National **S**emiconductor

November 1995

74VHC541
Octal Buffer/Line Driver with TRI-STATE® Outputs

General Description

The VHC541 is an advanced high-speed CMOS device fabricated with silicon gate CMOS technology. It achieves the high-speed operation similar to equivalent Bipolar Schottky TTL while maintaining the CMOS low power dissipation.

The VHC541 is an octal buffer/line driver designed to be employed as memory and address drivers, clock drivers and bus oriented transmitter/receivers.

This device is similar in function to the VHC244 while providing flow-through architecture (inputs on opposite side from outputs). This pinout arrangement makes this device especially useful as an output port for microprocessors, allowing ease of layout and greater PC board density.

An input protection circuit insures that 0V to 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 backup. This circuit prevents device destruction due to mismatched supply and input voltages.
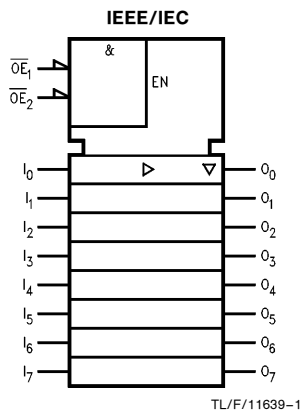
Features

■ Low power dissipation:
  $I_{CC} = 4 \mu A$ (max) at $T_A = 25°C$
■ High noise immunity: $V_{NIH} = V_{NIL} = 28\% \ V_{CC}$ (min)
■ All inputs are equipped with a power down protection function
■ Balanced propagation delays: $t_{PLH} \cong t_{PHL}$
■ Low noise: $V_{OLP} = 0.9V$ (typ)
■ Pin and function compatible with 74HC541

Commercial	Package Number	Package Description
74VHC541M	M20B	20-Lead Molded JEDEC SOIC
74VHC541SJ	M20D	20-Lead Molded EIAJ SOIC
74VHC541MTC	MTC20	20-Lead Molded JEDEC Type 1 TSSOP
74VHC541N	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.

Logic Symbol

IEEE/IEC

TL/F/11639–1

Connection Diagram

Pin Assignment for DIP, TSSOP and SOIC

TL/F/11639–2
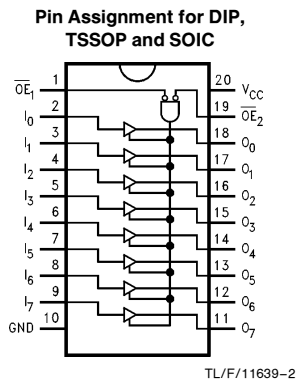
Truth Table

Inputs			Outputs
$\overline{OE}_1$	$\overline{OE}_2$	I	
L	L	H	H
H	X	X	Z
X	H	X	Z
L	L	L	L

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

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})	$-0.5V$ to $V_{CC} + 0.5V$
Input Diode Current (I_{IK})	-20 mA
Output Diode Current (I_{OK})	±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)	$260°C$

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})	2.0V to $+5.5V$
Input Voltage (V_{IN})	0V to $+5.5V$
Output Voltage (V_{OUT})	0V to V_{CC}
Operating Temperature (T_{OPR})	$-40°C$ to $+85°C$
Input Rise and Fall Time (t_r, t_f)	
$V_{CC} = 3.3V \pm 0.3V$	$0 \sim 100$ ns/V
$V_{CC} = 5.0V \pm 0.5V$	$0 \sim 20$ ns/V

DC Characteristics for 'VHC Family Devices

Symbol	Parameter	V_{CC} (V)	$T_A = 25°C$ Min	Typ	Max	$T_A = -40°C$ to $+85°C$ Min	Max	Units	Conditions	
V_{IH}	High Level Input Voltage	2.0	1.50			1.50		V		
		3.0–5.5	0.7 V_{CC}			0.7 V_{CC}				
V_{IL}	Low Level Input Voltage	2.0			0.50		0.50	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}	$I_{OH} = -50\ \mu A$
		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}	$I_{OL} = 50\ \mu A$
		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
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	0.9	1.2	V	$C_L = 50$ pF
V_{OLV}**	Quiet Output Minimum Dynamic V_{OL}	5.0	−0.8	−1.0	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.

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		5.0	7.0	1.0	8.5	ns		C$_L$ = 15 pF
				7.5	10.5	1.0	12.0			C$_L$ = 50 pF
		5.0 ±0.5		3.5	5.0	1.0	6.0	ns		C$_L$ = 15 pF
				5.0	7.0	1.0	8.0			C$_L$ = 50 pF
t$_{PZL}$, t$_{PZH}$	TRI-STATE Output Enable Time	3.3 ±0.3		6.8	10.5	1.0	12.5	ns	R$_L$ = 1 kΩ	C$_L$ = 15 pF
				9.3	14.0	1.0	16.0			C$_L$ = 50 pF
		5.0 ±0.5		4.7	7.2	1.0	8.5	ns		C$_L$ = 15 pF
				6.2	9.2	1.0	10.5			C$_L$ = 50 pF
t$_{PLZ}$, t$_{PHZ}$	TRI-STATE Output Disable Time	3.3 ±0.3		11.2	15.4	1.0	17.5	ns	R$_L$ = 1 kΩ	C$_L$ = 50 pF
		5.0 ±0.5		6.0	8.8	1.0	10.0			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$_{CC}$ = 5.0V	
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$_{PHLmin}$|.
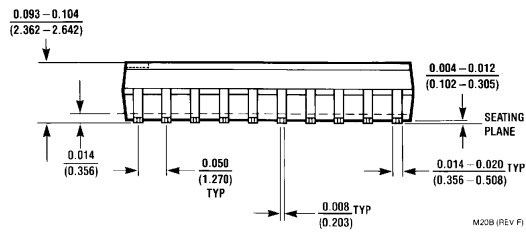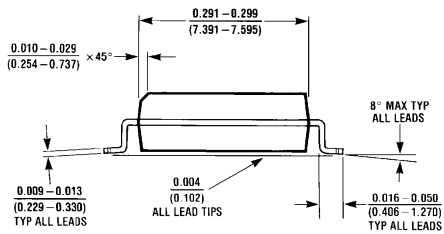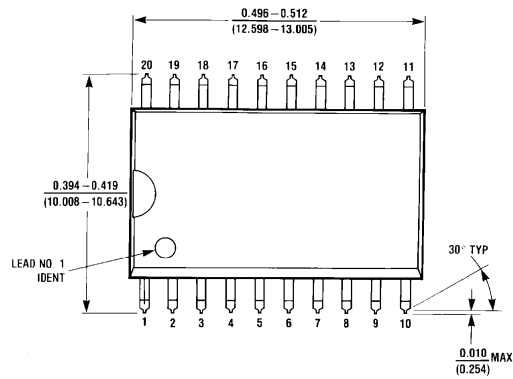
Note 2: C$_{PD}$ is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load. Average operating current can be obtained by the equation: I$_{CC}$ (OPR.) = C$_{PD}$ * V$_{CC}$ * f$_{IN}$ + I$_{CC}$/8 (per bit).

4

Ordering Information

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                                    74VHC  541  M  X
Temperature Range Family ─────────────┘     │   │  │
   74VHC = Commercial                        │   │  └──── Special Variations
                                             │   │            "X" = Tape and Reel
Device Type ─────────────────────────────────┘   │            " " = Rail/Tube
                                                  │
Package Code ─────────────────────────────────────┘
     M  = Small Outline JEDEC SOIC
     SJ = Small Outline EIAJ SOIC
    MTC = Thin Shrink Small Outline JEDEC TSSOP Type 1
     N  = Molded Plastic DIP
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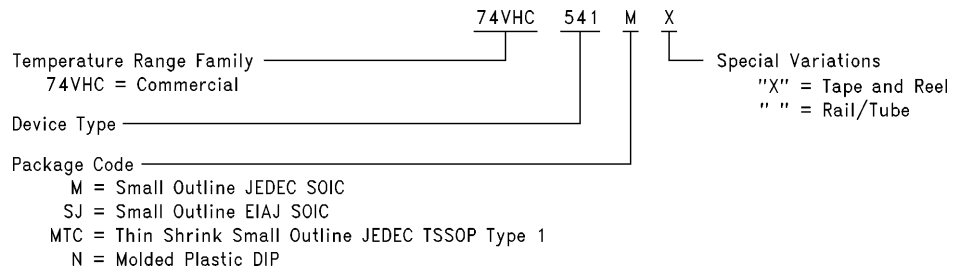
TL/F/11639–3

Physical Dimensions inches (millimeters)

0.496 − 0.512
(12.598 − 13.005)

20 19 18 17 16 15 14 13 12 11

0.394 − 0.419
(10.008 − 10.643)

LEAD NO. 1
IDENT

30° TYP

1 2 3 4 5 6 7 8 9 10

0.010
(0.254) MAX

0.291 − 0.299
(7.391 − 7.595)

0.010 − 0.029
(0.254 − 0.737) × 45°

0.093 − 0.104
(2.362 − 2.642)

8° MAX TYP
ALL LEADS

0.004 − 0.012
(0.102 − 0.305)

SEATING
PLANE

0.009 − 0.013
(0.229 − 0.330)
TYP ALL LEADS

0.004
(0.102)
ALL LEAD TIPS

0.016 − 0.050
(0.406 − 1.270)
TYP ALL LEADS

0.014
(0.356)

0.050
(1.270)
TYP

0.014 − 0.020
(0.356 − 0.508) TYP

0.008
(0.203) TYP

M20B (REV F)

20-Lead Small Outline Integrated Circuit—JEDEC SOIC (M)
NS Package Number M20B

0.492 − 0.500
(12.50 − 12.70)

20 19 18 17 16 15 14 13 12 11

0.295 − 0.319
(7.493 − 8.103)

0.205 − 0.213
(5.207 − 5.410)

0°-8°

1 2 3 4 5 6 7 8 9 10

0.016 − 0.031
(0.406 − 0.787)

DETAIL F

0.006 − 0.010
(0.152 − 0.254)

0.071
(1.803) REF

0.067 − 0.083
(1.702 − 2.108)

SEATING PLANE

SEE DETAIL F

0.049
(1.245) REF

0.050
(1.270)

0.000 − 0.010
(0.000 − 0.254)

0.014 − 0.020
(0.356 − 0.508)

M20D (REV A)
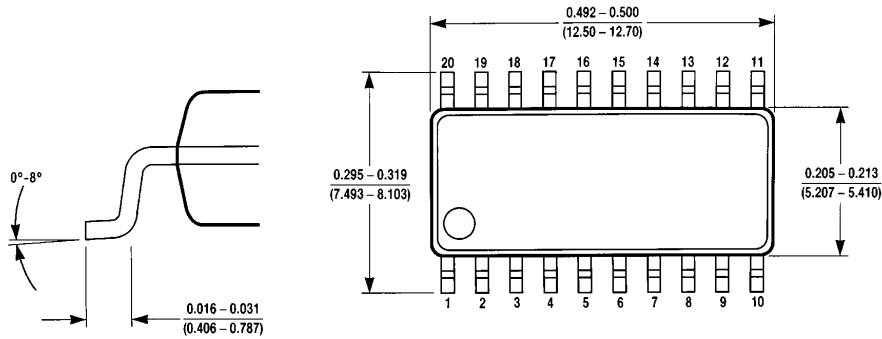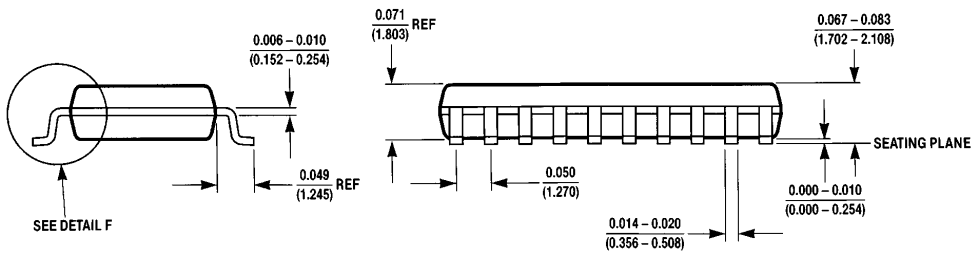
20-Lead Plastic EIAJ SOIC (SJ)
NS Package Number M20D

Physical Dimensions inches (millimeters) (Continued)

7.72

4.16

(1.78 TYP)

0.42 TYP

0.65 TYP

LAND PATTERN RECOMMENDATION

6.5 ± 0.1

-A-

20   11

6.4

4.4 ± 0.1

-B-

3.2

1   10

⌓ 0.2 C B A
ALL LEAD TIPS

GAGE PLANE

0.25

0°-8°

SEATING PLANE

0.6 ± 0.1

DETAIL A
TYPICAL

⌓ 0.1 C
ALL LEAD TIPS

-C-

0.65 TYP

0.19 - 0.30 TYP

(0.90)

1.1 MAX

0.10 ± 0.05 TYP

SEE DETAIL D

0.09-0.20

⊕ 0.13 Ⓜ A B Ⓢ C Ⓢ

MTC20 (REV C)
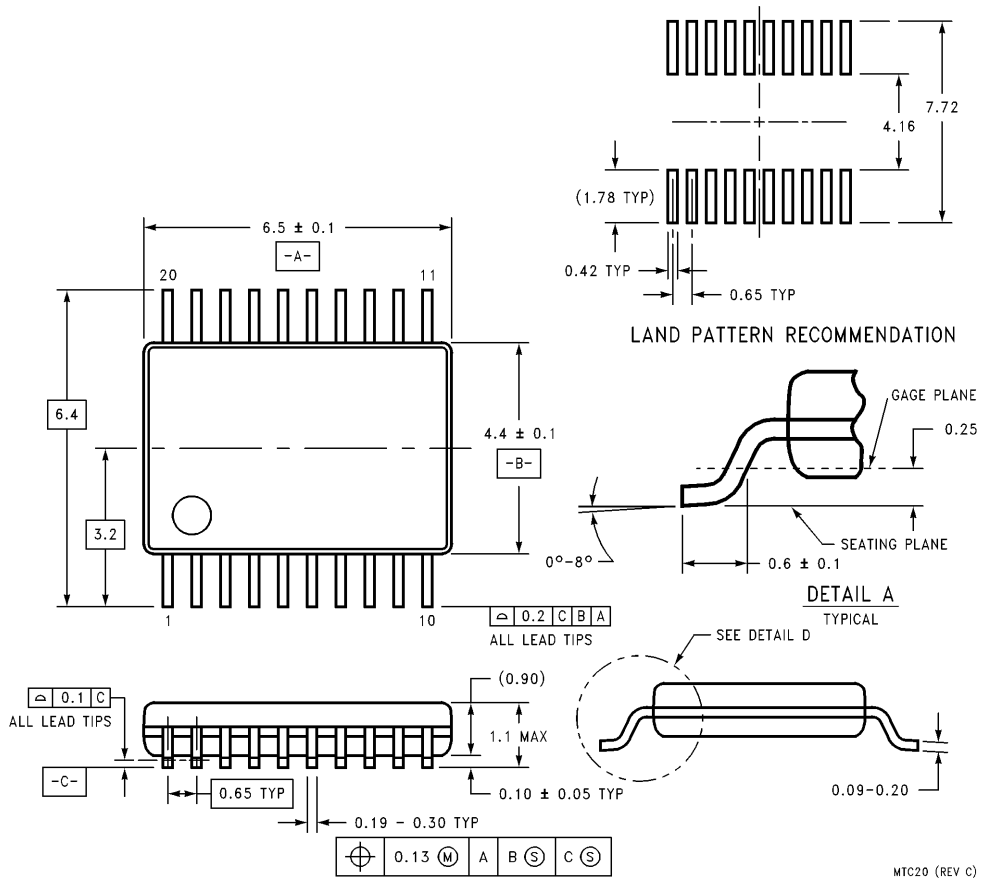
20-Lead Molded Thin Shrink Small Outline JEDEC Type 1 TSSOP
Order Number 74VHC541MTC
NS Package Number MTC20

Physical Dimensions millimeters (Continued)

1.013−1.040
(25.73−26.42)

0.092 × 0.030
(2.337 × 0.762)
MAX DP

PIN NO. 1 IDENT

OPTION 1

0.280
(7.112)
MIN

0.300−0.320
(7.620−8.128)

0.065
(1.651)

95°± 5°

0.009−0.015
(0.229−0.381)
TYP

0.060 ±0.005
(1.524 ±0.127)

0.325 +0.040 −0.015

(8.255 +1.016 −0.381)

0.260 ±0.005
(6.604 ±0.127)

0.090
(2.286)

0.060
(1.524)
TYP
NOM

0.040
(1.016)
TYP

OPTION 2
4° (4X)

0.100 ± 0.010
(2.540 ± 0.254)

0.018 ±0.003
(0.457 ±0.076)

90° ± 0.004°

0.130 0.005
(3.302 0.127)

0.145−0.200
(3.683−5.080)

0.125−0.140
(3.175−3.556)

0.020
(0.508)
MIN

0.032 ±0.005
(0.813 ±0.127)
RAD

PIN NO. 1 IDENT

OPTION 2

N20A (REV G)

20-Lead (0.300″ Wide) Molded Dual-In-Line Package
Order Number 74VHC541N
NS Package Number N20A

LIFE SUPPORT POLICY

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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.