February 1998

FAIRCHILD SEMICONDUCTOR™

74VHC374 • 74VHCT374
Octal D Flip-Flop with 3-STATE Outputs

General Description

The VHC/VHCT374 is an advanced high speed CMOS octal flip-flop with 3-STATE output 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. This 8-bit D-type flip-flop is controlled by a clock input (CP) and an output enable input ($\overline{OE}$). When the $\overline{OE}$ input is high, the eight outputs are in a high impedance state.

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 Speed:
  VHC t_{pd} = 5.4 ns (typ) at V_{CC} = 5V
  VHCT t_{pd} = 6.4 ns (typ) at V_{CC} = 5V
- 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 power dissipation:
  I_{CC} = 4 μA (Max) @ T_A = 25°C
- Pin and function compatible with 74HC/HCT374

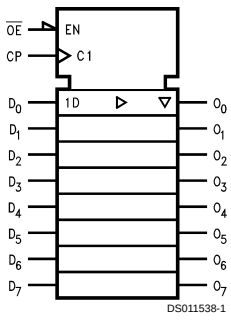
Ordering Code:

Commercial	Package Number	Package Description
74VHC374M	M20B	20-Lead Molded JEDEC SOIC
74VHC374SJ	M20D	20-Lead Molded EIAJ SOIC
74VHC374MTC	MTC20	20-Lead Molded JEDEC Type 1 TSSOP
74VHC374N	N20A	20-Lead Molded DIP
74VHCT374M	M20B	20-Lead Molded JEDEC SOIC
74VHCT374SJ	M20D	20-Lead Molded EIAJ SOIC
74VHCT374MTC	MTC20	20-Lead Molded JEDEC Type 1 TSSOP
74VHCT374N	N20A	20-Lead Molded DIP

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



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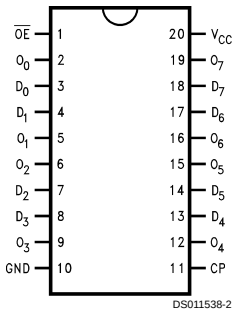
Connection Diagram

Pin Assignment for DIP, TSSOP and SOIC



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Pin Descriptions

Pin Names	Description
D_0–D_7	Data Inputs
CP	Clock Pulse Input
$\overline{OE}$	3-STATE Output Enable Input
O_0–O_7	3-STATE Outputs

Truth Table

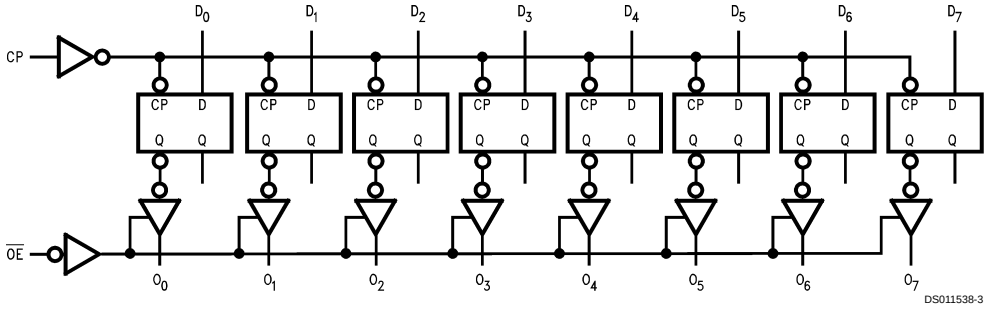
Inputs			Outputs
D_n	CP	$\overline{OE}$	O_n
H	⌐	L	H
L	⌐	L	L
X	X	H	Z

H = HIGH Voltage Level X = Immaterial
L = LOW Voltage Level Z = High Impedance
⌐ = LOW-to-HIGH Transition

Functional Description

The VHC/VHCT374 consists of eight edge-triggered flip-flops with individual D-type inputs and 3-STATE true outputs. The buffered clock and buffered Output Enable are common to all flip-flops. The eight flip-flops will store the state of their individual D inputs that meet the setup and hold time requirements on the LOW-to-HIGH Clock (CP) transition. With the Output Enable ($\overline{OE}$) LOW, the contents of the eight flip-flops are available at the outputs. When the $\overline{OE}$ is HIGH, the outputs go to the high impedance state. Operation of the $\overline{OE}$ input does not affect the state of the flip-flops.

Logic Diagram



Please note that this diagram is provided only for the understanding of logic operations and should not be used to estimate propagation delays.

Absolute Maximum Ratings (Note 2)

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 (Note 1)	−0.5V to +7.0V
Input Diode Current (I_{IK})	−20 mA
Output Diode Current (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

Recommended Operating Conditions (Note 3)

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})	−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

Note 1: V_{OUT} > V_{CC} only if output is in H or Z state.

Note 2: 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. Fairchild does not recommend operation outside databook specifications.

Note 3: Unused inputs must be held HIGH or LOW. They may not float.

DC Electrical Characteristics for VHC

Symbol	Parameter	V_{CC} (V)	T_A = 25˚C			T_A = −40˚C to +85˚C		Units	Conditions	
			Min	Typ	Max	Min	Max			
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_{IN} = V_{IH}	I_{OH} = −50 µA
		3.0	2.9	3.0		2.9		V	or V_{IL}	
		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_{IN} = V_{IH}	I_{OL} = 50 µA
		3.0		0.0	0.1		0.1	V	or V_{IL}	
		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}	3-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	

Noise Characteristics for VHC

Symbol	Parameter	V_{CC} (V)	$T_A = 25^\circ C$		Units	Conditions
			Typ	Limits		
V_{OLP} (Note 4)	Quiet Output Maximum Dynamic V_{OL}	5.0	0.6	0.9	V	C_L = 50 pF
V_{OLV} (Note 4)	Quiet Output Minimum Dynamic V_{OL}	5.0	−0.6	−0.9	V	C_L = 50 pF
V_{IHD} (Note 4)	Minimum High Level Dynamic Input Voltage	5.0		3.5	V	C_L = 50 pF
V_{ILD} (Note 4)	Maximum Low Level Dynamic Input Voltage	5.0		1.5	V	C_L = 50 pF

Note 4: Parameter guaranteed by design.

DC Electrical Characteristics for VHCT

Symbol	Parameter	V_{CC} (V)	$T_A = 25^\circ C$			$T_A = -40^\circ C$ to $+85^\circ C$		Units	Conditions	
			Min	Typ	Max	Min	Max			
V_{IH}	High Level Input Voltage	4.5	2.0			2.0		V		
		5.5	2.0			2.0				
V_{IL}	Low Level Input Voltage	4.5			0.8		0.8	V		
		5.5			0.8		0.8			
V_{OH}	High Level Output Voltage	4.5	3.15	3.65		3.15		V	$V_{IN} = V_{IH}$	I_{OH} = −50 μA
			2.5			2.4		V	or V_{IL}	I_{OH} = −8 mA
V_{OL}	Low Level Output Voltage	4.5		0.0	0.1		0.1	V	$V_{IN} = V_{IH}$	I_{OL} = −50 μA
					0.36		0.44	V	or V_{IL}	I_{OL} = −8 mA
I_{OZ}	3-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_{OFF}	Output Leakage Current (Power Down State)	0.0			±0.5		+5.0	μA	V_{OUT} = 5.5V	

Noise Characteristics for VHCT

Symbol	Parameter	V_{CC} (V)	$T_A = 25^\circ C$		Units	Conditions
			Typ	Limits		
V_{OLP} (Note 5)	Quiet Output Maximum Dynamic V_{OL}	5.0	0.8	1.2	V	C_L = 50 pF
V_{OLV} (Note 5)	Quiet Output Minimum Dynamic V_{OL}	5.0	−0.8	−1.2	V	C_L = 50 pF
V_{IHD} (Note 5)	Minimum High Level Dynamic Input Voltage	5.0		2.0	V	C_L = 50 pF
V_{ILD} (Note 5)	Maximum Low Level Dynamic Input Voltage	5.0		0.8	V	C_L = 50 pF

Note 5: Parameter guaranteed by design.

AC Electrical Characteristics for VHC

Symbol	Parameter	V_{CC} (V)	T_A = 25°C			T_A = −40°C to +85°C		Units	Conditions	
			Min	Typ	Max	Min	Max			
t_{PLH}	Propagation Delay Time (CP to O_n)	3.3 ±0.3		8.1	12.7	1.0	15.0	ns		C_L = 15 pF
t_{PHL}				10.6	16.2	1.0	18.5			C_L = 50 pF
		5.0 ±0.5		5.4	8.1	1.0	9.5	ns		C_L = 15 pF
				6.9	10.1	1.0	11.5			C_L = 50 pF
t_{PZL}	3-STATE Output Enable Time	3.3 ±0.3		7.1	11.0	1.0	13.0	ns	R_L = 1 kΩ	C_L = 15 pF
t_{PZH}				9.6	14.5	1.0	16.5			C_L = 50 pF
		5.0 ±0.5		5.1	7.6	1.0	9.0	ns		C_L = 15 pF
				6.6	9.6	1.0	11.0			C_L = 50 pF
t_{PLZ}	3-STATE Output Disable Time	3.3 ±0.3		10.2	14.0	1.0	16.0	ns	R_L = 1 kΩ	C_L = 50 pF
t_{PHZ}		5.0 ±0.5		6.1	8.8	1.0	10.0			C_L = 50 pF
t_{OSLH}	Output to Output Skew	3.3 ±0.3			1.5		1.5	ns	(Note 6)	C_L = 50 pF
t_{OSHL}		5.0 ±0.5			1.0		1.0			C_L = 50 pF
f_{max}	Maximum Clock Frequency	3.3 ±0.3	80	130		70		MHz		C_L = 15 pF
			55	85		50				C_L = 50 pF
		5.0 ±0.5	130	185		110				C_L = 15 pF
			85	120		75				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			32				pF	(Note 7)	

Note 6: Parameter guaranteed by design. $t_{OSLH} = |t_{PLH\ max} - t_{PLH\ min}|$; $t_{OSHL} = |t_{PHL\ max} - t_{PHL\ min}|$

Note 7: 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 F/F). The total C_{PD} when n pcs. of the Octal D Flip-Flop operates can be calculated by the equation: C_{PD} (total) = 20 + 12n.

AC Operating Requirements for VHC

Symbol	Parameter	V_{CC} (V)	T_A = 25°C			T_A = −40°C to +85°C		Units	Conditions
			Min	Typ	Max	Min	Max		
$t_{W(H)}$	Minimum Pulse Width (CP)	3.3 ±0.3	5.0			5.5		ns	
$t_{W(L)}$		5.0 ±0.5	5.0			5.0			
t_S	Minimum Set-Up Time	3.3 ±0.3	4.5			4.5		ns	
		5.0 ±0.5	3.0			3.0			
t_H	Minimum Hold Time	3.3 ±0.3	2.0			2.0			
		5.0 ±0.5	2.0			2.0			

AC Electrical Characteristics for VHCT

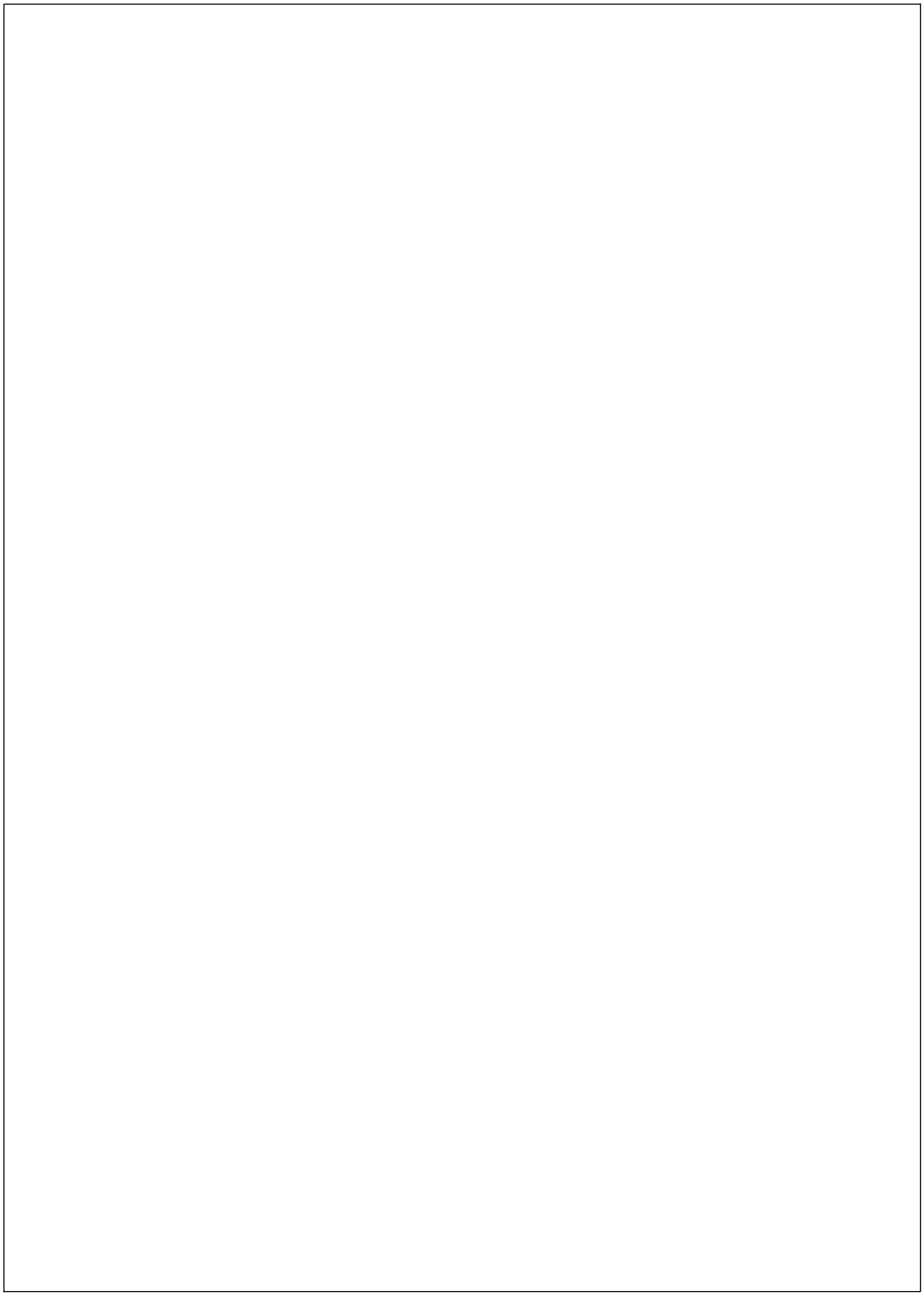
Symbol	Parameter	V_{CC} (V)	T_A = 25˚C			T_A = −40˚C to +85˚C		Units	Conditions	
			Min	Typ	Max	Min	Max			
t_{PLH}	Propagation Delay Time	5.0 ± 0.5		5.6	9.4	1.0	10.5	ns		C_L = 15 pF
t_{PHL}				6.4	10.4	1.0	11.5			C_L = 50 pF
t_{PZL}	3-STATE Output Enable Time	5.0 ± 0.5		6.5	10.2	1.0	11.5	ns	R_L = 1 kΩ	C_L = 15 pF
t_{PZH}				7.3	11.2	1.0	12.5			C_L = 50 pF
t_{PLZ}	3-STATE Output Disable Time	5.0 ± 0.5		7.0	11.2	1.0	12.0	ns	R_L = 1 kΩ	C_L = 50 pF
t_{PHZ}										
t_{OSLH}	Output to Output Skew	5.0 ± 0.5			1.0		1.0		(Note 8)	
t_{OSHL}										
f_{max}	Maximum Clock Frequency	5.0 ± 0.5	90	140		80		MHz		C_L = 15 pF
			85	130		75				C_L = 50 pF
C_{IN}	Input Capacitance			4	10		10	pF	V_{CC} = Open	
C_{OUT}	Output Capacitance			9				pF	V_{CC} = 5.0V	
C_{PD}	Power Dissipation Capacitance			27				pF	(Note 9)	

Note 8: Parameter guaranteed by design. $t_{OSLH} = |t_{PLH\ max} - t_{PLH\ min}|$; $t_{OSHL} = |t_{PHL\ max} - t_{PHL\ min}|$

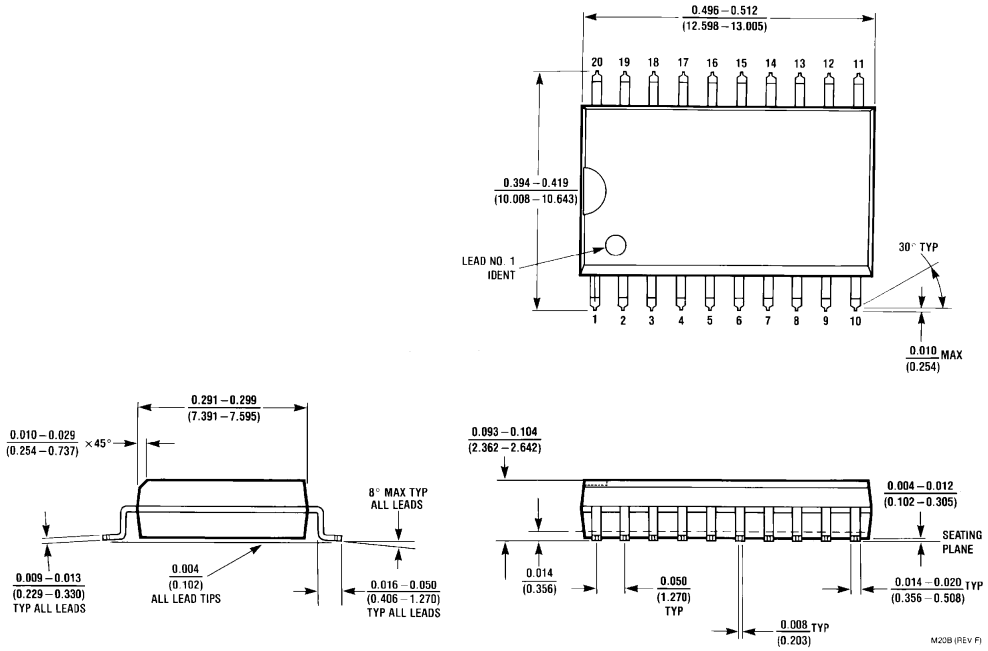
Note 9: C_{PD} is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load. Average operating current can be obtained by the equation: I_{CC} (opr.) = C_{PD} * V_{CC} * f_{IN} + I_{CC}/8 (per F/F).

AC Operating Requirements for VHCT

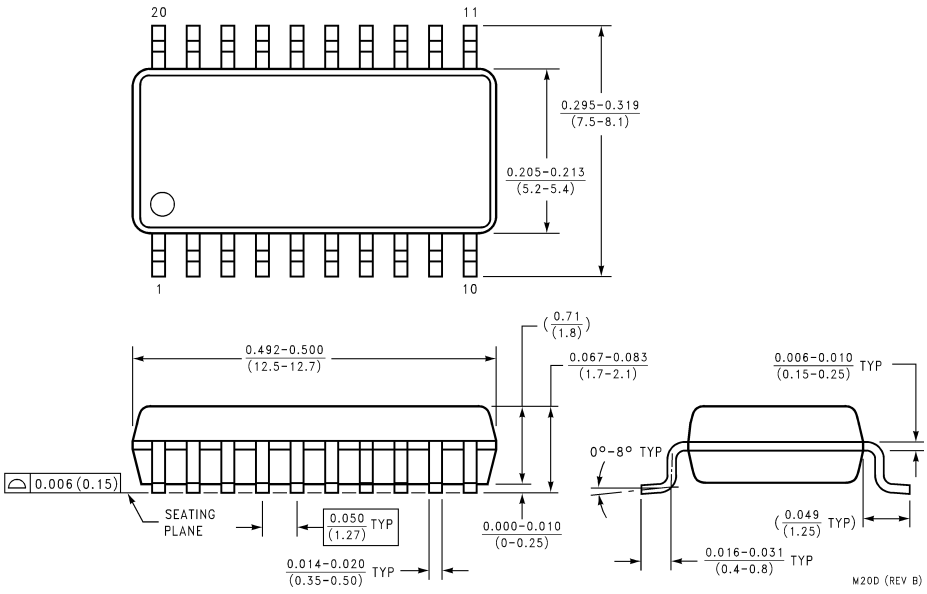
Symbol	Parameter	V_{CC} (V)	T_A = 25˚C			T_A = −40˚C to +85˚C		Units
			Min	Typ	Max	Min	Max	
$t_{W(H)}$	Minimum Pulse Width (CP)	5.0 ± 0.5	6.5			6.5		ns
$t_{W(L)}$								
t_S	Minimum Set-up Time	5.0 ± 0.5	2.5			2.5		ns
t_H	Minimum Hold Time	5.0 ± 0.5	2.5			2.5		



Physical Dimensions inches (millimeters) unless otherwise noted

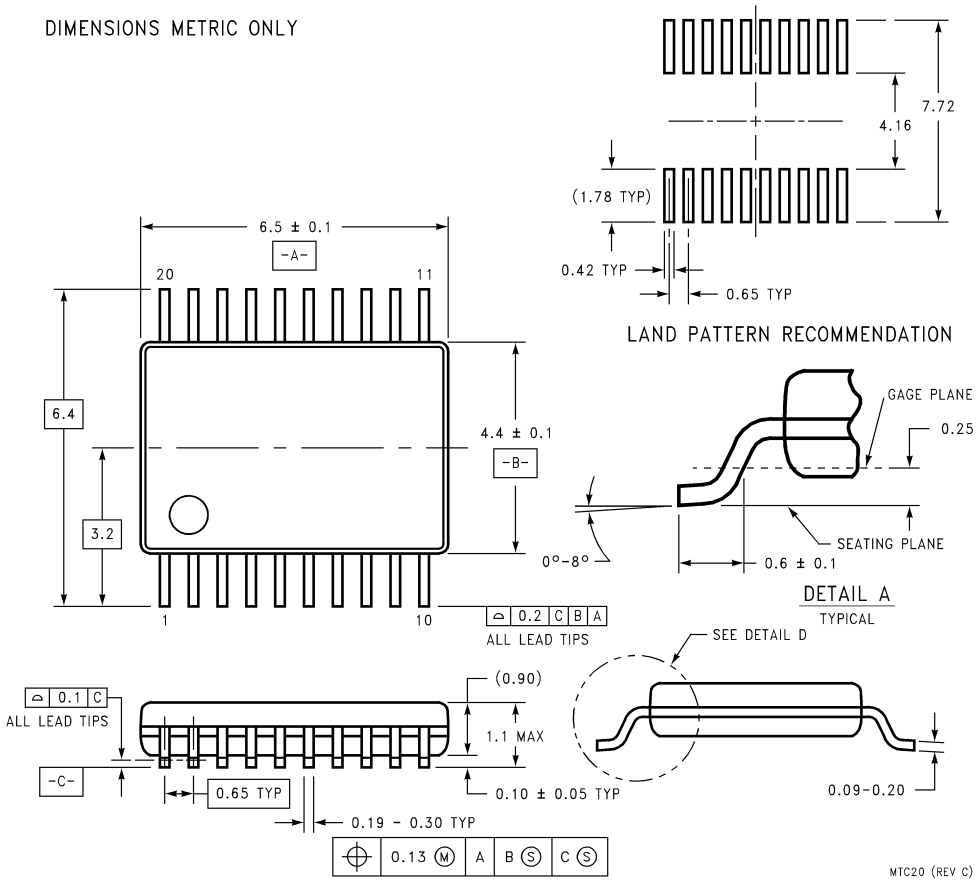


20-Lead Small Outline Integrated Circuit—JEDEC SOIC (M)
Package Number M20B



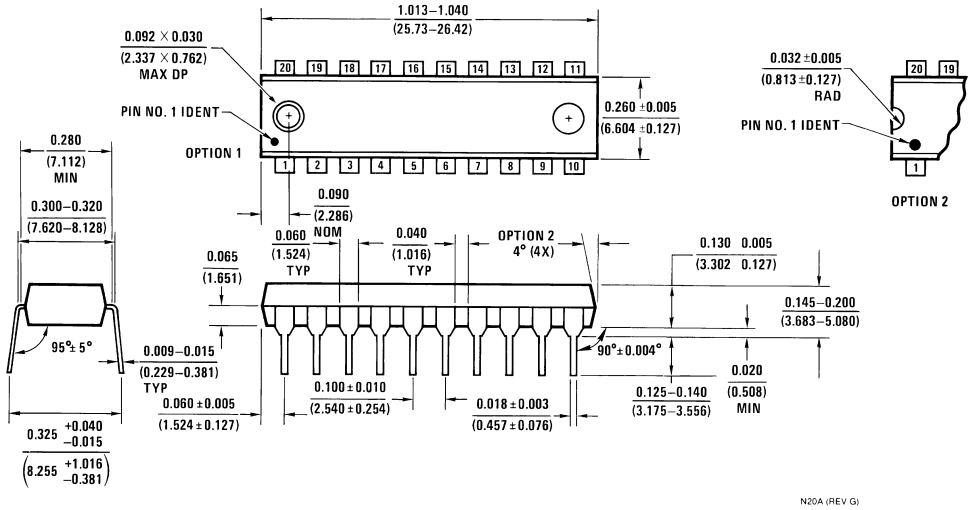
20-Lead Plastic EIAJ SOIC (SJ)
Package Number M20D

Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



20-Lead Plastic JEDEC TSSOP Type 1 (MTC)
Package Number MTC20

Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



20-Lead (0.300" Wide) Molded Dual-In-Line Package
Package Number N20A

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Fairchild Semiconductor Corporation
Americas
Customer Response Center
Tel: 1-888-522-5372

Fairchild Semiconductor Europe
Fax: +49 (0) 1 80-530 85 86
Email: europe.support@nsc.com
Deutsch Tel: +49 (0) 8 141-35-0
English Tel: +44 (0) 1 793-85-68-56
Italy Tel: +39 (0) 2 57 5631

Fairchild Semiconductor Hong Kong Ltd.
13th Floor, Straight Block,
Ocean Centre, 5 Canton Rd.
Tsimshatsui, Kowloon
Hong Kong
Tel: +852 2737-7200
Fax: +852 2314-0061

National Semiconductor Japan Ltd.
Tel: 81-3-5620-6175
Fax: 81-3-5620-6179

www.fairchildsemi.com