National Semiconductor

October 1995

74VHC244 • 74VHCT244
Octal Buffer/Line Driver with TRI-STATE® Outputs

General Description

The 'VHC/'VHCT244 is an advanced high speed CMOS octal bus buffer fabricated with silicon gate C^2MOS technology. It achieves high speed operation similar to equivalent Bipolar Schottky TTL while maintaining the CMOS low power dissipation. The 'VHC/'VHCT244 is a non-inverting TRI-STATE buffer having two active-low output enables. These devices are designed to be used as TRI-STATE memory address drivers, clock drivers, and bus oriented transmitter/receivers.

An input protection circuit ensures that 0V–7V can be applied to the input pins without regard to the supply voltage. This device can be used to interface 5V to 3V systems and two supply systems such as battery back up. This circuit prevents device destruction due to mismatched supply and input voltages.

Features

- High noise immunity:
  VHC $V_{NIH} = V_{NIL} = 28\%\ V_{CC}$ (min)
  VHCT $V_{IH} = 2.0V$, $V_{IL} = 0.8V$
- Power down protection:
  VHC inputs only
  VHCT inputs and outputs
- Low noise:
  VHC $V_{OLP} = 0.6V$ (typ)
  VHCT $V_{OLP} = 0.7V$ (typ)
- Low power dissipation:
  $I_{CC} = 4\ \mu A$ (max) @ $T_A = 25°C$
- Balanced propagation delays: $t_{PLH} \cong t_{PHL}$
- Pin and function compatible with 74HC/HCT244

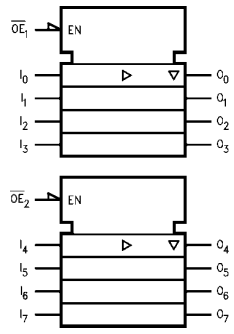
NOTE: ADD EXTERNAL PULL UP RESISTOR TO VHCT OUTPUTS TO DRIVE CMOS INPUTS

Commercial	Package Number	Package Description
74VHC244M	M20B	20-Lead Molded JEDEC SOIC
74VHC244SJ	M20D	20-Lead Molded EIAJ SOIC
74VHC244MSC	MSC20	20-Lead Molded EIAJ Type 1 SSOP
74VHC244MTC	MTC20	20-Lead Molded JEDEC Type 1 TSSOP
74VHC244N	N20A	20-Lead Molded DIP
74VHCT244M	M20B	20-Lead Molded JEDEC SOIC
74VHCT244SJ	M20D	20-Lead Molded EIAJ SOIC
74VHCT244MTC	MTC20	20-Lead Molded JEDEC Type 1 TSSOP
74VHCT244N	N20A	20-Lead Molded DIP

Note: Surface mount packages are also available on Tape and Reel. Specify by appending the suffix letter "X" to the ordering code. EIAJ Type 1 SSOP available on Tape and Reel only, order MSCX.

Logic Symbol

IEEE/IEC



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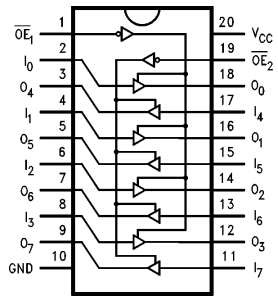
Connection Diagram

Pin Assignment for DIP, SSOP, TSSOP and SOIC



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Truth Tables

Inputs		Outputs (Pins 12, 14, 16, 18)
$\overline{OE}_1$	I_n	
L	L	L
L	H	H
H	X	Z

Inputs		Outputs (Pins 3, 5, 7, 9)
$\overline{OE}_2$	I_n	
L	L	L
L	H	H
H	X	Z

H = HIGH Voltage Level
L = LOW Voltage Level
I = Immaterial
Z = High Impedance

Pin Names	Description
$\overline{OE}_1$, $\overline{OE}_2$	TRI-STATE Output Enable Inputs
I_0–I_7	Inputs
O_0–O_7	TRI-STATE Outputs

TRI-STATE® is a registered trademark of National Semiconductor Corporation.

Absolute Maximum Ratings (Note 1)

Supply Voltage (V_{CC})	−0.5V to +7.0V
DC Input Voltage (V_{IN})	−0.5V to +7.0V
DC Output Voltage (V_{OUT})	
VHC	−0.5V to V_{CC} + 0.5V
VHCT*	−0.5V to 7.0V
Input Diode Current (I_{IK})	−20 mA
Output Diode Current (I_{OK})	
VHC	±20 mA
VHCT	−20 mA
DC Output Current (I_{OUT})	±25 mA
DC V_{CC}/GND Current (I_{CC})	±75 mA
Storage Temperature (T_{STG})	−65°C to +150°C
Lead Temperature (T_L)	
(Soldering, 10 seconds)	260°C

*V_{OUT} > V_{CC} only if output is in H or Z state.

Note 1: *Absolute Maximum Ratings are values beyond which the device may be damaged or have its useful life impaired. The databook specifications should be met, without exception, to ensure that the system design is reliable over its power supply, temperature, and output/input loading variables. National does not recommend operation outside databook specifications.*

Recommended Operating Conditions

Supply Voltage (V_{CC})	
VHC	2.0V to 5.5V
VHCT	4.5V to 5.5V
Input Voltage (V_{IN})	0V to +5.5V
Output Voltage (V_{OUT})	0V to V_{CC}
Operating Temperature (T_{OPR})	
74VHC/VHCT	−40°C to +85°C
Input Rise and Fall Time (t_r, t_f)	
V_{CC} = 3.3V ±0.3V (VHC Only)	0 ns/V ~ 100 ns/V
V_{CC} = 5.0V ±0.5V	0 ns/V ~ 20 ns/V

DC Characteristics for 'VHC Family Devices

Symbol	Parameter	V_{CC} (V)	74VHC T_A = 25°C			74VHC T_A = −40°C to +85°C		Units	Conditions	
			Min	Typ	Max	Min	Max			
V_{IH}	High Level Input Voltage	2.0	1.5			1.5		V		
		3.0–5.5	0.7 V_{CC}			0.7 V_{CC}				
V_{IL}	Low Level Input Voltage	2.0			0.5		0.5	V		
		3.0–5.5			0.3 V_{CC}		0.3 V_{CC}			
V_{OH}	High Level Output Voltage	2.0	1.9	2.0		1.9		V	V_{IN} = V_{IH} or V_{IL}	I_{OH} = −50 μA
		3.0	2.9	3.0		2.9				
		4.5	4.4	4.5		4.4				
		3.0	2.58			2.48		V		I_{OH} = −4 mA
		4.5	3.94			3.80				I_{OH} = −8 mA
V_{OL}	Low Level Output Voltage	2.0		0.0	0.1		0.1	V	V_{IN} = V_{IH} or V_{IL}	I_{OL} = 50 μA
		3.0		0.0	0.1		0.1			
		4.5		0.0	0.1		0.1			
		3.0			0.36		0.44	V		I_{OL} = 4 mA
		4.5			0.36		0.44			I_{OL} = 8 mA

DC Characteristics for 'VHC Family Devices (Continued)

Symbol	Parameter	V_{CC} (V)	74VHC $T_A = 25°C$			74VHC $T_A = -40°C$ to $+85°C$		Units	Conditions
			Min	Typ	Max	Min	Max		
I_{OZ}	TRI-STATE Output Off-State Current	5.5			±0.25		±2.5	μA	$V_{IN} = V_{IH}$ or V_{IL} $V_{OUT} = V_{CC}$ or GND
I_{IN}	Input Leakage Current	0–5.5			±0.1		±1.0	μA	$V_{IN} = 5.5V$ or GND
I_{CC}	Quiescent Supply Current	5.5			4.0		40.0	μA	$V_{IN} = V_{CC}$ or GND

DC Characteristics for 'VHC Family Devices

Symbol	Parameter	V_{CC} (V)	74VHC $T_A = 25°C$		Units	Conditions
			Typ	Limits		
V_{OLP}**	Quiet Output Maximum Dynamic V_{OL}	5.0	0.6	0.9	V	$C_L = 50$ pF
V_{OLV}**	Quiet Output Minimum Dynamic V_{OL}	5.0	−0.6	−0.9	V	$C_L = 50$ pF
V_{IHD}**	Minimum High Level Dynamic Input Voltage	5.0		3.5	V	$C_L = 50$ pF
V_{ILD}**	Maximum High Level Dynamic Input Voltage	5.0		1.5	V	$C_L = 50$ pF

**Parameter guaranteed by design.

DC Characteristics for 'VHCT Family Devices

Symbol	Parameter	V_{CC} (V)	74VHC $T_A = 25°C$			74VHC $T_A = -40°C$ to $+85°C$		Units	Conditions	
			Min	Typ	Max	Min	Max			
V_{IH}	High Level Input Voltage	4.5 5.5	2.0 2.0			2.0 2.0		V		
V_{IL}	Low Level Input Voltage	4.5 5.5			0.8 0.8		0.8 0.8	V		
V_{OH}	High Level Output Voltage	4.5	3.15	3.65		3.15		V	$V_{IN} = V_{IH}$ or V_{IL}	$I_{OH} = -50\ \mu A$
		4.5	2.5			2.4				$I_{OH} = -8$ mA
V_{OL}	Low Level Output Voltage	4.5		0.0	0.1		0.1	V	$V_{IN} = V_{IH}$ or V_{IL}	$I_{OL} = 50\ \mu A$
		4.5			0.36		0.44			$I_{OL} = 8$ mA
I_{OZ}	TRI-STATE Output Off-State Current	5.5			± 0.25		± 2.5	μA	$V_{IN} = V_{IH}$ or V_{IL} $V_{OUT} = V_{CC}$ or GND	
I_{IN}	Input Leakage Current	0–5.5			± 0.1		± 1.0	μA	$V_{IN} = 5.5V$ or GND	
I_{CC}	Quiescent Supply Current	5.5			4.0		40.0	μA	$V_{IN} = V_{CC}$ or GND	
I_{CCT}	Maximum I_{CC}/Input	5.5			1.35		1.50	mA	$V_{IN} = 3.4V$, Other Inputs $= V_{CC}$ or GND	
I_{OPD}	Output Leakage (Power Down State)	0.0			$+0.5$		$+5.0$	μA	$V_{OUT} = 5.5V$	

DC Characteristics for 'VHCT Family Devices:

Symbol	Parameter	V_{CC} (V)	74VHCT $T_A = 25°C$		Units	Conditions
			Typ	Limits		
V_{OLP}**	Quiet Output Maximum Dynamic V_{OL}		0.7	1.0	V	$C_L = 50$ pF
V_{OLV}**	Quiet Output Minimum Dynamic V_{OL}		-0.7	-1.0	V	$C_L = 50$ pF
V_{IHD}**	Minimum High Level Dynamic Input Voltage			2.0	V	$C_L = 50$ pF
V_{ILD}**	Maximum High Level Dynamic Input Voltage			0.8	V	$C_L = 50$ pF

**Parameter guaranteed by design.

AC Electrical Characteristics for 'VHC Family Devices:

Symbol	Parameter	V_{CC} (V)	74VHC $T_A = 25°C$			74VHC $T_A = -40°C$ to $+85°C$		Units	Conditions	
			Min	Typ	Max	Min	Max			
t_{PLH}, t_{PHL}	Propagation Delay Time	3.3 ±0.3		5.8	8.4	1.0	10.0	ns		$C_L = 15$ pF
				8.3	11.9	1.0	13.5			$C_L = 50$ pF
		5.0 ±0.5		3.9	5.5	1.0	6.5	ns		$C_L = 15$ pF
				5.4	7.5	1.0	8.5			$C_L = 50$ pF
t_{PZL}, t_{PZH}	TRI-STATE Output Enable Time	3.3 ±0.3		6.6	10.6	1.0	12.5	ns	$R_L = 1$ kΩ	$C_L = 15$ pF
				9.1	14.1	1.0	16.0			$C_L = 50$ pF
		5.0 ±0.5		4.7	7.3	1.0	8.5	ns		$C_L = 15$ pF
				6.2	9.3	1.0	10.5			$C_L = 50$ pF
t_{PLZ}, t_{PHZ}	TRI-STATE Output Disable Time	3.3 ±0.3		10.3	14.0	1.0	16.0	ns	$R_L = 1$ kΩ	$C_L = 50$ pF
		5.0 ±0.5		6.7	9.2	1.0	10.5			$C_L = 50$ pF
t_{OSLH}, t_{OSHL}	Output to Output Skew	3.3 ±0.3			1.5		1.5	ns	(Note 1)	$C_L = 50$ pF
		5.0 ±0.5			1.0		1.0			$C_L = 50$ pF
C_{IN}	Input Capacitance			4	10		10	pF	V_{CC} = Open	
C_{OUT}	Output Capacitance			6				pF	$V_{CC} = 5.0$V	
C_{PD}	Power Dissipation Capacitance			19				pF	(Note 2)	

Note 1: Parameter guaranteed by design. $t_{OSLH} = |t_{PLHmax} - t_{PLHmin}|$; $t_{OSHL} = |t_{PHLmax} - t_{PHLmin}|$.

Note 2: C_{PD} is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load. Average operating current can be obtained by the equation: I_{CC} (OPR.) = $C_{PD} * V_{CC} * f_{IN} + I_{CC}/8$ (per bit).

AC Electrical Characteristics for 'VHCT Family Devices

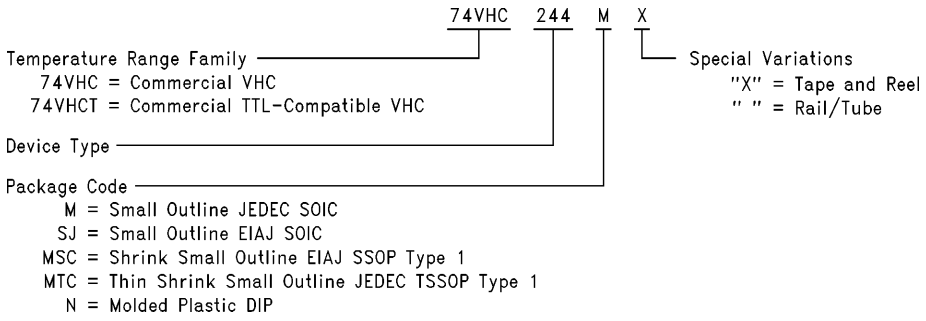
Symbol	Parameter	V_{CC} (V)	74VHCT $T_A = 25°C$			74VHCT $T_A = -40°C$ to $+85°C$		Units	Conditions	
			Min	Typ	Max	Min	Max			
t_{PLH}, t_{PHL}	Propagation Delay Time	5.0 ±0.5		5.4	7.4	1.0	8.5	ns		$C_L = 15$ pF
				5.9	8.4	1.0	9.5			$C_L = 50$ pF
t_{PZL}, t_{PZH}	TRI-STATE Output Enable Time	5.0 ±0.5		7.7	10.4	1.0	12.0	ns	$R_L = 1$ kΩ	$C_L = 15$ pF
				8.2	11.4	1.0	13.0			$C_L = 50$ pF
t_{PLZ}, t_{PHZ}	TRI-STATE Output Disable Time	5.0 ±0.5		8.8	11.4	1.0	13.0	ns	$R_L = 1$ kΩ	$C_L = 50$ pF
t_{OSLH}, t_{OSHL}	Output to Output Skew	5.0 ±0.5			1.0		1.0	ns	(Note 1)	$C_L = 50$ pF
C_{IN}	Input Capacitance			4	10		10	pF	V_{CC} = Open	
C_{OUT}	Output Capacitance			9				pF	$V_{CC} = 5.0$V	
C_{PD}	Power Dissipation Capacitance			18				pF	(Note 2)	

Note 1: Parameter guaranteed by design. $t_{OSLH} = |t_{PLHmax} - t_{PLHmin}|$; $t_{OSHL} = |t_{PHLmax} - t_{PHLmin}|$.

Note 2: C_{PD} is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load. Average operating current can be obtained by the equation: I_{CC} (OPR.) = C_{PD} * V_{CC} * f_{IN} + $I_{CC}/8$ (per bit).

Ordering Information

The device number is used to form part of a simplified purchasing code, where the package type and temperature range are defined as follows:



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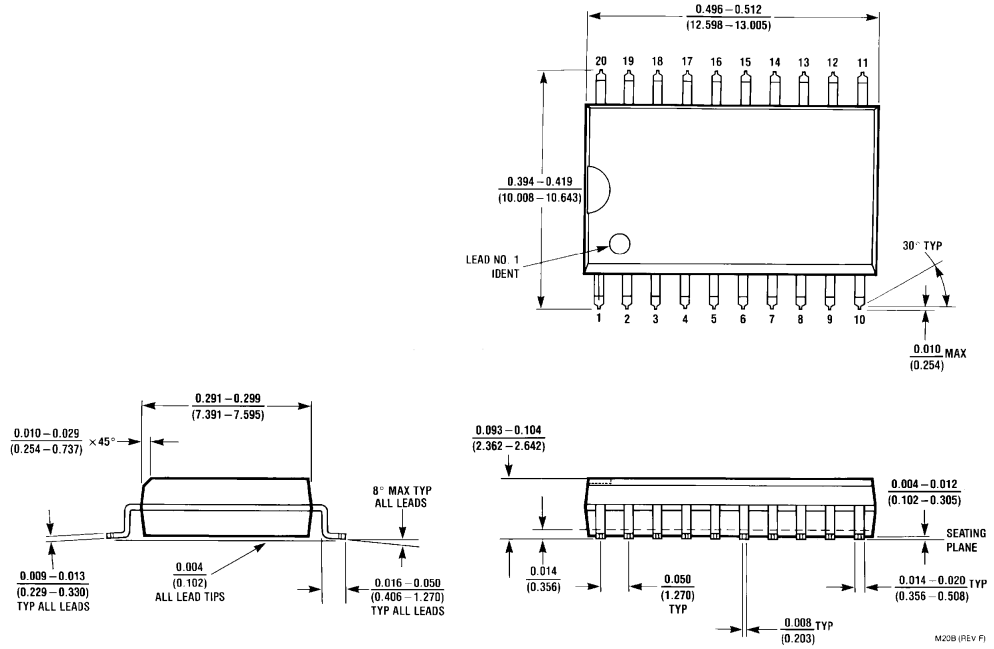
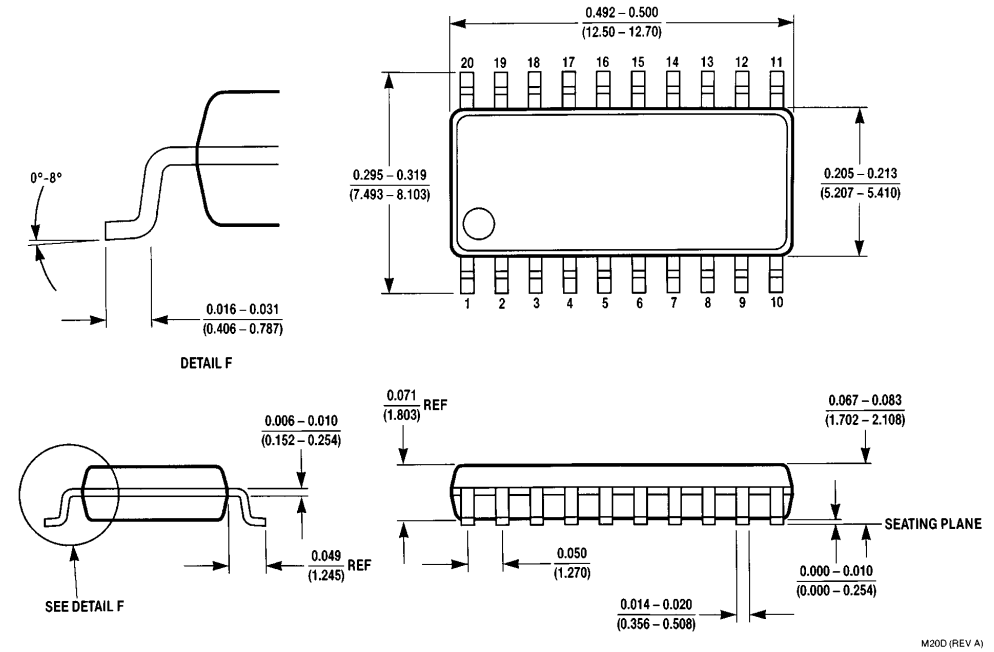
Physical Dimensions inches (millimeters)

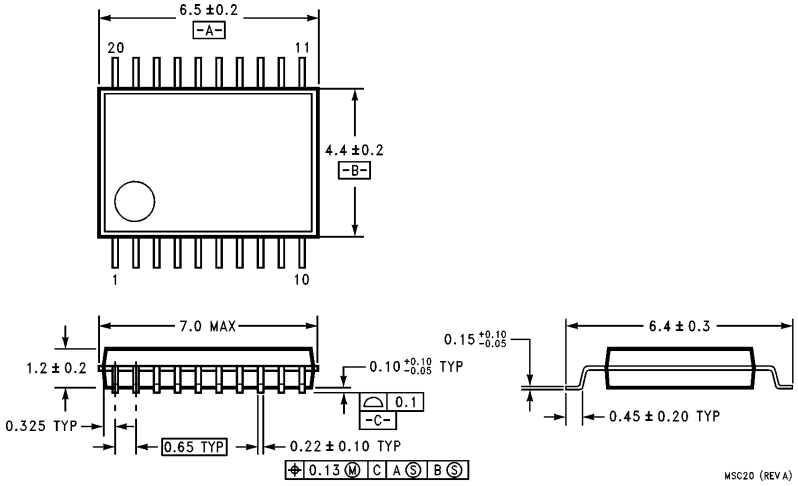


20-Lead Small Outline Integrated Circuit JEDEC SOIC (M)
Order Number 74VHC244M, 74VHC244MX, 74VHCT244M or 74VHCT244MX
NS Package Number M20B

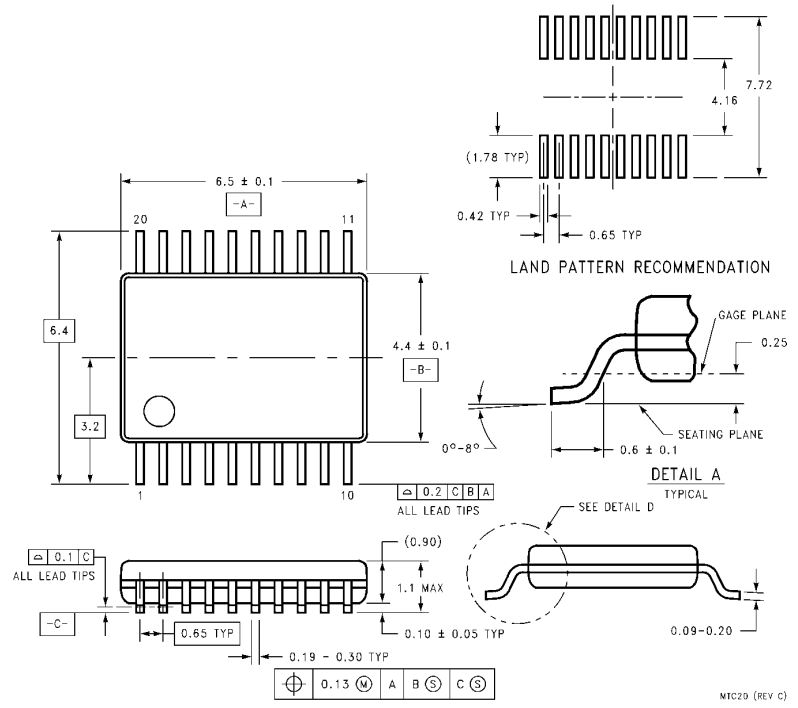


20-Lead Small Outline Integrated Circuit-EIAJ SOIC (SJ)
Order Number 74VHC244SJ, 74VHC244SJX, 74VHCT244SJ or 74VHCT244SJX
NS Package Number M20D

Physical Dimensions millimeters

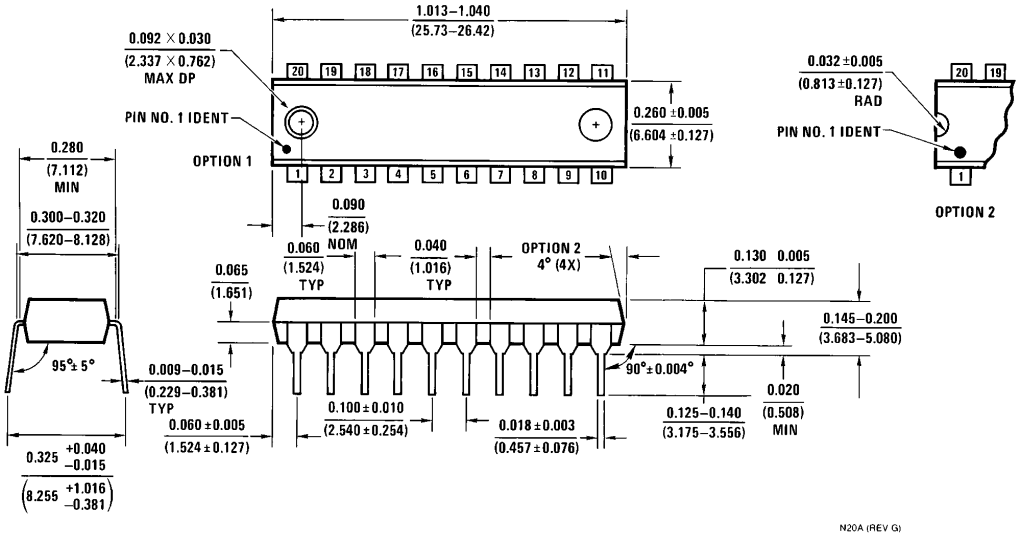


20-Lead Plastic EIAJ SSOP Type I (MSC)
Order Number 74VHC244MSCX
NS Package Number MSC20



20-Lead Plastic JEDEC TSSOP Type I (MTC)
Order Number 74VHC244MTC, 74VHC244MTCX, 74VHCT244MTC or 74VHCT244MTCX
NS Package Number MTC20

Physical Dimensions (millimeters) (Continued)



20-Lead Molded DIP
Order Number 74VHC244N or 74VHCT244N
NS Package Number N20A

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2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

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