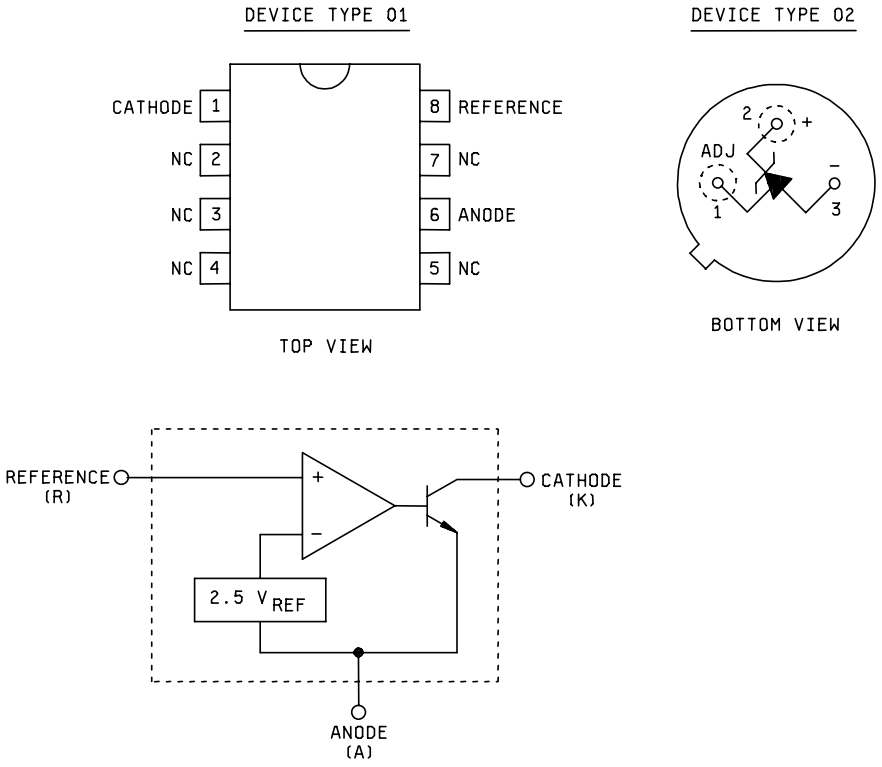


FIGURE 2. Functional diagram and terminal connections.

DEVICE TYPE 01

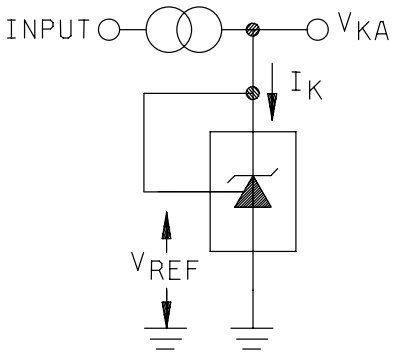


FIGURE 3. Test circuit for ($V_{KA} = V_{REF}$).

DEVICE TYPE 01

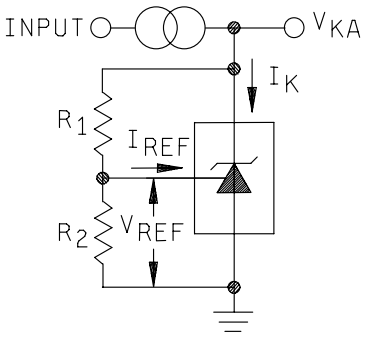
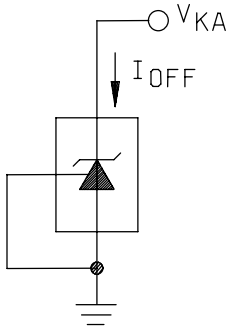


FIGURE 4. Test circuit for ($V_{KA} > V_{REF}$).

DEVICE TYPE 01

(TEST CIRCUIT FOR I_{OFF})



DEVICE TYPE 02

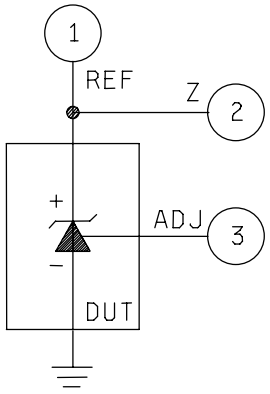
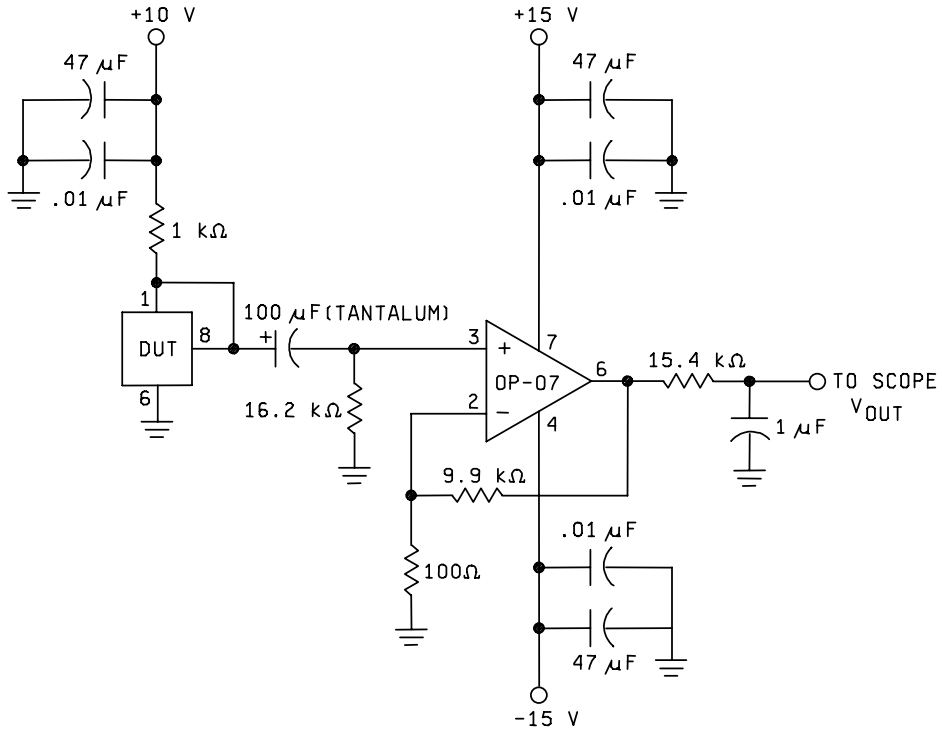


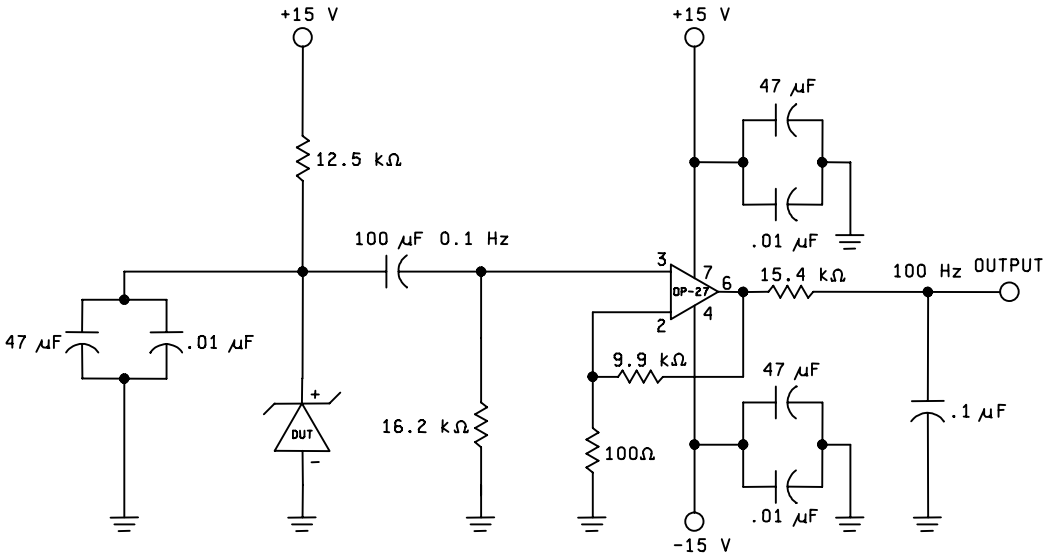
FIGURE 5. Test circuit.



NOTES:

1. Test time = 10 nano seconds.
2. V_{OUT} measured with differential amplifier 7A22 and lower frequency set to 0.1 Hz.

FIGURE 6. Low frequency noise test circuit for device type 01.



NOTES:

1. Test time = 10 seconds.
2. V_{OUT} measured with differential amplifier 7A22 and lower frequency set to 0.1 Hz.
3. Device noise = V_{OUT} / 100.

FIGURE 6. Low frequency noise test circuit for device type 02 – Continued.

TABLE III. Group A inspection for all device type 01. 1/

Subgroup	Symbol	Test no.	Conditions R_1 = 10 kΩ, I_K = 10 mA unless otherwise specified	Measured value	See figure	Notes	Limits		Unit
							Min	Max	
1	V_{REF1}	1	$V_{KA} = V_{REF}$	V_{R1}		$V_R = V_{REF}$	2.44	2.55	V dc
	V_{KA10}	2	R_2 = 3.33 kΩ	V_{KA10}	3	$V_{KA10} = V_{KA}$ 2/	8.00	12.00	V dc
T_A = +25°C	V_{KA36}	3	R_2 = 746 Ω	V_{KA36}	3	$V_{KA36} = V_{KA}$ 2/	31.00	36.00	V dc
	$\Delta V_R / \Delta V_K$	4	R_2 = 3.33 kΩ	V_{R2}	3	$\Delta V_{REF} = V_{R2} - V_{R1}$ $\Delta V_{KA} = V_{KA10} - V_{R1}$		-2.70	mV / V
		5	R_2 = 746 Ω	V_{R3}	3	$\Delta V_{REF} = V_{R3} - V_{R2}$ $\Delta V_{KA} = V_{KA36} - V_{KA10}$		-2.00	mV / V
	I_{REF}	6	$R_2 = \infty$	I_{R1}	3	$I_R = I_{REF}$	-0.1	4.00	µA
	I_{MIN}	7	$V_{KA} = V_{REF}$ I_{KMIN} = 1 mA	V_{R4}		I_K = Cathode current	2.40	2.60	V dc
	I_{OFF}	8	V_{KA} = 36 V, V_{REF} = 0 V	I_{K1}	4		-0.1	1.00	µA
	Z_{KA}	9	$V_{KA} = V_{REF}$, I_K = 100 mA	V_{R5}		$Z_{KA} = (V_{R5} - V_{R4}) / 99$ mA 3/		0.50	Ω
2	V_{REF1}	10	$V_{KA} = V_{REF}$	V_{R6}		$V_R = V_{REF}$	2.42	2.57	V dc
	V_{KA10}	11	R_2 = 3.33 kΩ	V_{KA10}	3	$V_{KA10} = V_{KA}$ 2/	8.00	12.00	V dc
T_A = +125°C	V_{KA36}	12	R_2 = 746 Ω	V_{KA36}	3	$V_{KA36} = V_{KA}$ 2/	31.00	36.00	V dc
	$\Delta V_R / \Delta V_K$	13	R_2 = 3.33 kΩ	V_{R7}	3	$\Delta V_{REF} = V_{R7} - V_{R6}$ $\Delta V_{KA} = V_{KA10} - V_{R6}$		-2.70	mV / V
		14	R_2 = 746 Ω	V_{R8}	3	$\Delta V_{REF} = V_{R8} - V_{R7}$ $\Delta V_{KA} = V_{KA36} - V_{KA10}$		-2.00	mV / V
	I_{REF}	15	$R_2 = \infty$	I_{R2}	3	$I_R = I_{REF}$	-0.1	7.00	µA
	I_{MIN}	16	$V_{KA} = V_{REF}$ I_{KMIN} = 1 mA	V_{R9}		I_K = Cathode current	2.40	2.60	V dc
	I_{OFF}	17	V_{KA} = 36 V, V_{REF} = 0 V	I_{K2}	4		-0.1	1.00	µA
	Z_{KA}	18	$V_{KA} = V_{REF}$, I_K = 100 mA	V_{R10}		$Z_{KA} = (V_{R10} - V_{R6}) / 99$ mA 3/		0.50	Ω
3	V_{REF1}	19	$V_{KA} = V_{REF}$	V_{R11}		$V_R = V_{REF}$	2.42	2.57	V dc
	V_{KA10}	20	R_2 = 3.33 kΩ	V_{KA10}	3	$V_{KA10} = V_{KA}$ 2/	8.00	12.00	V dc
T_A = -55°C	V_{KA36}	21	R_2 = 746 Ω	V_{KA36}	3	$V_{KA36} = V_{KA}$ 2/	31.00	36.00	V dc
	$\Delta V_R / \Delta V_K$	22	R_2 = 3.33 kΩ	V_{R12}	3	$\Delta V_{REF} = V_{R12} - V_{R11}$ $\Delta V_{KA} = V_{KA10} - V_{R11}$		-2.70	mV / V
		23	R_2 = 746 Ω	V_{R13}	3	$\Delta V_{REF} = V_{R13} - V_{R12}$ $\Delta V_{KA} = V_{KA36} - V_{KA10}$		-2.00	mV / V
	I_{REF}	24	$R_2 = \infty$	I_{R3}	3	$I_R = I_{REF}$	-0.1	7.00	µA
	I_{MIN}	25	$V_{KA} = V_{REF}$ I_{KMIN} = 1 mA	V_{R14}		I_K = Cathode current	2.40	2.60	V dc
	I_{OFF}	26	V_{KA} = 36 V, V_{REF} = 0 V	I_{K3}	4		-0.1	1.00	µA
	Z_{KA}	27	$V_{KA} = V_{REF}$, I_K = 100 mA	V_{R15}		$Z_{KA} = (V_{R15} - V_{R14}) / 99$ mA 3/		0.50	Ω

See footnotes at end of table.

TABLE III. Group A inspection for all device type 01 – Continued. 1/

Subgroup	Symbol	Test no.	Conditions R_1 = 10 kΩ, I_K = 10 mA unless otherwise specified	Measured value	See figure	Notes	Limits		Unit
							Min	Max	
4 T_A = +25°C	N_O	28	I_K = 10 mA, BW = 0.1 Hz to 10 Hz	N_O	5	4/		20.00	µVp-p
5 T_A = +125°C	$\Delta V_{REF}/\Delta T$	29	$V_{KA} = V_{REF}$	CALC		$\Delta V_{REF} = V_{R1} - V_{R6}$	-44.00	44.00	mV
6 T_A = -55°C	$\Delta V_{REF}/\Delta T$	30	$V_{KA} = V_{REF}$	CALC		$\Delta V_{REF} = V_{R1} - V_{R11}$	-44.00	44.00	mV
	$\Delta V_{REF}/\Delta T$	31	$V_{KA} = V_{REF}$	CALC		$\Delta V_{REF} = V_{R11} - V_{R6}$	-44.00	44.00	mV
	$\Delta V_{REF}/\Delta T$	32	$R_2 = \infty$	CALC	3	$\Delta I_{REF} = V_{R2} - V_{R3}$	-3.00	3.00	µA

1/ For devices marked with the "Q" certification mark, the parameters listed herein may be guaranteed if not tested to the limits specified herein in accordance with the manufacturer's QM plan.

2/ $V_{KA} = V_{REF} (1+ (R_1 / R_2)) + I_{REF} \times R_2$ (see figure 3).

3/ $Z_{KA} = \Delta V_{KA} / \Delta I_K$, f < 1 kHz.

4/ If not tested, shall be guaranteed to the limits specified in table III herein.

TABLE III. Group A inspection for all device type 02. 1/

Subgroup	Symbol	Test no.	Measured value	Reference	Z	Adjustment	Pin measurement	Equations	Limits		Unit
									Min	Max	
1	I_{MIN}	1	I1	260 µA			1		2.48		V
T_A = +25°C	V_Z	2	V1	400 µA			2	V_Z = V1	2.495	2.505	V
		3	V2	1 mA			2	V_Z = V2	2.495	2.505	
		4	V3	10 mA			2	V_Z = V3	2.490	2.510	
	V_{ZLOAD}	5						V_{ZLOAD} = V1 – V3	-10.0	10.0	mV
	V_{ADJ}	6	V4	1 mA		600 mV	2	V_{ADJ} = V4		2.500	V
		7	V5	1 mA		1.9 V	2	V_{ADJ} = V5	2.500		
	V_{ZADJ}	8					2	V_{ZADJ} = V5 – V4	100.0		mV
	V_Z / I_Z	9	V6	0.4 mA			2	V_Z / I_Z = (V6 – V7) / 9.6 mA		1.0	Ω
		10	V7	10 mA			2				
2	I_{MIN}	11	I2	340 µA			1		2.465		V
T_A = +125°C	V_Z	12	V8	400 µA			2	V_Z = V8	2.480	2.520	V
		13	V9	1 mA			2	V_Z = V9	2.480	2.520	
		14	V10	10 mA			2	V_Z = V10	2.480	2.520	
	V_{ZLOAD}	15						V_{ZLOAD} = V10 – V8	-10.0	10.0	mV
	V_{ADJ}	16	V11	1 mA		600 mV	2	V_{ADJ} = V11		2.500	V
		17	V12	1 mA		1.9 V	2	V_{ADJ} = V12	2.500		
	V_{ZADJ}	18					2	V_{ZADJ} = V12 – V11	100.0		mV
	V_Z / I_Z	19	V13	400 µA			2	V_Z / I_Z = (V14 – V13) / 9.6 mA		1.0	Ω
		20	V14	10 mA			2				
3	I_{MIN}	21	I3	200 µA			1		2.465		V
T_A = -55°C	V_Z	22	V15	400 µA			2	V_Z = V15	2.480	2.520	V
		23	V16	1 mA			2	V_Z = V16	2.480	2.520	
		24	V17	10 mA			2	V_Z = V17	2.480	2.520	
	V_{ZLOAD}	25						V_{ZLOAD} = V15 – V17	-10.0	10.0	mV
	V_{ADJ}	26	V18	1 mA		600 mV	2	V_{ADJ} = V18		2.500	V
		27	V19	1 mA		1.9 V	2	V_{ADJ} = V19	2.500		
	V_{ZADJ}	28					2	V_{ZADJ} = V19 – V18	100.0		mV
	V_Z / I_Z	29	V20	400 µA			2	V_Z / I_Z = (V21 – V20) / 9.6 mA		1.0	Ω
		30	V21	10 mA			2				
4	N_O	31	N1					See figure 6		30	µVp-p
T_A = +25°C											
5	V_Z / dT	32						V_Z / dT = | V9 – V2 |		15	mV
T_A = +125°C											
6	V_Z / dT	33						V_Z / dT = | V16 – V2 |		15	mV
T_A = -55°C											

1/ Use test circuit for device type 02 shown on figure 5. For devices marked with the “Q” certification mark, the parameters listed herein may be guaranteed if not tested to the limits specified herein in accordance with the manufacturer’s QM plan.

TABLE IV. Group C end point electrical parameters. T_A = 25°C

Device type	Symbol	Delta 1/		End point limits		Unit
		Min	Max	Min	Max	
01	V_{REF}	-0.015	0.015	2.44	2.55	V
	I_{REF}	-1.0	1.0	-0.1	3.0	µA
02	V_Z for I_R = 1 mA			2.495	2.505	V

1/ Delta limits apply to the measured value (see delta limit definition in MIL-PRF-38535).

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 personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activity within the Military Department of Defense Agency, or within the Military Department'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. 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 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 acquiring activity in addition to notification of the qualifying activity, if applicable.

f. Requirements for failure analysis (including required test condition of MIL-STD-883, method 5003), 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, MIL-STD-1331, and as follows:

Symbol	Description
V_{REF}	Reference input voltage
V_{KA10}	Cathode voltage
V_{KA36}	Cathode voltage
V_R / V_K (1)	Ratio of change in V_{REF} to change in V_{KA}
V_R / V_K (2)	Ratio of change in V_{REF} to change in V_{KA}
I_{REF}	Reference input current
I_{MIN}	Minimum cathode current for regulation
I_{OFF}	Off state cathode
Z_{KA}	Input impedance
I_{MIN}	Minimum operating current
V_Z	Voltage reference
V_{ZLOAD}	Load regulation
V_{ADJ}	Voltage adjust reference
V_{ZADJ}	Reference adjustment
V_Z / I_Z	Impedance
V_Z / d_T	Delta voltage / delta temperature
N_O	Noise

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	TL431
02	LT1009

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

Preparing activity:
DLA - CC

Project 5962-2033

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

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIT Online database at www.dodssp.daps.mil.