

MILITARY SPECIFICATION

MICROCIRCUITS, DIGITAL, TTL,
 EXCLUSIVE-OR GATES MONOLITHIC SILICON

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

1. SCOPE

1.1 Scope. This specification covers the detail requirements for monolithic, silicon, TTL, quadruple 2-input exclusive-OR gate microcircuits. Three product assurance classes and a choice of case outline/lead finish are provided and are reflected in the complete part number.

1.2 Part number. The complete part number shall be as shown in the following example:

M38510	/007	01	B	A	C
Military designator	Detail specification	Device type (1.2.1)	Device class (1.2.2)	Case outline (1.2.3)	Lead finish (3.3)

1.2.1 Device type. The device type shall be as follows:

Device type	Circuit
01	Quadruple 2-input exclusive-or gate

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

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

- Case outline A - 1/4" x 1/4" flat pack
- Case outline B - 1/4" x 1/8" flat pack
- Case outline C - Dual-in-line pack
- Case outline D - 1/4" x 3/8" flat pack

1.2.4 Absolute maximum ratings.

Supply voltage range - - - - -	-0.5 Vdc to 7.0 Vdc
Input voltage range - - - - -	-1.5 Vdc at -12 mA to 5.5 Vdc
Storage temperature range - - - - -	-65°C to 150°C
Maximum power dissipation, P _D ^{1/} - - - - -	64 mWdc per gate
Lead temperature (soldering 10 seconds) - -	300°C
Thermal resistance, junction to case - - - -	$\theta_{JC} = \begin{cases} 0.15^\circ\text{C}/\text{mW} \text{ for flat pack} \\ 0.08^\circ\text{C}/\text{mW} \text{ for dual-in-line pack} \end{cases}$
Junction temperature - - - - -	T _J = 175°C

1.2.5 Recommended operating conditions.

Supply voltage - - - - -	4.5 Vdc minimum to 5.5 Vdc maximum
Minimum high level input voltage - - - - -	2.0 Vdc
Maximum low level input voltage - - - - -	0.8 Vdc
Logical "0" fanout (each output) - - - - -	10 maximum
Logical "1" fanout (each output) - - - - -	20 maximum
Ambient operating temperature range - - - -	-55°C to 125°C

^{1/} Must withstand the added P_D due to short circuit condition (e.g. I_{OS}) at one output for five (5) seconds duration.

2. APPLICABLE DOCUMENT

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

SPECIFICATION

MILITARY

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

STANDARD

MILITARY

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

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

3. REQUIREMENTS

3.1 Detail specifications. The individual item requirements shall be in accordance with MIL-M-38510, and as specified herein. In the event of conflict between MIL-M-38510 and this detail specification, this detail specification shall govern.

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

3.2.1 Case outline.

3.2.1.1 Case outline A. Case outline A shall be in accordance with F-1 of Appendix C to MIL-M-38510.

3.2.1.2 Case outline B. Case outline B shall be in accordance with F-3 of Appendix C to MIL-M-38510.

3.2.1.3 Case outline C. Case outline C shall be in accordance with D-1 of Appendix C to MIL-M-38510.

3.2.1.4 Case outline D. Case outline D shall be in accordance with F-2 of Appendix C to MIL-M-38510.

3.2.2 Logic diagram and terminal connections. The logic diagram and terminal connections shall be as specified on figure 1.

3.2.3 Truth tables and logic equations. The truth tables and logic equations shall be as specified on figure 2.

3.2.4 Schematic circuit. The schematic circuit shall be as specified on figure 3.

3.3 Lead material and finish. Lead material and finish shall be in accordance with MIL-M-38510 (see 6.5).

3.4 Electrical performance characteristics. The electrical performance characteristics are as specified in table I, and apply over the full recommended ambient operating temperature range, unless otherwise specified.

TABLE I. Electrical performance characteristics.

Test	Symbol	Conditions	Limits		Units
			Min	Max	
High-level output voltage	V _{OH}	V _{CC} = 4.5V, V _{IN} = 2.0V V _{IN} = 0.8V, I _{OH} = -800 μ A <u>1/</u>	2.4	---	Volts
Low-level output voltage	V _{OL}	V _{CC} = 4.5V, V _{IN} = 2.0V (all) or V _{IN} = 0.8V (all) I _{OL} = 16 mA <u>1/</u>	---	0.4	Volts
Input clamp voltage	V _{IC}	V _{CC} = 4.5V, I _{IN} = -12 mA at T _A = 25°C (only)	---	-1.5	Volts
High-level input current	I _{IH1}	V _{CC} = 5.5V, V _{IN} = 2.4V <u>2/</u>	---	40	μ A
High-level input current	I _{IH2}	V _{CC} = 5.5V, V _{IN} = 5.5V <u>2/</u>	---	100	μ A
Low-level input current	I _{IL}	V _{CC} = 5.5V, V _{IN} = 0.4V <u>1/</u>	-0.7	-1.6	mA
Short-circuit output current	I _{OS}	V _{CC} = 5.5V, V _{IN} = 5.5V V _{IN} = 0.0V, <u>2/ 3/</u>	-20	-65	mA
High-level supply current per gate	I _{CCH}	V _{CC} = 5.5V, V _{IN} = 5.5V, V _{IN} = GND <u>2/</u>	---	10	mA
Low-level supply current per gate	I _{CCL1}	V _{CC} = 5.5V, V _{IN} = 0.0V (all inputs)	---	10.5	mA
Low-level supply current per gate	I _{CCL2}	V _{CC} = 5.5V, V _{IN} = 5.5V (all inputs)	---	11.5	mA
Propagation delay time high-to-low (other input low)	t _{PHL1}	V _{CC} = 5.0V, R _L = 390 Ω C _L = 50 pF	3	26	ns
Propagation delay time high-to-low (other input high)	t _{PHL2}	V _{CC} = 5.0V, C _L = 50 pF R _L = 390 Ω	3	30	ns
Propagation delay time low-to-high (other input low)	t _{PLH1}	V _{CC} = 5.0V, C _L = 50 pF R _L = 390 Ω	3	32	ns
Propagation delay time low-to-high (other input high)	t _{PLH2}	V _{CC} = 5.0V, C _L = 50 pF R _L = 390 Ω	3	37	ns

1/ All unspecified inputs at 5.5 volts.

2/ All unspecified inputs at 0.0 volts.

3/ Not more than one output should be shorted at one time.

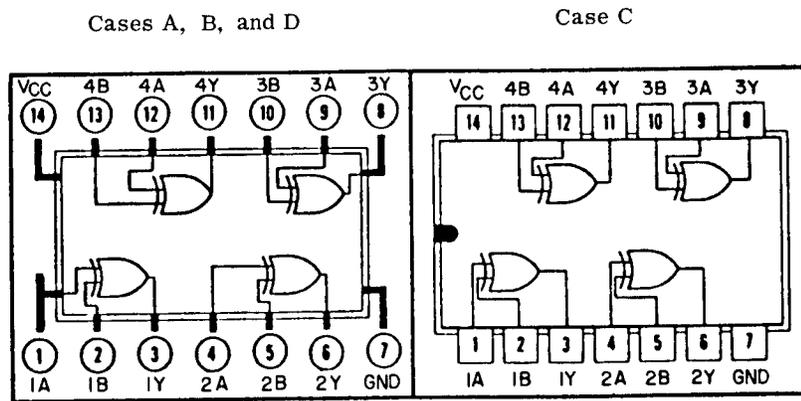


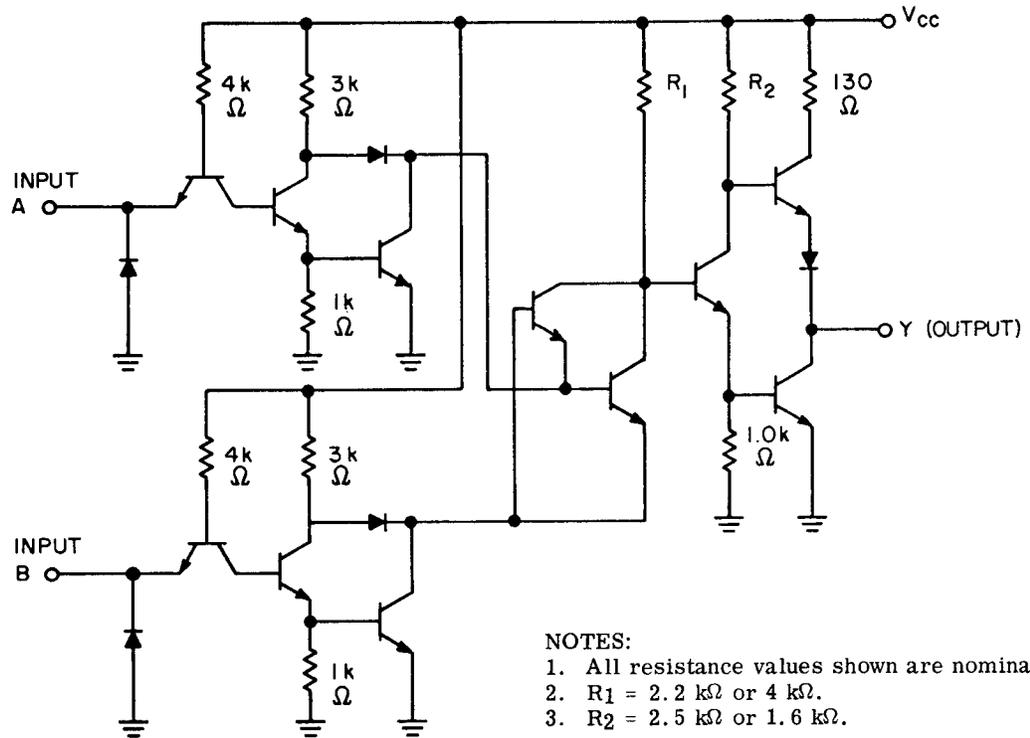
FIGURE 1. Logic diagram and terminal connections.

TRUTH TABLE (each gate)

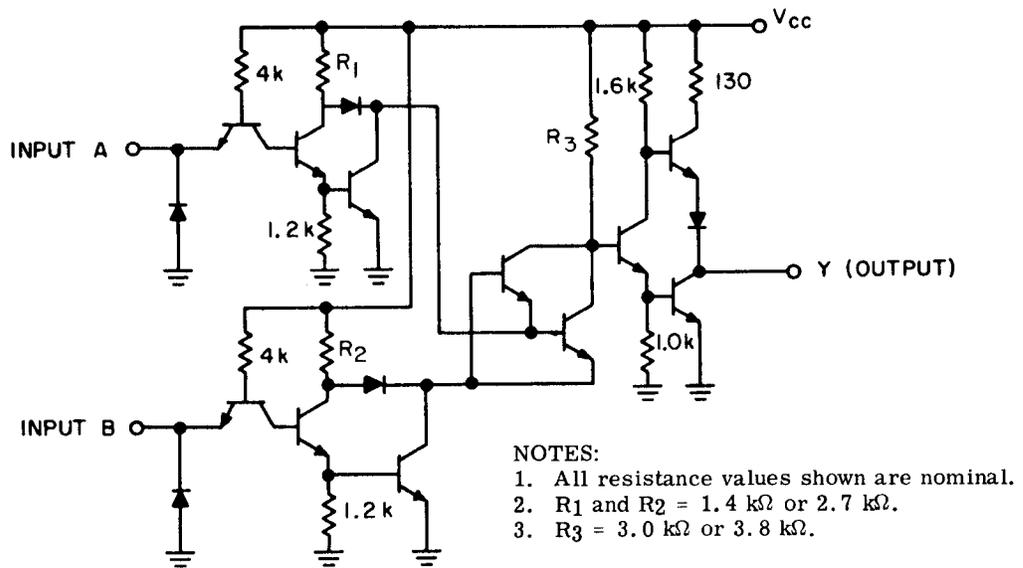
INPUTS		OUTPUTS
A	B	Y
L	L	L
L	H	H
H	L	H
H	H	L

Positive Logic: $Y = A \oplus B$

FIGURE 2. Truth Table

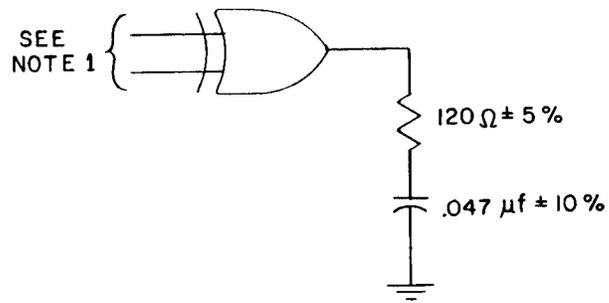


CIRCUIT A



Circuit B

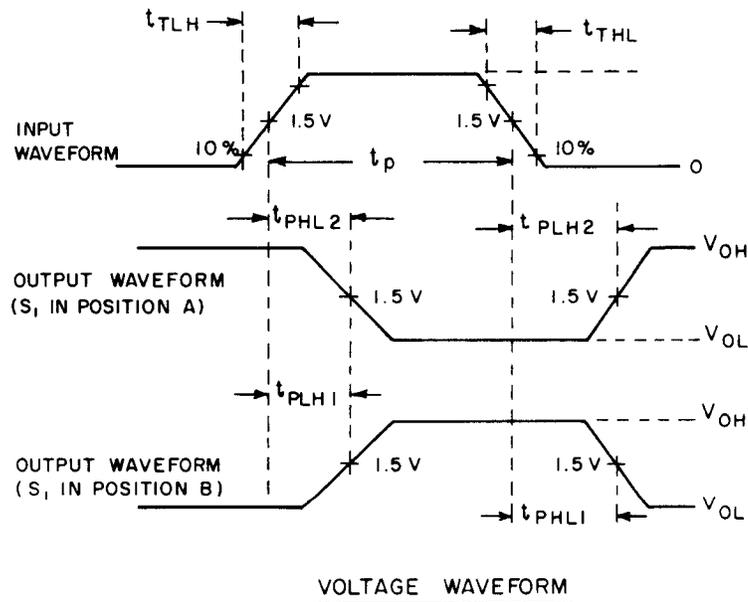
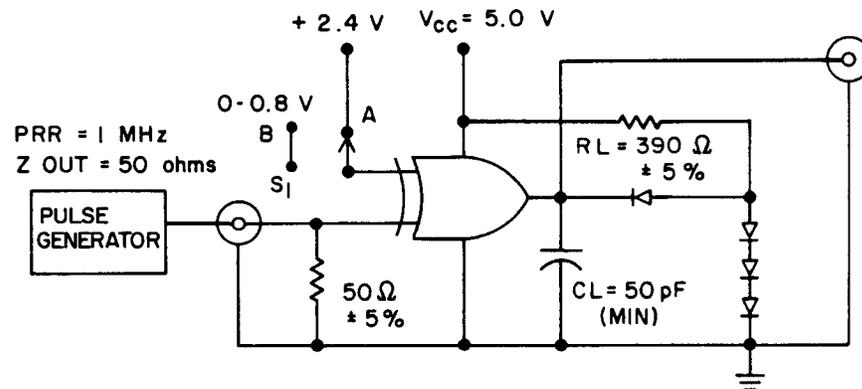
FIGURE 3. Schematic circuits.



NOTES:

1. One input of each gate shall be driven. Remaining gate inputs shall be connected to V_{CC} through appropriate current limiting resistors.
2. $V_{CC} = 5.0 \text{ V}$.
3. If parallel excitation is used, clock frequency shall be 100 kHz with minimum $V_{IN} = 3 \text{ V}$ and minimum duty cycle of 50%.

FIGURE 4. Burn-in and life test circuit.



NOTES:

- The generator has the following characteristics: $V_{gen} = 3 \text{ V}$, $t_{THL} = t_{TLH} < 15 \text{ ns}$, $t_p = 0.5 \text{ } \mu\text{s}$, PRR = 1 MHz, $Z_{out} \approx 50 \text{ } \Omega$.
- All diodes are 1N3064, or equivalent.
- C_L includes probe and jig capacitance.
- Each gate tested separately.

FIGURE 5. Switching time test circuit.

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

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

TABLE II. Electrical test requirements.

MIL-STD-883 Test requirement	Subgroups (see table III)		
	Class A devices	Class B devices	Class C devices
Interim electrical parameters (Pre Burn-In) (Method 5004)	1	1	None
Final electrical test parameters (Method 5004)	1*, 2, 3, 9	1*, 2, 3, 9	1
Group A test requirements (Method 5005)	1, 2, 3, 9 10, 11	1, 2, 3, 9	1, 2, 3, 9
Group C end point electrical parameters (Method 5005)	1, 2, 3	1, 2, 3	1
Additional electrical subgroups for Group C periodic inspections	None	10, 11	None

*PDA applies to subgroup 1 (see 4.3(e)).

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

- (a) Country of origin.

4. PRODUCT ASSURANCE PROVISIONS

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

4.2 Qualification inspection. Qualification inspection shall be in accordance with MIL-M-38510. Inspections to be performed shall be those specified herein for groups A, B, and C inspections (see 4.4.1, 4.4.2, and 4.4.3). After qualification of one or more electrically and structurally similar types with a single lead finish, other lead finishes of the same case outline may be qualified by submitting a single type in the qualified case outline to the group B, subgroup 3 test and the group C, subgroups 1, 3, and 4 tests.

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

- (a) Test samples for the group B bond strength test specified in Method 5005 of MIL-STD-883 may, at the manufacturer's option, be randomly selected immediately following the internal visual (precap) inspection and prior to sealing (see 4.4.2(a)).
- (b) Burn-in test (Method 1015 of MIL-STD-883).
 - (1) Test condition D or E, using the circuit shown on figure 4, or equivalent, subject to approval of qualifying activity.
 - (2) T_A = 125 °C minimum.

- (c) Reverse bias burn-in and interim electrical test in accordance with 3.1.10 of Method 5004 of MIL-STD-883 may be omitted.
- (d) 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.
- (e) Percent defective allowable (PDA) - The PDA is specified as 5 percent for class A devices and 10 percent for class B devices based on failures from group A, subgroup 1 test after cooldown as final electrical test in accordance with method 5004 of MIL-STD-883, and with no intervening electrical measurements. If interim electrical parameter tests are performed prior to burn-in, failures resulting from pre burn-in screening may be excluded from the PDA. If interim electrical parameter tests prior to burn-in are omitted, then all screening failures shall be included in the PDA. The verified failures of Group A, subgroup 1 after burn-in divided by the total number of devices submitted for burn-in in that lot shall be used to determine the percent defective for that lot, and the lot shall be accepted or rejected based on the PDA for the applicable device class.

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

4.4.1 Group A inspection. Group A inspection shall consist of the test subgroups and LTPD values shown in table I of Method 5005 of MIL-STD-883 and as follows:

- (a) Tests shall be as specified in table II.
- (b) Subgroups 4, 5, 6, 7, and 8 shall be omitted.

4.4.2 Group B inspection. Group B inspection shall consist of the test subgroups and LTPD values shown in table II of Method 5005 of MIL-STD-883 and as follows:

- (a) Bond strength test may be conducted on samples collected prior to sealing (see 4.3(a)).

4.4.3 Group C inspection. Group C inspection shall consist of the test subgroups and LTPD values shown in table III of Method 5005 of MIL-STD-883 and as follows:

- (a) End point electrical parameters shall be as specified in table II.
- (b) Subgroups 7 and 8 shall be added to the group C inspection requirements for class B devices and shall consist of the tests, conditions and limits specified for subgroups 10 and 11 of group A.
- (c) High temperature storage test (Method 1008 of MIL-STD-883) conditions:
 - (1) Temperature: $150 \pm 10^{\circ}\text{C}$.
 - (2) Duration: 1,000 hours, except as otherwise permitted by Appendix B of MIL-M-38510.
- (d) Operating life test (Method 1005 of MIL-STD-883) conditions:
 - (1) Test condition D or E, using the circuit shown on figure 4, or equivalent, subject to approval of qualifying activity.
 - (2) $T_A = 125^{\circ}\text{C}$, minimum.
 - (3) Test duration: 1,000 hours, except as permitted by Appendix B of MIL-M-38510.
- (e) Omit steady state reverse bias test.

4.5 Methods of examination and test. Methods of examination and test shall be as specified in the appropriate tables and as follows.

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

Subgroup	Symbol	ML-STD-883 method	Case A, B, D		3	4	5	6	7	9	10	8	11	12	13	14	Meas. terminal		Test limits						
			Case C	Test No.													1A	1B	1A	1B	Min	Max	Unit		
1 TA=25°C	IH2	3010	5.5 v GND	1A	1Y	2A	2B	2Y	GND	3A	3B	3Y	4Y	GND	GND	VCC	1A	1B	100	μA					
					1B	5.5 v	GND	5.5 v	GND	5.5 v	GND	5.5 v	GND	5.5 v	GND	5.5 v	GND	5.5 v	2A	2B					
					1A	5.5 v	GND	5.5 v	GND	5.5 v	GND	5.5 v	GND	5.5 v	GND	5.5 v	GND	5.5 v	3A	3B					
					1B	5.5 v	GND	5.5 v	GND	5.5 v	GND	5.5 v	GND	5.5 v	GND	5.5 v	GND	5.5 v	4A	4B					
					1A	5.5 v	GND	5.5 v	GND	5.5 v	GND	5.5 v	GND	5.5 v	GND	5.5 v	GND	5.5 v	1A	1B					
					1B	5.5 v	GND	5.5 v	GND	5.5 v	GND	5.5 v	GND	5.5 v	GND	5.5 v	GND	5.5 v	2A	2B					
					1A	5.5 v	GND	5.5 v	GND	5.5 v	GND	5.5 v	GND	5.5 v	GND	5.5 v	GND	5.5 v	3A	3B					
					1B	5.5 v	GND	5.5 v	GND	5.5 v	GND	5.5 v	GND	5.5 v	GND	5.5 v	GND	5.5 v	4A	4B					
					1A	5.5 v	GND	5.5 v	GND	5.5 v	GND	5.5 v	GND	5.5 v	GND	5.5 v	GND	5.5 v	1A	1B					
					1B	5.5 v	GND	5.5 v	GND	5.5 v	GND	5.5 v	GND	5.5 v	GND	5.5 v	GND	5.5 v	2A	2B					
					1A	5.5 v	GND	5.5 v	GND	5.5 v	GND	5.5 v	GND	5.5 v	GND	5.5 v	GND	5.5 v	3A	3B					
					1B	5.5 v	GND	5.5 v	GND	5.5 v	GND	5.5 v	GND	5.5 v	GND	5.5 v	GND	5.5 v	4A	4B					
					2	IOS	3011	5.5 v GND	49	GND	GND	GND	GND	GND	1Y	2Y	-20	-65							
										GND	GND	GND	GND	GND	GND	GND	3Y	4Y							
GND	GND	GND	GND	GND						GND	GND	GND	VCC	VCC											
GND	GND	GND	GND	GND						GND	GND	GND	VCC	VCC											
GND	GND	GND	GND	GND						GND	GND	GND	VCC	VCC											
GND	GND	GND	GND	GND						GND	GND	GND	VCC	VCC											
3	ICCI2	55 CKT D	5.5 v	55 CKT D	5.5 v	5.5 v	5.5 v	5.5 v	5.5 v	5.5 v	5.5 v	5.5 v	5.5 v	5.5 v	5.5 v	5.5 v	VCC	VCC		46					
					5.5 v	5.5 v	5.5 v	5.5 v	5.5 v	5.5 v	5.5 v	5.5 v	5.5 v	5.5 v	5.5 v	5.5 v	5.5 v	5.5 v	VCC	VCC					

2 Same tests, terminal conditions and limits as for subgroup 1, except TA = 125°C and VIC tests are omitted.

3 Same tests, terminal conditions and limits as for subgroup 1, except TA = -55°C and VIC tests are omitted.

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

Subgroup	Symbol	MIL-STD-883 method	Case A, B, D				Case C				Case E				Meas. terminal				Test limits					
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	14	14	Min	Max	Unit			
9 T _A = 25°C	t _{PHL1} ↓ t _{PHL2} ↓ t _{PLH1} ↓ t _{PLH2} ↓	3003 (Fig. 5)	56	in	0.8 v	out	1A	1Y	2A	2B	2Y	GND	3A	3B	3Y	4A	4B	VCC	1A to 1Y	3	22	ns		
			57	in	0.8 v	out	1A	1Y	2A	2B	2Y	GND	3A	3B	3Y	4A	4B	VCC	2A to 2Y	3	22	ns		
			58	in	0.8 v	out	1A	1Y	2A	2B	2Y	GND	3A	3B	3Y	4A	4B	VCC	3A to 3Y	3	22	ns		
			59	in	0.8 v	out	1A	1Y	2A	2B	2Y	GND	3A	3B	3Y	4A	4B	VCC	4A to 4Y	3	22	ns		
			60	in	2.4 v	out	in	in	0.8 v	out	in	in	0.8 v	out	in	in	0.8 v	out	in	0.8 v	1A to 1Y	3	24	ns
			61	in	2.4 v	out	in	in	2.4 v	out	in	in	2.4 v	out	in	in	2.4 v	out	in	2.4 v	2A to 2Y	3	24	ns
			62	in	0.8 v	out	in	in	0.8 v	out	in	in	0.8 v	out	in	in	0.8 v	out	in	0.8 v	3A to 3Y	3	24	ns
			63	in	0.8 v	out	in	in	0.8 v	out	in	in	0.8 v	out	in	in	0.8 v	out	in	0.8 v	4A to 4Y	3	24	ns
			64	in	0.8 v	out	in	in	0.8 v	out	in	in	0.8 v	out	in	in	0.8 v	out	in	0.8 v	1A to 1Y	3	27	ns
			65	in	0.8 v	out	in	in	0.8 v	out	in	in	0.8 v	out	in	in	0.8 v	out	in	0.8 v	2A to 2Y	3	27	ns
			66	in	0.8 v	out	in	in	0.8 v	out	in	in	0.8 v	out	in	in	0.8 v	out	in	0.8 v	3A to 3Y	3	27	ns
10	t _{PHL1} ↓ t _{PHL2} ↓ t _{PLH1} ↓ t _{PLH2} ↓		67	in	2.4 v	out	in	in	2.4 v	out	in	in	2.4 v	out	in	in	2.4 v	out	1A to 1Y	3	30	ns		
			68	in	2.4 v	out	in	in	2.4 v	out	in	in	2.4 v	out	in	in	2.4 v	out	2A to 2Y	3	30	ns		
			69	in	2.4 v	out	in	in	2.4 v	out	in	in	2.4 v	out	in	in	2.4 v	out	3A to 3Y	3	30	ns		
			70	in	2.4 v	out	in	in	2.4 v	out	in	in	2.4 v	out	in	in	2.4 v	out	4A to 4Y	3	30	ns		
			71	in	2.4 v	out	in	in	2.4 v	out	in	in	2.4 v	out	in	in	2.4 v	out	1A to 1Y	3	30	ns		
11	Same tests and terminal conditions and limits as for subgroup 10, except T _A = -55°C.		72 to 75	Same tests and terminal conditions as for subgroup 9, except that T _A = 125°C.																3	26	ns		
			76 to 79																		3	30	ns	
			80 to 83																			3	32	ns
			84 to 87																			3	37	ns

NOTE:
1/ Terminal conditions (Pins not designated may be H ≥ 2.0 V, or I ≤ 0.8 V, or open).

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 cooldown procedure. When devices are measured at 25°C following application of the operating life or burn-in test condition, they shall be cooled to room temperature prior to removal of the bias. Alternately, the bias may be removed during cooling if the case temperature is reduced to room temperature within 30 minutes after removal of the test condition.

4.6 Inspection of preparation for delivery. Inspection of preparation for delivery shall be in accordance with MIL-M-38510, except that the rough handling test shall not apply.

5. PREPARATION FOR DELIVERY

5.1 Preservation-packaging and packing. Microcircuits shall be prepared for delivery in accordance with MIL-M-38510.

6. NOTES

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

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

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

- (a) Complete part number (see 1.2).
- (b) Requirements for delivery of one copy of the quality conformance inspection data pertinent to the device inspection lot to be supplied with each shipment by the device manufacturer, if applicable.
- (c) Requirement for certificate of compliance, if applicable.
- (d) Requirements for notification of change of product or process to procuring activity in addition to notification to qualifying activity, if applicable.
- (e) Requirements for packaging and packing, if other than level C of MIL-M-55565.
- (f) Requirements for failure analysis (including required test condition of Method 5003), corrective action and reporting of results, if applicable.
- (g) Requirements for product assurance options.
- (h) Requirements for carriers, special lead lengths or lead forming, if applicable. These requirements shall not affect the part number.

6.4 Abbreviations, symbols, and definitions. The abbreviations, symbols, and definitions used herein are defined in MIL-STD-1313, MIL-STD-1331 and as follows:

GND	- - - - -	Electrical ground (common terminal)
VIN	- - - - -	Voltage level at an input terminal
VIC	- - - - -	Input clamp voltage
IIN	- - - - -	Current flowing into an input terminal

6.5 Logistic support. Lead materials and finishes (see 3.3), are interchangeable. Unless otherwise specified, microcircuits procured for Government logistic support will be procured to device class "B" (see 1.2.2), lead material and finish "C" (see 3.3), and case outline "A" (see 1.2.3). There is no substitute for case outline "C". Longer length leads and lead forming shall not affect the part number.

6.6 Substitutability. Microcircuits covered by this specification will replace commercial device types:

<u>Device type</u>	<u>Commercial type</u>
01	5486 (Circuit A - SN5486, S5486 and 7486)
01	5486 (Circuit B)
01	MC3021 (Circuit B)

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

Review activities:
Army - EL, MI, MU
Air Force - 11, 17, 80
DSA - ES

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

Preparing activity:
Air Force - 17

Agent:
DSA - ES

(Project 5962-0111)