INCH-POUND
MIL-M-38510/102C
02 September 2003
SUPERSEDING
MIL-M-38510/102B
24 April 1987

MILITARY SPECIFICATION
MICROCIRCUITS, LINEAR, VOLTAGE REGULATOR, MONOLITHIC SILICON

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

Reactivated for new design as of 02 September 2003. May be used for either new or existing design acquisition.

1. SCOPE

1.1 Scope. This specification covers the detail requirements for monolithic silicon, voltage regulator. Two product assurance classes and a choice of case outlines and lead finish are provided for each type 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 For this product, the requirements of MIL-M-38510 have been superseded by MIL-PRF-38535, (see 6.3).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 number. The complete part number should be in accordance with MIL-PRF-38535, and as specified herein.

1.2.1 Device types. The device types should be as shown in the following:

Device type	Circuit
01	Precision voltage regulator

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

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

Outline letter	Descriptive designator	Terminals	Package style
A 1/	GDFP5-F14 or CDFP6-F14	14	Flat pack
B 1/	GDFP4-F14	14	Flat pack
C	GDIP1-T14 or CDIP2-T14	14	Dual-in-line
D	GDFP1-F14 or CDFP2-F14	14	Flat pack
H	GDFP1-F10 or CDFP2-F10	10	Flat pack
I	MACY1-X10	10	Can
2	CQCC1-N20	20	Square leadless chip carrier

1/ Inactive package case outline.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Defense Supply Center Columbus, ATTN: DSCC-VAS, P.O. Box 3990, Columbus, OH 43216-5000, using the self addresses Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A FSC 5962

1.3 Absolute maximum ratings.

Pulse voltage from +V to -V (50 ms) ..... 50 V
Continuous voltage from +V to –V ..... 40 V
Input – output voltage differential ..... 40 V
Differential input voltage ..... ±5 V
Voltage between noninverting input and –V ..... +8 V
Current from V_Z ..... 25 mA
Current from V_{REF} ..... 15 mA
Lead temperature (soldering, 10 seconds) ..... +300°C
Junction temperature (T_J) ..... +175°C 2/
Storage temperature range ..... -65°C to +150°C

1.4 Recommended operating conditions.

Input voltage range ..... 9.5 V to 40 V dc
Output voltage range ..... 2 V to 37 V dc
Input – output voltage differential ..... 2.5 V to 38 V dc
Ambient temperature range (T_A) ..... -55°C to +125°C

1.5 Power and thermal characteristics.

Case outlines	Maximum allowable power dissipation	Maximum θ_{JC}	Maximum θ_{JA}
A,B,D	350 mW at T_A = +125°C	60°C/W	140°C/W
C	400 mW at T_A = +125°C	35°C/W	120°C/W
H	350 mW at T_A = +125°C	60°C/W	150°C/W
I	350 mW at T_A = +125°C	40°C/W	140°C/W
2	72 mW at T_A = +125°C	55°C/W	121°C/W

2/ For short term test (up to 100 hours, maximum) T_J = 275°C.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 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 listed in the issue of the Departments of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation.

SPECIFICATION

DEPARTMENT OF DEFENSE

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

STANDARDS

DEPARTMENT OF DEFENSE

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

(Unless otherwise indicated, copies of the above specifications and standards are available from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.2 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. The terminal connections shall be as specified on figure 1.

3.3.2 Block diagram. The block diagram shall be as specified on figure 2.

3.3.3 Schematic circuits. The schematic circuits shall be maintained by the manufacturer and made available to the qualifying activity and the preparing activity (DSCC-VA) upon request.

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

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

3.5 Electrical performance characteristics. Unless otherwise specified, the electrical performance characteristics are as specified in table I and apply over the full operating ambient temperature range of -55°C to +125°C and for in voltages V_{IN} = +V = V_{CC} = 12 V dc (see table I).

TABLE I. Electrical performance characteristics.

Test	Symbol	Conditions 1/ 2/ $-55°C \le T_A \le +125°C$ unless otherwise specified	Group A subgroups	Device type	Limits		Unit
					Min	Max	
Line regulation	V_{RLINE}	V_{IN} = 12 V to 15 V, V_{OUT} = 5 V, I_L = 1 mA	1	01	-0.1	0.1	% V_{OUT}
			2		-0.2	0.2	
			3		-0.3	0.3	
		V_{IN} = 9.5 V to 40 V, V_{OUT} = 5 V, I_L = 1 mA, T_A = +25°C	1		-0.3	0.3	
		V_{IN} = 12 V to 40, V_{OUT} = 2 V, I_L = 1 mA, T_A = +25°C	1		-0.2	0.2	
Load regulation	V_{RLOAD}	V_{IN} = 12 V, V_{OUT} = 5 V, I_L = 1 mA to 50 mA	1	01	-0.15	0.15	% V_{OUT}
			2 3/		-0.4	0.4	
			3		-0.6	0.6	
		V_{IN} = 40 V, T_A = +25°C, V_{OUT} = 37 V, I_L = 1 mA to 10 mA	1		-0.5	0.5	
		V_{IN} = 10 V, T_A = +25°C, V_{OUT} = 7.5 V, I_L = 6 mA to 12 mA	1		-0.2	0.2	
Reference voltage	V_{REF}	V_{IN} = 12 V, I_{REF} = 1 mA	1	01	6.95	7.35	V dc
			2,3		6.90	7.40	

See footnotes at end of table.

TABLE I. Electrical performance characteristics – Continued.

Test	Symbol	Conditions 1/ 2/ $-55°C \le T_A \le +125°C$ unless otherwise specified	Group A subgroups	Device type	Limits		Unit
					Min	Max	
Output short circuit current	I_{OS}	V_{IN} = 12 V, V_{OUT} = 5 V, R_{SC} = 10 Ω, R_L = 0 Ω, T_A = +25°C	1	01	45	85	mA
Standby current drain	I_{SCD}	V_{IN} = 30 V,	1	01	0.5	3.0	mA
		$V_{OUT} = V_{REF}$,	2		0.5	2.4	
		$I_L = I_{REF}$ = 0	3		0.5	3.5	
Average temperature coefficient of output voltage	TC_{VOUT}	V_{IN} = 12 V, V_{OUT} = 5 V,	8A	01	-.010	.010	%/°C
		I_L = 1 mA	8B		-0.015	.015	
Zener voltage	V_Z	I_Z = 1 mA, T_A = +25°C, available in packages A, B, C, D, and 2 only.	1	01	5.58	6.82	V dc
Ripple rejection	$\Delta V_{OUT} / \Delta V_{IN}$	V_{OUT} = 5 V, C_{REF} = 0 µF, f = 50 Hz to 10 kHz, see figure 3, T_A = +25°C	4	01	64		dB
		V_{OUT} = 5 V, C_{REF} = 5 µF, f = 50 Hz to 10 kHz, see figure 3, T_A = +25°C			76		
Output noise	N_O	V_{OUT} = 5 V, C_{REF} = 0 µF, BW = 100 Hz to 10 kHz, see figure 3, T_A = +25°C	4	01		120	µV rms
		V_{OUT} = 5 V, C_{REF} = 5 µF, BW = 100 Hz to 10 kHz, see figure 3, T_A = +25°C				7.0	

See footnotes at end of table.

TABLE I. Electrical performance characteristics – Continued.

Test	Symbol	Conditions 1/ 2/ $-55°C \le T_A \le +125°C$ unless otherwise specified	Group A subgroups	Device type	Limits		Unit
					Min	Max	
Line transient response	$\Delta V_{OUT} / \Delta V_{IN}$	V_{IN} = 12 V, V_{OUT} = 5 V, I_L = 1 mA, R_{SC} = 0 Ω, ΔV_{IN} = 3 V for 25 µs, see figure 4, T_A = +25°C	4	01	0	10	mV/V
Load transient response	$\Delta V_{OUT} / \Delta I_L$	V_{IN} = 12 V, V_{OUT} = 5 V, I_L = 40 mA, R_{SC} = 0 Ω, ΔI_L = 10 mA for 25 µs, see figure 4, T_A = +25°C	4	01	-1.5	0	mV/mA

1/ All V_{OUT} values are nominal.

2/ All regulation requirements are based on a constant junction temperature.

3/ The test time is less than 50 ms. For sustained operation, the maximum power dissipation must be taken into account.

3.6 Rebonding. Rebonding shall be in accordance with MIL-PRF-38535.

3.7 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.

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

3.9 Microcircuit group assignment. The devices covered by this specification shall be in microcircuit group number 52 (see MIL-PRF-38535, appendix A).

Device type	01		
Case outlines	A, B, C,and D	H and I	2
Terminal number	Terminal symbol		
1	NC	CURRENT SENSE	NC
2	CURRENT LIMIT	INVERTING INPUT	NC
3	CURRENT SENSE	NONINVERTING INPUT	CURRENT LIMIT
4	INVERTING INPUT	V_{REF}	CURRENT SENSE
5	NONINVERTING INPUT	-V	NC
6	V_{REF}	V_{OUT}	-INPUT
7	-V	V_{CC}	NC
8	NC	+V	+INPUT
9	V_Z	FREQUENCY COMPENSATION	V_{REF}
10	V_{OUT}	CURRENT LIMIT	-V
11	V_{CC}	---	NC
12	+V	---	NC
13	FREQUENCY COMPENSATION	---	V_Z
14	NC	---	V_{OUT}
15	---	---	NC
16	---	---	V_{CC}
17	---	---	NC
18	---	---	+V
19	---	---	FREQUENCY COMPENSATION
20	---	---	NC

NC = No connection
-V connected to case of metal packages.

FIGURE 1. Terminal connections.

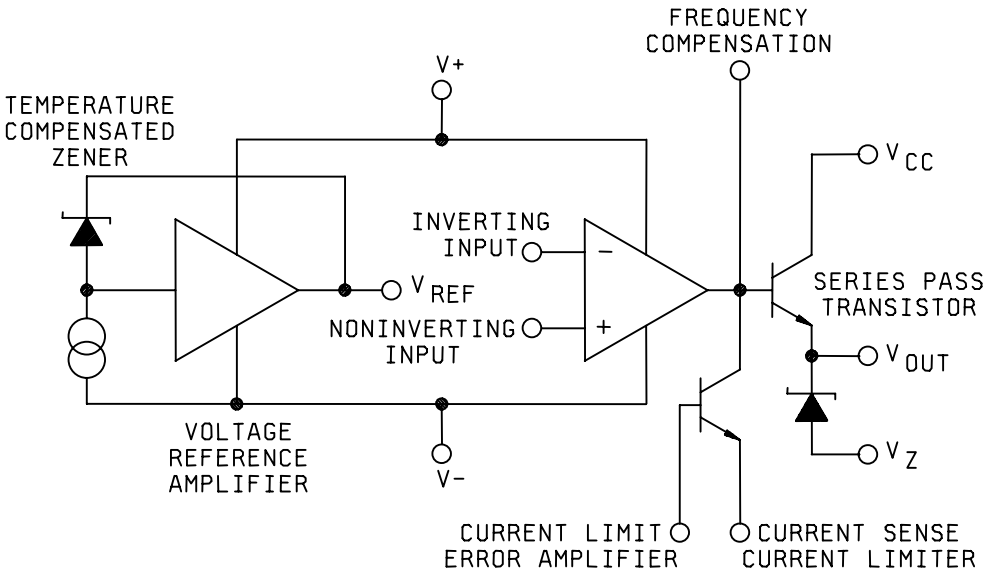


FIGURE 2. Block diagram.

4. VERIFICATION.

4.1 Sampling and inspection. Sampling and inspection procedures should 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 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 5, 6, 7, 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. A subgroup shall be added to group C inspection requirements for class B devices and shall consists of the tests, conditions and limits specified for group A subgroup 4 as specified in table III herein. The sample size series number for the subgroup shall be 5 for all classes.

c. 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.

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/	1,2,3	1,2,3
Group A test requirements	1,2,3,4,8A,8B	1,2,3,8A,8B
Group B electrical test parameters when using the method 5005 QCI option	1,2,3, and table IV delta limits	N/A
Group C electrical parameters	1,2,3, and table IV delta limits	1 and table IV delta limits
Additional electrical subgroups for group C periodic inspections	Not applicable	4
Group D end point electrical parameters	1,2,3	1

1/ PDA applies to subgroup 1.

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 voltages given are referenced to the microcircuit ground terminal. Currents given are conventional current and positive when flowing into the referenced terminal.

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

TABLE III. Group A inspection.

Subgroup	Symbol	Test No.	Conditions 1/ 2/	Limits		Units
				Min	Max	
1 T_A = +25°C	V_{RLINE}	1	V_{OUT} = 5 V, I_L = 1 mA, V_{IN} = 12 V to 15 V	-0.10	0.10	% V_{OUT}
	V_{RLINE}	2	V_{OUT} = 5 V, I_L = 1 mA, V_{IN} = 9.5 V to 40 V	-0.3	0.3	% V_{OUT}
	V_{RLINE}	3	V_{OUT} = 2 V, I_L = 1 mA, V_{IN} = 12 V to 40 V	-0.2	0.2	% V_{OUT}
	V_{RLOAD}	4	V_{OUT} = 5 V, V_{IN} = 12 V, I_L = 1 mA to 50 mA	-0.15	0.15	% V_{OUT}
	V_{RLOAD}	5	V_{OUT} = 37 V, V_{IN} = 40 V, I_L = 1 mA to 10 mA	-0.5	0.5	% V_{OUT}
	V_{RLOAD}	6	V_{OUT} = 7.5 V, V_{IN} = 10 V, I_L = 6 mA to 12 mA	-0.2	0.2	% V_{OUT}
	V_{REF}	7	V_{IN} = 12 V, I_{REF} = 1 mA	6.95	7.35	V dc
	I_{OS}	8	V_{OUT} = 5 V, V_{IN} = 12 V, 3/ R_{SC} = 10 Ω, R_L = 0 Ω	45	85	mA
	I_{SCD}	9	V_{OUT} = V_{REF}, V_{IN} = 30 V, I_L = I_{REF} = 0	0.5	3.0	mA
	V_Z	10	I_Z = 1 mA, available in packages A, B, C, D, and 2 only.	5.58	6.82	V dc
2 T_A = +125°C	V_{RLINE}	11	V_{IN} = 12 V to 15 V, V_{OUT} = 5 V, I_L = 1 mA	-0.2	0.2	% V_{OUT}
	V_{RLOAD}	12	V_{OUT} = 5 V, V_{IN} = 12 V, 4/ I_L = 1 mA to 50 mA	-0.4	0.4	% V_{OUT}
	V_{REF}	13	V_{IN} = 12 V, I_{REF} = 1 mA	6.90	7.40	V dc
	I_{SCD}	14	V_{OUT} = V_{REF}, V_{IN} = 30 V, I_L = I_{REF} = 0	0.5	2.4	mA

See footnotes at end of table.

TABLE III. Group A inspection – continued.

Subgroup	Symbol	Test No.	Conditions 1/ 2/	Limits		Units
				Min	Max	
3 T_A = -55°C	V_{RLINE}	15	V_{OUT} = 5 V, I_L = 1 mA, V_{IN} = 12 V to 15 V	-0.3	0.3	% V_{OUT}
	V_{RLOAD}	16	V_{OUT} = 5 V, V_{IN} = 12 V, I_L = 1 mA to 50 mA	-0.6	0.6	% V_{OUT}
	V_{REF}	17	V_{IN} = 12 V, I_{REF} = 1 mA	6.90	7.40	V dc
	I_{SCD}	18	V_{OUT} = V_{REF}, V_{IN} = 30 V, I_L = I_{REF} = 0	0.5	3.5	mA
4 T_A = +25°C	Ripple rej.	19	f = 10 kHz, C_{REF} = 0, see figure 3	64		dB
	Ripple rej.	20	f = 10 kHz, C_{REF} = 5 µF, see figure 3	76		dB
	Output noise	21	BW = 100 Hz to 10 kHz, C_{REF} = 0, see figure 3		120	µV rms
	Output noise	22	BW = 100 Hz to 10 kHz, C_{REF} = 5 µF, see figure 3		7.0	µV rms
	Line transient response	23	V_{IN} = 12 V, V_{OUT} = 5 V, I_L = 1 mA, C_{REF} = 5 µF, R_{SC} = 0 Ω, ΔV_{IN} = 3 V, see figure 4	0	10	mV/V
	Load transient response	24	V_{IN} = 12 V, V_{OUT} = 5 V, I_L = 40 mA, C_{REF} = 5 µF, R_{SC} = 0 Ω, ΔI_L = 10 mA, see figure 4	-1.5	0	mV/mA
8A T_A = +125°C	TC_{VOUT}	25	V_{OUT} = 5 V, V_{IN} = 12 V, I_L = 1 mA	-0.010	0.010	%/°C
8B T_A = -55°C	TC_{VOUT}	26	V_{OUT} = 5 V, V_{IN} = 12 V, I_L = 1 mA	-0.015	0.015	%/°C

1/ All V_{OUT} values are nominal.

2/ Unless otherwise specified, use figure 5.

3/ To eliminate heating, test must be made in less than 10 ms, duty cycle of less than 5 percent. V_{OUT} is the nominal output voltage prior to application of short circuit.

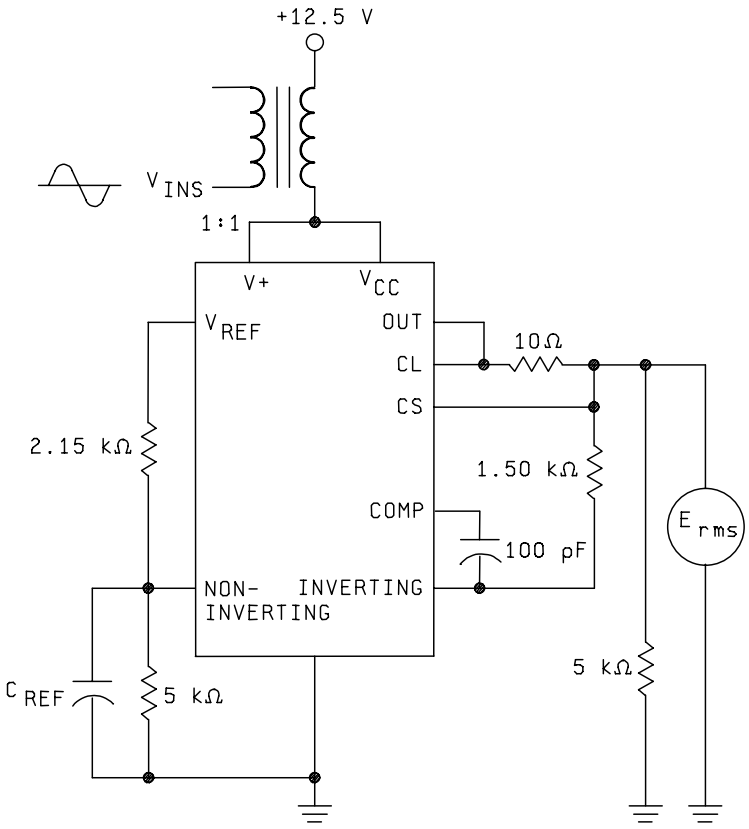
4/ The test time is less than 50 ms. For sustained operation, the maximum power dissipation must be taken into account.

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

Table III test no.	Characteristic	Symbol	Delta limits 1/	Limits		Units
				Min	Max	
1	Line regulation	V_{RLINE}	±15 % or 1 mV 2/	-0.10	0.10	% V_{OUT}
4	Load regulation	V_{RLOAD}	±20 % or 1 mV 2/	-0.15	0.15	% V_{OUT}
7	Reference voltage	V_{REF}	±15 mV	6.95	7.35	V dc
9	Standby current drain	I_{SCD}	±10 %	0.5	3.0	mA dc

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

2/ Whichever is greater.



NOTES:

1. For ripple rejection:

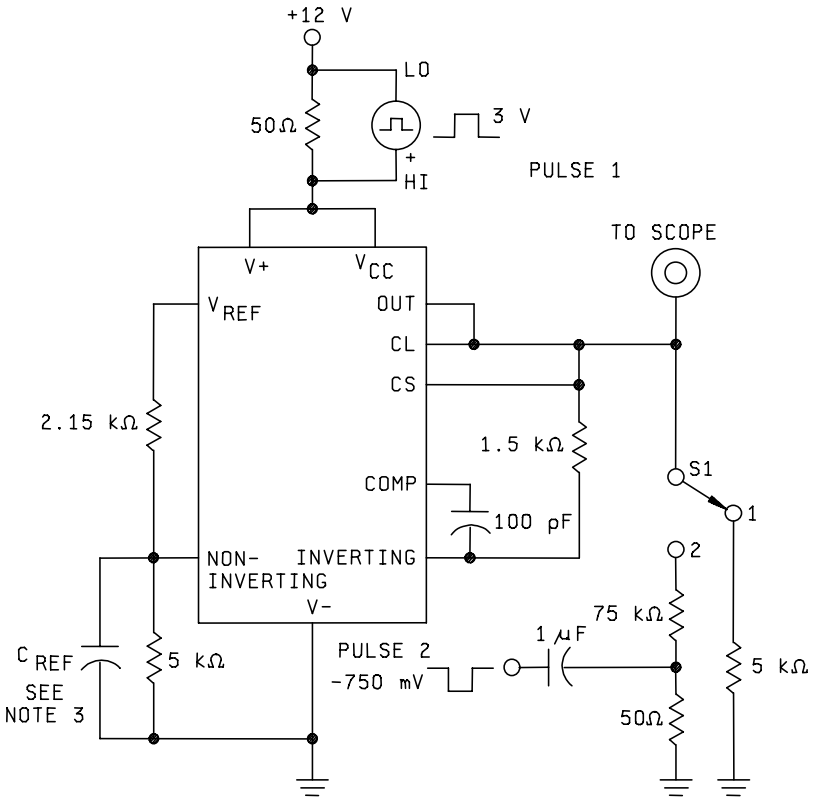
   V_{INS} = 2 V rms, 10 kHz. Ripple rejection (dB) = 20 log (V_{INS} / E_{rms})

2. For noise:

   V_{INS} = 0 V rms. E_{rms} is over a bandwith of 100 Hz to 10 kHz = noise μV rms.

3. C_{REF} is as specified in table III.

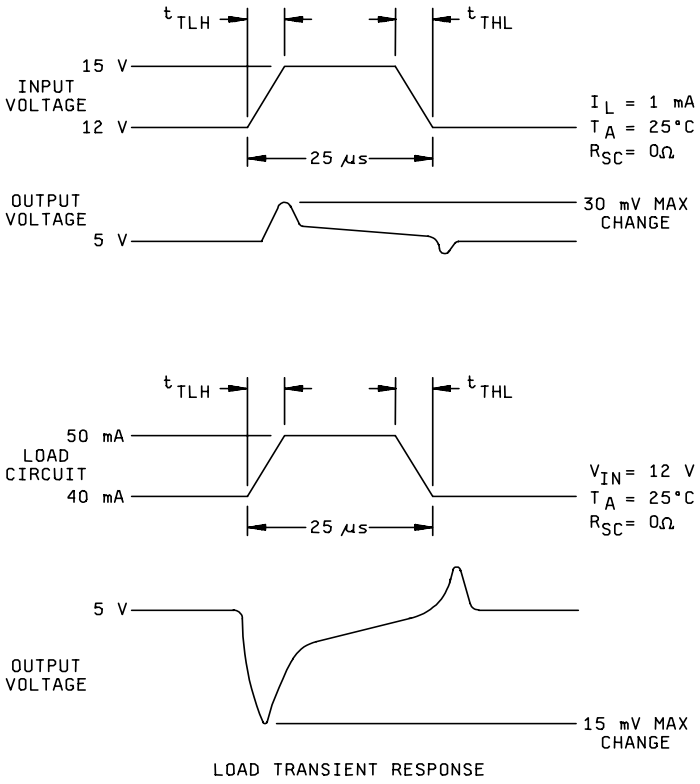
FIGURE 3. Ripple rejection and noise test circuit.



NOTES:

1. For line transient response, S1 in position 1, pulse 1 equals 3 V high, 25 μs wide, 3 percent duty cycle. $t_{TLH} = t_{THL} = 1$ μs.
2. For load transient response, S1 in position 2, pulse 1 = 0. Pulse 2 equals –750 mV, 25 μs wide, 3 percent duty cycle, $t_{TLH} = t_{THL} = 1$ μs.
3. C_{REF} is as specified in table III.

FIGURE 4. Transient response test circuits.



Load transient response

FIGURE 4. Transient response test circuits – continued.

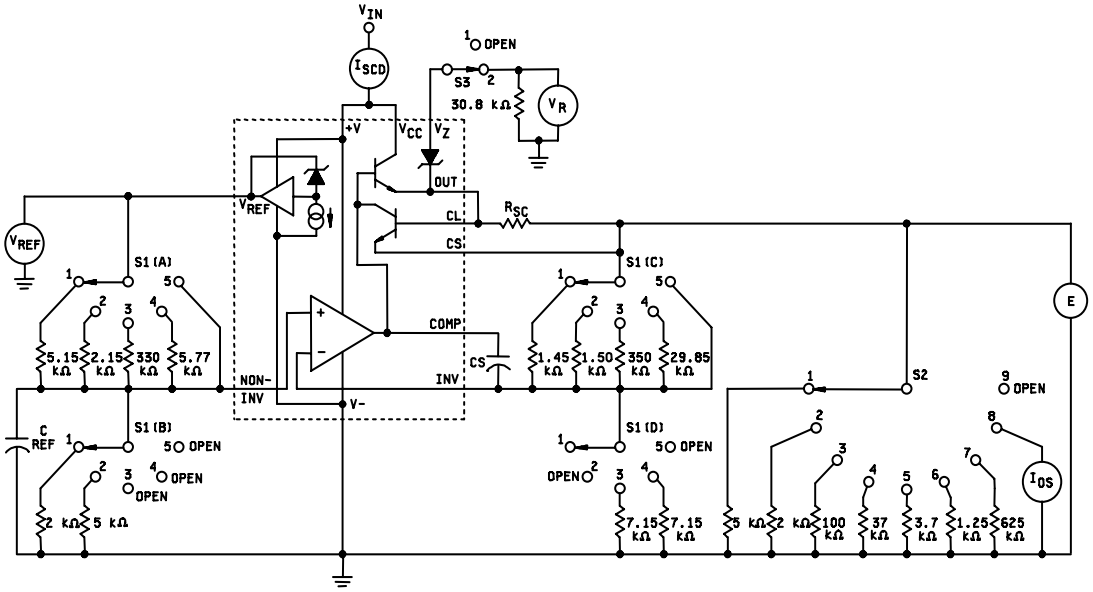


FIGURE 5. Test circuit for static and dynamic tests.

Parameter	Test	V_{IN} (volts)	Switch postions			Measure		Measured parameters equation	Units
			S1	S2	S3	Value	Units		
V_{RLINE}	1,11,15	12	2	1	1	E1	Volts	$V_{RLINE} = \frac{(E1 - E2)}{E1} \times 100$	% V_{OUT}
		15	2	1	1	E2	Volts		
V_{RLINE}	2	9.5	2	1	1	E3	Volts	$V_{RLINE} = \frac{(E3 - E4)}{E3} \times 100$	% V_{OUT}
		40	2	1	1	E4	Volts		
V_{RLINE}	3	12	1	2	1	E5	Volts	$V_{RLINE} = \frac{(E5 - E6)}{E5} \times 100$	% V_{OUT}
		40	1	2	1	E6	Volts		
V_{RLOAD}	4,12,16	12	2	1	1	E7	Volts	$V_{RLOAD} = \frac{(E7 - E8)}{E7} \times 100$	% V_{OUT}
		12	2	3	1	E8	Volts		
V_{RLOAD}	5	40	4	4	1	E9	Volts	$V_{RLOAD} = \frac{(E9 - E10)}{E9} \times 100$	% V_{OUT}
		40	4	5	1	E10	Volts		
V_{RLOAD}	6	10	3	6	1	E11	Volts	$V_{RLOAD} = \frac{(E11 - E12)}{E11} \times 100$	% V_{OUT}
		10	3	7	1	E12	Volts		
V_{REF}	7,13,17	12	2	1	1	V_{REF}	Volts		
I_{OS}	8	12	2	8	1	I_{OS}	mA		
I_{SD}	9,14,18	30	5	9	1	I_{SD}	mA		
V_Z	10	40	4	4	2	V_R	Volts	V_Z = E9 - VR	Volts
TC_{VOUT}	25,26	12	2	1	1	E1	Volts	See notes 4 and 5	%/°C

FIGURE 5. Test circuit for static and dynamic tests – Continued.

NOTES

1. Unless otherwise specified:
   V_{IN} = V+ = V_{CC} = 12 V, V- = 0 V, I_L = 1 mA, R_{SC} = 0 Ω, C1 = 100 pF, and C_{REF} = 0

2. Resistor values required to set output voltage.

   a. For V_{OUT} = 2 to 7 V dc, R1, R2, R3, and R4 are determined as follows:

      $V_{OUT} = V_{REF} \times (R2 / (R1 + R2))$, $V_{REF} / (R1 + R2) = 1$ mA,

      $(R1 \times R2) / (R1 + R2) = R3 \leq 10$ kΩ, R4 = Open circuit

   b. For V_{OUT} = 7 to 37 V dc, R1, R2, R3, and R4 are determined as follows:

      $V_{OUT} = V_{REF} \times ((R3 + R4) / R4)$, $V_{OUT} / (R3 + R4) = 1$ mA,

      $(R3 \times R4) / (R3 + R4) = R1 \leq 10$ kΩ, R2 = Open circuit

   c. For the purpose of this specification, the following table shall be used to determine the resistor value required to obtain a given nominal output voltage.

V_{OUT}	R1 S1(A)	R2 S1(B)	R3 S1(C)	R4 S1(D)
2 V	5.15 kΩ	2 kΩ	1.45 kΩ	∞
5 V	2.15 kΩ	5 kΩ	1.50 kΩ	∞
7.5 V	0.33 kΩ	∞	0.35 kΩ	7.15 kΩ
3.7 V	5.77 kΩ	∞	29.85 kΩ	7.15 kΩ

      If 1 percent resistors are used, nominal V_{OUT} will be achieved within ±5 percent.

3. R_L chosen to obtain required I_L for given nominal output voltage.

4. T_C V_{OUT}:

   25°C to 125°C = 100 $((V_{OUT}$ @ 25°C – V_{OUT} @ 125°C) / V_{OUT} @ 25°C) ÷ 100°C = % / °C.

5. T_C V_{OUT}:

   -55°C to 25°C = 100 $((V_{OUT}$ @ 55°C – V_{OUT} @ 25°C) / V_{OUT} @ 25°C) ÷ 100°C = % / °C.

6. Precautions shall be taken to prevent damage to the device under test during insertion into socket and change of switch positions (e.g., disable power supplies, current limit, V_{CC}, V+, V-, etc.).

FIGURE 5. Test circuit for static and dynamic tests – Continued.

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. Issue of DoDISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1).

c. Packaging requirements (see 5.1).

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.

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:

Line regulation. The percentage change in output voltage for a specified change in input voltage (V_{RLINE}).

Load regulation. The percentage change in output voltage for a specified change in load current (V_{RLOAD}).

Ripple rejection. The ratio of the peak to peak input ripple voltage to the peak to peak output ripple voltage (V_{OUT} / V_{IN}).

Average temperature coefficient of output voltage. The percentage change in output voltage for a specified change in ambient temperature (TC_{VOUT}).

Short circuit current limit. The output current of the regulator with the output shorted to the negative supply (I_{OS}).

Reference voltage. The output of the reference amplifier measured with respect to the negative supply (V_{REF}).

Output noise voltage. The rms output noise voltage with constant load and no input ripple (N_O).

Standby current drain. The supply current drawn by the regulator with no output load and no reference voltage load (I_{SCD}).

Input voltage range. The range of supply voltage over which the regulator will operate.

Input-output voltage differential. The range of voltage difference between the supply voltage and the regulator output voltage over which the regulator will operate.

Sense voltage. The voltage between current sense and current limit terminals necessary to cause current limiting.

Transient response. The closed-loop step function response of the regulator under small-signal conditions.

6.6 Logistic support. Lead materials and finishes (see 3.4) are interchangeable. Unless otherwise specified, microcircuits acquired to Government logistic support will be acquired to device class B (see 1.2.2), and 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	723

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

Project 5962-1975

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.

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3. The preparing activity must provide a reply within 30 days from receipt of the form.

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I RECOMMEND A CHANGE:	1. DOCUMENT NUMBER MIL-M-38510/102C	2. DOCUMENT DATE *(YYYYMMDD)* 2003/09/02

3. DOCUMENT TITLE

MICROCIRCUITS, LINEAR, VOLTAGE REGULATOR, MONOLITHIC SILICON, PART NUMBER M38510/10201

4. NATURE OF CHANGE *(Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)*

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME *(Last, First Middle Initial)*	b. ORGANIZATION	
c. ADDRESS *(Include Zip Code)*	d. TELEPHONE *(Include Area Code)* (1) Commercial (2) DSN *(If applicable)*	7. DATE SUBMITTED *(YYYYMMDD)*

8. PREPARING ACTIVITY

a. NAME Rick Officer	b. TELEPHONE *(Include Area Code* (1) Commercial 614-692-0518 (2) DSN 850-0518
c. ADDRESS *(Include Zip Code)* DSCC-VAS 3990 East Broad Street Columbus, Ohio 43216-5000	IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Standardization Program Office (DLSC-LM) 8725 John J. Kingman Road, Suite 2533 Fort Belvoir, Virginia 22060-6221 Telephone (703)767-6888 DSN 427-6888

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WHS/DIOR, Feb 99