

DATA SHEET

74ALVT16821

20-bit bus-interface D-type flip-flop;
positive-edge trigger (3-State)

Product specification
Supersedes data of 1997 May 01
IC24 Data Handbook

1998 Feb 13

2.5V/3.3V 20-bit bus-interface D-type flip-flop; positive-edge trigger (3-State)

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FEATURES

- 20-bit positive-edge triggered register
- 5V I/O Compatible
- Multiple V_{CC} and GND pins minimize switching noise
- Live insertion/extraction permitted
- Power-up reset
- Power-up 3-State
- Output capability: +64mA/-32mA
- Latch-up protection exceeds 500mA per Jedec Std 17
- ESD protection exceeds 2000V per MIL STD 883 Method 3015 and 200V per Machine Model
- Bus hold data inputs eliminate the need for external pull-up resistors to hold unused inputs

DESCRIPTION

The 74ALVT16821 high-performance BiCMOS device combines low static and dynamic power dissipation with high speed and high output drive. It is designed for V_{CC} operation at 2.5V or 3.3V with I/O compatibility to 5V.

The 74ALVT16821 has two 10-bit, edge triggered registers, with each register coupled to a 3-State output buffer. The two sections of each register are controlled independently by the clock (nCP) and Output Enable ($\overline{nOE}$) control gates.

Each register is fully edge triggered. The state of each D input, one set-up time before the Low-to-High clock transition, is transferred to the corresponding flip-flop's Q output.

The 3-State output buffers are designed to drive heavily loaded 3-State buses, MOS memories, or MOS microprocessors.

The active Low Output Enable ($\overline{nOE}$) controls all ten 3-State buffers independent of the register operation. When $\overline{nOE}$ is Low, the data in the register appears at the outputs. When $\overline{nOE}$ is High, the outputs are in high impedance "off" state, which means they will neither drive nor load the bus.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS $T_{amb} = 25^{\circ}\text{C}$	TYPICAL		UNIT
			2.5V	3.3V	
t_{PLH} t_{PHL}	Propagation delay nCP to nQ	$C_L = 50\text{pF}$	2.6 2.7	1.7 1.8	ns
C_{IN}	Input capacitance	$V_I = 0\text{V}$ or V_{CC}	3	3	pF
C_{OUT}	Output capacitance	$V_O = 0$ or V_{CC}	9	9	pF
I_{CCZ}	Total supply current	Outputs disabled	40	70	μA

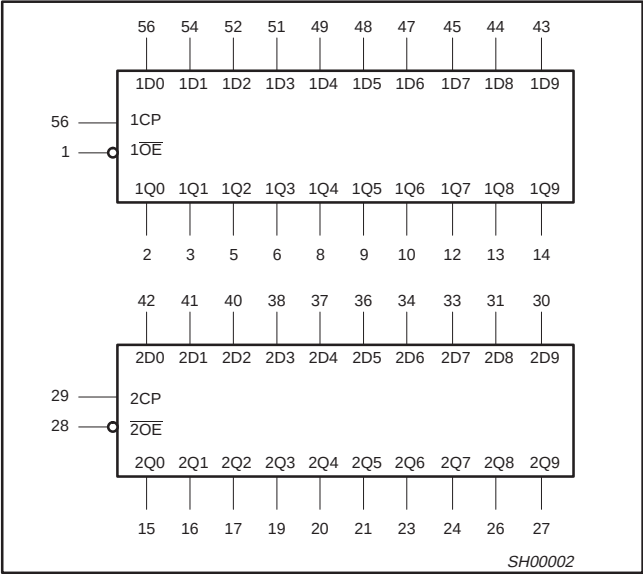
ORDERING INFORMATION

PACKAGES	TEMPERATURE RANGE	OUTSIDE NORTH AMERICA	NORTH AMERICA	DWG NUMBER
56-Pin Plastic SSOP Type III	-40°C to $+85^{\circ}\text{C}$	74ALVT16821 DL	AV16821 DL	SOT371-1
56-Pin Plastic TSSOP Type II	-40°C to $+85^{\circ}\text{C}$	74ALVT16821 DGG	AV16821 DGG	SOT364-1

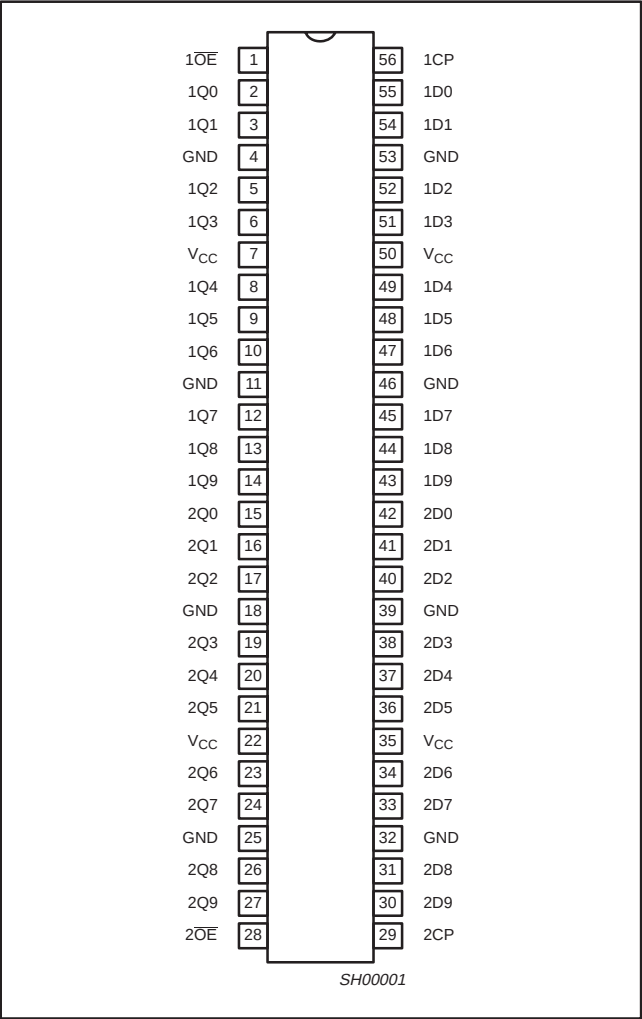
2.5V/3.3V 20-bit bus-interface D-type flip-flop;
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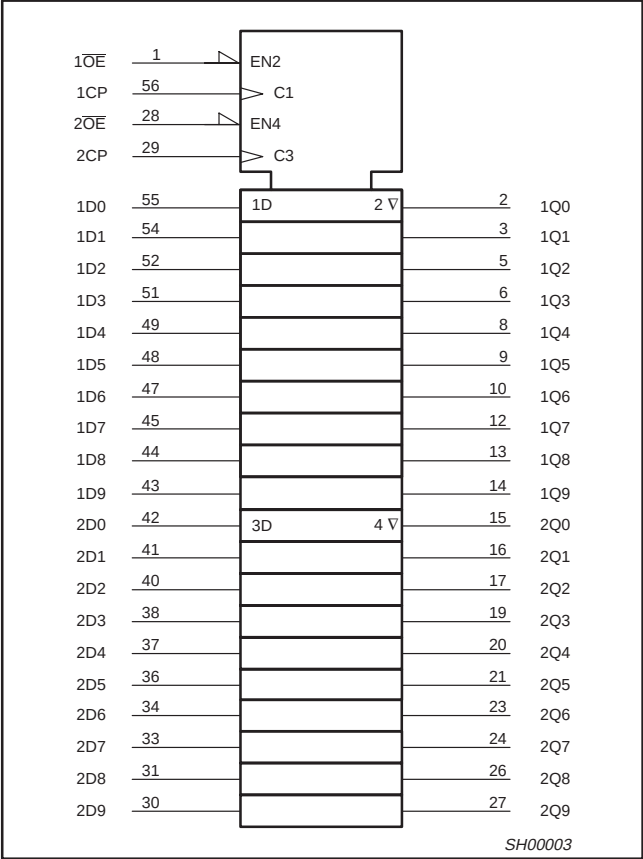
LOGIC SYMBOL



PIN CONFIGURATION



LOGIC SYMBOL (IEEE/IEC)



2.5V/3.3V 20-bit bus-interface D-type flip-flop;
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PIN DESCRIPTION

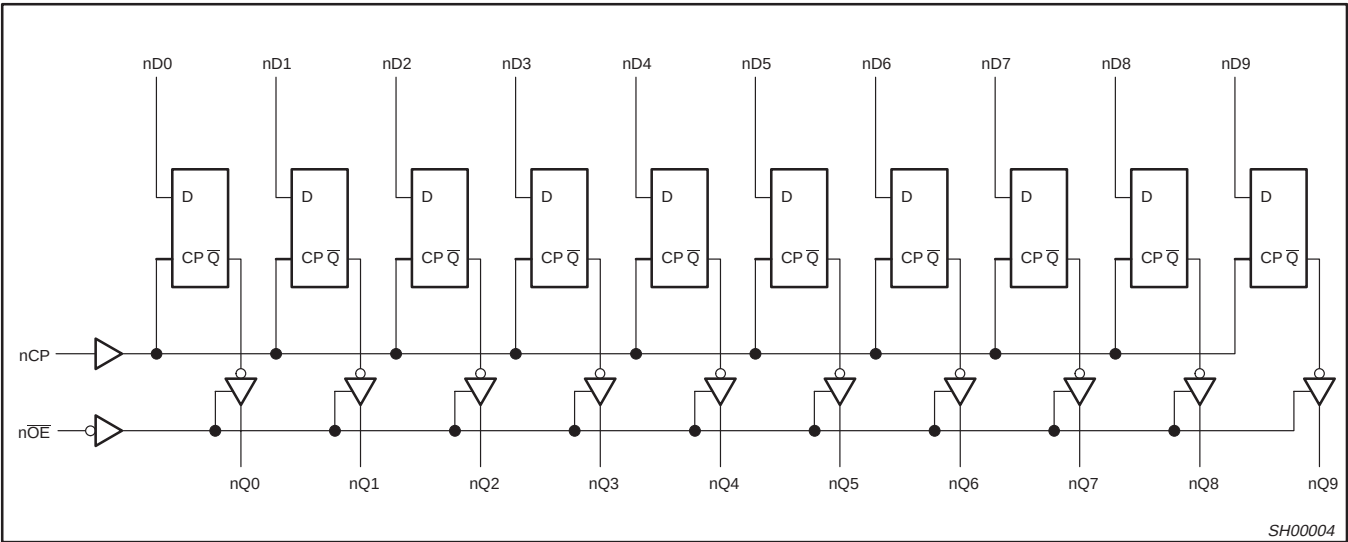
PIN NUMBER	SYMBOL	FUNCTION
56, 54, 52, 51, 49, 48, 47, 45, 44, 43, 42, 41, 40, 38, 37, 36, 34, 33, 31, 30	1D0 - 1D9 2D0 - 2D9	Data inputs
2, 3, 5, 6, 8, 9, 10, 12, 13, 14, 15, 16, 17, 19, 20, 21, 23, 24, 26, 27	1Q0 - 1Q9 2Q0 - 2Q9	Data outputs
1, 28	1OE, 2OE	Output enable inputs (active-Low)
56, 29	1CP, 2CP	Clock pulse inputs (active rising edge)
4, 11, 18, 25, 32, 39, 46, 53	GND	Ground (0V)
7, 22, 35, 50	VCC	Positive supply voltage

FUNCTION TABLE

INPUTS			INTERNAL REGISTER	OUTPUTS	OPERATING MODE
nOE	nCP	nDx		nQ0 - nQ9	
L L	$\uparrow$ $\uparrow$	l h	L H	L H	Load and read register
L	$\uparrow$	X	NC	NC	Hold
H H	$\uparrow$ $\uparrow$	X Dn	NC Dn	Z Z	Disable outputs

H = High voltage level
h = High voltage level one set-up time prior to the Low-to-High clock transition
L = Low voltage level
l = Low voltage level one set-up time prior to the Low-to-High clock transition
NC= No change
X = Don't care
Z = High impedance "off" state
 $\uparrow$ = Low to High clock transition
 $\uparrow$ = Not a Low-to-High clock transition

LOGIC DIAGRAM



2.5V/3.3V 20-bit bus-interface D-type flip-flop; positive-edge trigger (3-State)

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ABSOLUTE MAXIMUM RATINGS^{1, 2}

SYMBOL	PARAMETER	CONDITIONS	RATING	UNIT
V_{CC}	DC supply voltage		−0.5 to +4.6	V
I_{IK}	DC input diode current	$V_I < 0$	−50	mA
V_I	DC input voltage ³		−1.2 to +7.0	V
I_{OK}	DC output diode current	$V_O < 0$	−50	mA
V_{OUT}	DC output voltage ³	Output in Off or High state	−0.5 to +7.0	V
I_{OUT}	DC output current	Output in Low state	128	mA
		Output in High state	−64	
T_{stg}	Storage temperature range		−65 to 150	°C

NOTES:

- Stresses beyond those listed may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- The performance capability of a high-performance integrated circuit in conjunction with its thermal environment can create junction temperatures which are detrimental to reliability. The maximum junction temperature of this integrated circuit should not exceed 150°C.
- The input and output voltage ratings may be exceeded if the input and output current ratings are observed.

RECOMMENDED OPERATING CONDITIONS

SYMBOL	PARAMETER	2.5V RANGE LIMITS		3.3V RANGE LIMITS		UNIT
		MIN	MAX	MIN	MAX	
V_{CC}	DC supply voltage	2.3	2.7	3.0	3.6	V
V_I	Input voltage	0	5.5	0	5.5	V
V_{IH}	High-level input voltage	1.7		2.0		V
V_{IL}	Input voltage		0.7		0.8	V
I_{OH}	High-level output current		−8		−32	mA
I_{OL}	Low-level output current		8		32	mA
	Low-level output current; current duty cycle ≤ 50%; f ≥ 1kHz		24		64	
$\Delta t/\Delta v$	Input transition rise or fall rate; Outputs enabled		10		10	ns/V
T_{amb}	Operating free-air temperature range	−40	+85	−40	+85	°C

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DC ELECTRICAL CHARACTERISTICS (3.3V $\pm$ 0.3V RANGE)

SYMBOL	PARAMETER	TEST CONDITIONS		LIMITS			UNIT
				Temp = -40°C to +85°C			
				MIN	TYP ¹	MAX	
V _{IK}	Input clamp voltage	V _{CC} = 3.0V; I _{IK} = -18mA			-0.85	-1.2	V
V _{OH}	High-level output voltage	V _{CC} = 3.0 to 3.6V; I _{OH} = -100μA		V _{CC} -0.2	V _{CC}		V
		V _{CC} = 3.0V; I _{OH} = -32mA		2.0	2.3		
V _{OL}	Low-level output voltage	V _{CC} = 3.0V; I _{OL} = 100μA			0.07	0.2	V
		V _{CC} = 3.0V; I _{OL} = 16mA			0.25	0.4	
		V _{CC} = 3.0V; I _{OL} = 32mA			0.3	0.5	
		V _{CC} = 3.0V; I _{OL} = 64mA			0.4	0.55	
V _{RST}	Power-up output low voltage ⁶	V _{CC} = 3.6V; I _O = 1mA; V _I = V _{CC} or GND				0.55	V
I _I	Input leakage current	V _{CC} = 3.6V; V _I = V _{CC} or GND	Control pins		0.1	±1	μA
		V _{CC} = 0 or 3.6V; V _I = 5.5V			0.1	10	
		V _{CC} = 3.6V; V _I = V _{CC}	Data pins ⁴		0.5	1	
		V _{CC} = 3.6V; V _I = 0V			0.1	-5	
I _{OFF}	Off current	V _{CC} = 0V; V _I or V _O = 0 to 4.5V			0.1	±100	μA
I _{HOLD}	Bus Hold current Data inputs ⁷	V _{CC} = 3V; V _I = 0.8V		75	130		μA
		V _{CC} = 3V; V _I = 2.0V		-75	-140		
		V _{CC} = 0V to 3.6V; V _{CC} = 3.6V		±500			
I _{EX}	Current into an output in the High state when V _O > V _{CC}	V _O = 5.5V; V _{CC} = 3.0V			10	125	μA
I _{PU/PD}	Power up/down 3-State output current ³	V _{CC} ≤ 1.2V; V _O = 0.5V to V _{CC} ; V _I = GND or V _{CC} OE/OE = Don't care			1	±100	μA
I _{OZH}	3-State output High current	V _{CC} = 3.6V; V _O = 3.0V; V _I = V _{IL} or V _{IH}			0.5	5	μA
I _{OZL}	3-State output Low current	V _{CC} = 3.6V; V _O = 0.5V; V _I = V _{IL} or V _{IH}			0.5	-5	μA
I _{CCH}	Quiescent supply current	V _{CC} = 3.6V; Outputs High, V _I = GND or V _{CC} , I _O = 0			0.07	0.1	mA
I _{CCL}		V _{CC} = 3.6V; Outputs Low, V _I = GND or V _{CC} , I _O = 0			5.1	7	
I _{CCZ}		V _{CC} = 3.6V; Outputs Disabled; V _I = GND or V _{CC} , I _O = 0 ⁵			0.07	0.1	
ΔI _{CC}	Additional supply current per input pin ²	V _{CC} = 3V to 3.6V; One input at V _{CC} -0.6V, Other inputs at V _{CC} or GND			0.04	0.4	mA

NOTES:

- All typical values are at V_{CC} = 3.3V and T_{amb} = 25°C.
- This is the increase in supply current for each input at the specified voltage level other than V_{CC} or GND
- This parameter is valid for any V_{CC} between 0V and 1.2V with a transition time of up to 10msec. From V_{CC} = 1.2V to V_{CC} = 3.3V $\pm$ 0.2V a transition time of 100 μ sec is permitted. This parameter is valid for T_{amb} = 25°C only.
- Unused pins at V_{CC} or GND.
- I_{CCZ} is measured with outputs pulled up to V_{CC} or pulled down to ground.
- For valid test results, data must not be loaded into the flip-flops (or latches) after applying power.
- This is the bus hold overdrive current required to force the input to the opposite logic state.

AC CHARACTERISTICS (3.3V $\pm$ 0.3V RANGE)

GND = 0V; t_R = t_F = 2.5ns; C_L = 50pF; R_L = 500 Ω ; T_{amb} = -40°C to +85°C.

SYMBOL	PARAMETER	WAVEFORM	LIMITS			UNIT
			T _{amb} = −40 to +85°C V _{CC} = +3.3V			
			MIN	TYP	MAX	
f _{MAX}	Maximum clock frequency	1	150			MHz
t _{PLH} t _{PHL}	Propagation delay nCP to nQx	1	0.5 0.5	1.7 1.8	3.2 3.5	ns
t _{PZH} t _{PZL}	Output enable time to High and Low level	3 4	1.0 0.5	2.1 1.4	3.5 2.4	ns
t _{PHZ} t _{PLZ}	Output disable time from High and Low level	3 4	1.5 1.5	2.9 2.4	4.2 3.4	ns

NOTE:

- All typical values are at V_{CC} = 3.3V and T_{amb} = 25°C.

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AC SETUP REQUIREMENTS (3.3V $\pm$ 0.3V RANGE)

GND = 0V, $t_R = t_F = 2.5\text{ns}$, $C_L = 50\text{pF}$, $R_L = 500\Omega$

SYMBOL	PARAMETER	WAVEFORM	LIMITS		UNIT
			T _{amb} = -40 to +85°C V _{CC} = +3.3V ±0.3V		
			MIN	TYP	
t _S (H) t _S (L)	Setup time, High or Low nDx to nCP	2	1.5 1.5	0.1 0.1	ns
t _H (H) t _H (L)	Hold time, High or Low nDx to nCP	2	0.5 0.5	0.1 0.1	ns
t _W (H) t _W (L)	nCP pulse width High or Low	1	1.5 1.5		ns

DC ELECTRICAL CHARACTERISTICS (2.5V $\pm$ 0.2V RANGE)

SYMBOL	PARAMETER	TEST CONDITIONS		LIMITS			UNIT
				Temp = -40°C to +85°C			
				MIN	TYP ¹	MAX	
V _{IK}	Input clamp voltage	V _{CC} = 2.3V; I _{IK} = -18mA			-0.85	-1.2	V
V _{OH}	High-level output voltage	V _{CC} = 2.3 to 3.6V; I _{OH} = -100μA		V _{CC} -0.2	V _{CC}		V
		V _{CC} = 2.3V; I _{OH} = -8mA		1.8	2.1		
V _{OL}	Low-level output voltage	V _{CC} = 2.3V; I _{OL} = 100μA			0.07	0.2	V
		V _{CC} = 2.3V; I _{OL} = 24mA			0.3	0.5	
		V _{CC} = 2.3V; I _{OL} = 8mA				0.4	
V _{RST}	Power-up output low voltage ⁷	V _{CC} = 2.7V; I _O = 1mA; V _I = V _{CC} or GND				0.55	V
I _I	Input leakage current	V _{CC} = 2.7V; V _I = V _{CC} or GND	Control pins		0.1	±1	μA
		V _{CC} = 0 or 2.7V; V _I = 5.5V			0.1	10	
		V _{CC} = 2.7V; V _I = V _{CC}	Data pins ⁴		0.1	1	
		V _{CC} = 2.7V; V _I = 0			0.1	-5	
I _{OFF}	Off current	V _{CC} = 0V; V _I or V _O = 0 to 4.5V			0.1	± 100	μA
I _{HOLD}	Bus Hold current	V _{CC} = 2.3V; V _I = 0.7V			90		μA
	Data inputs ⁶	V _{CC} = 2.3V; V _I = 1.7V			-10		
I _{EX}	Current into an output in the High state when V _O > V _{CC}	V _O = 5.5V; V _{CC} = 2.3V			10	125	μA
I _{PU/PD}	Power up/down 3-State output current ³	V _{CC} ≤ 1.2V; V _O = 0.5V to V _{CC} ; V _I = GND or V _{CC} OE/OE = Don't care			1	± 100	μA
I _{OZH}	3-State output High current	V _{CC} = 2.7V; V _O = 2.3V; V _I = V _{IL} or V _{IH}			0.5	5	μA
I _{OZL}	3-State output Low current	V _{CC} = 2.7V; V _O = 0.5V; V _I = V _{IL} or V _{IH}			0.5	-5	μA
I _{CCH}	Quiescent supply current	V _{CC} = 2.7V; Outputs High, V _I = GND or V _{CC} , I _O = 0			0.04	0.1	mA
I _{CCL}		V _{CC} = 2.7V; Outputs Low, V _I = GND or V _{CC} , I _O = 0			2.3	4.5	
I _{CCZ}		V _{CC} = 2.7V; Outputs Disabled; V _I = GND or V _{CC} , I _O = 0 ⁵			0.04	0.1	
ΔI _{CC}	Additional supply current per input pin ²	V _{CC} = 2.3V to 2.7V; One input at V _{CC} -0.6V, Other inputs at V _{CC} or GND			0.04	0.4	mA

NOTES:

1. All typical values are at $V_{\text{CC}} = 2.5\text{V}$ and $T_{\text{amb}} = 25^\circ\text{C}$.
2. This is the increase in supply current for each input at the specified voltage level other than V_{CC} or GND.
3. This parameter is valid for any V_{CC} between 0V and 1.2V with a transition time of up to 10msec. From $V_{\text{CC}} = 1.2\text{V}$ to $V_{\text{CC}} = 2.5\text{V} \pm 0.3\text{V}$ a transition time of 100 μsec is permitted. This parameter is valid for $T_{\text{amb}} = 25^\circ\text{C}$ only.
4. Unused pins at V_{CC} or GND.
5. I_{CCZ} is measured with outputs pulled up to V_{CC} or pulled down to ground.
6. Not guaranteed.
7. For valid test results, data must not be loaded into the flip-flops (or latches) after applying power.

2.5V/3.3V 20-bit bus-interface D-type flip-flop; positive-edge trigger (3-State)

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AC CHARACTERISTICS (2.5V $\pm$ 0.2V RANGE)

GND = 0V; $t_R = t_F = 2.5\text{ns}$; $C_L = 50\text{pF}$; $R_L = 500\Omega$; $T_{\text{amb}} = -40^\circ\text{C}$ to $+85^\circ\text{C}$.

SYMBOL	PARAMETER	WAVEFORM	LIMITS			UNIT
			T _{amb} = -40 to +85°C V _{CC} = +2.5V ±0.2V			
			MIN	TYP	MAX	
f _{MAX}	Maximum clock frequency	1	150			MHz
t _{PLH} t _{PHL}	Propagation delay nCP to nQx	1	1.0 1.0	2.6 2.7	4.0 4.4	ns
t _{PZH} t _{PZL}	Output enable time to High and Low level	3 4	1.5 1.0	2.8 1.8	4.6 3.0	ns
t _{PHZ} t _{PLZ}	Output disable time from High and Low level	3 4	1.5 1.0	2.7 2.1	4.1 3.3	ns

NOTE:

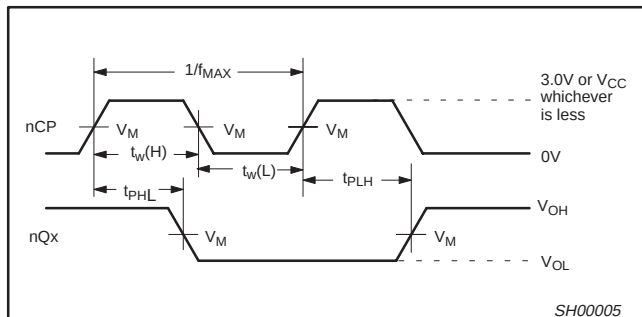
1. All typical values are at $V_{\text{CC}} = 3.3\text{V}$ and $T_{\text{amb}} = 25^\circ\text{C}$.

AC SETUP REQUIREMENTS (2.5V $\pm$ 0.2V RANGE)

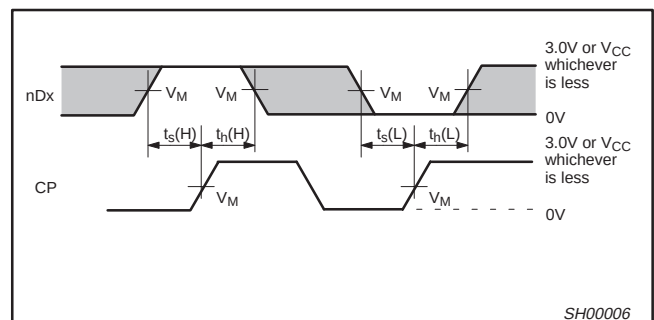
GND = 0V; $t_R = t_F = 2.5\text{ns}$; $C_L = 50\text{pF}$; $R_L = 500\Omega$

SYMBOL	PARAMETER	WAVEFORM	LIMITS		UNIT
			$T_{\text{amb}} = -40 \text{ to } +85^{\circ}\text{C}$ $V_{\text{CC}} = +2.5 \pm 0.2\text{V}$		
			MIN	TYP	
$t_{\text{S}}(\text{H})$ $t_{\text{S}}(\text{L})$	Setup time, High or Low nDx to nCP	2	1.5 2.0	0.1 0.5	ns
$t_{\text{H}}(\text{H})$ $t_{\text{H}}(\text{L})$	Hold time, High or Low nDx to nCP	2	0.3 0.5	-0.5 -0.1	ns
$t_{\text{W}}(\text{H})$ $t_{\text{W}}(\text{L})$	nCP pulse width High or Low	1	1.5 1.5		ns

AC WAVEFORMS

 $V_M = 1.5\text{V}$ at $V_{\text{CC}} \geq 3.0\text{V}$; $V_M = V_{\text{CC}}/2$ at $V_{\text{CC}} \leq 2.7\text{V}$ $V_X = V_{\text{OL}} + 0.3\text{V}$ at $V_{\text{CC}} \geq 3.0\text{V}$; $V_X = V_{\text{OL}} + 0.15\text{V}$ at $V_{\text{CC}} \leq 2.7\text{V}$ $V_Y = V_{\text{OH}} - 0.3\text{V}$ at $V_{\text{CC}} \geq 3.0\text{V}$; $V_Y = V_{\text{OH}} - 0.15\text{V}$ at $V_{\text{CC}} \leq 2.7\text{V}$ 

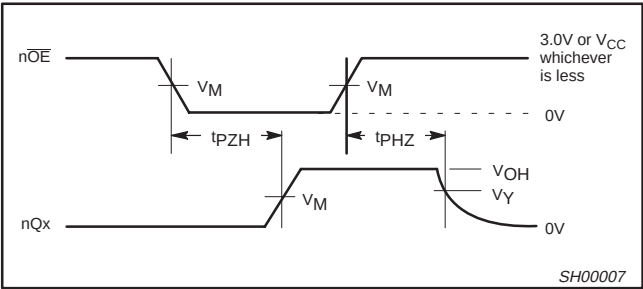
Waveform 1. Propagation Delay, Clock Input to Output,
Clock Pulse Width, and Maximum Clock frequency



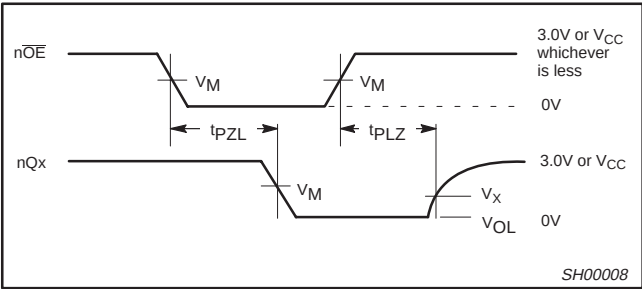
Waveform 2. Data Setup and Hold Times

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Waveform 3. 3-State Output Enable Time to High Level and Output Disable Time from High Level



Waveform 4. 3-State Output Enable Time to Low Level and Output Disable Time from Low Level

TEST CIRCUIT AND WAVEFORM

Test Circuit for 3-State Outputs

SWITCH POSITION	
TEST	SWITCH
t_{PLZ}/t_{PZL}	6V or $V_{CC} \times 2$
t_{PLH}/t_{PHL}	Open
t_{PHZ}/t_{PZH}	GND

DEFINITIONS

R_L = Load resistor; see AC CHARACTERISTICS for value.

C_L = Load capacitance includes jig and probe capacitance: See AC CHARACTERISTICS for value.

R_T = Termination resistance should be equal to Z_{OUT} of pulse generators.

FAMILY	INPUT PULSE REQUIREMENTS				
	Amplitude	Rep. Rate	t_W	t_R	t_F
74ALVT16	3.0V or V_{CC} whichever is less	$\leq 10\text{MHz}$	500ns	$\leq 2.5\text{ns}$	$\leq 2.5\text{ns}$

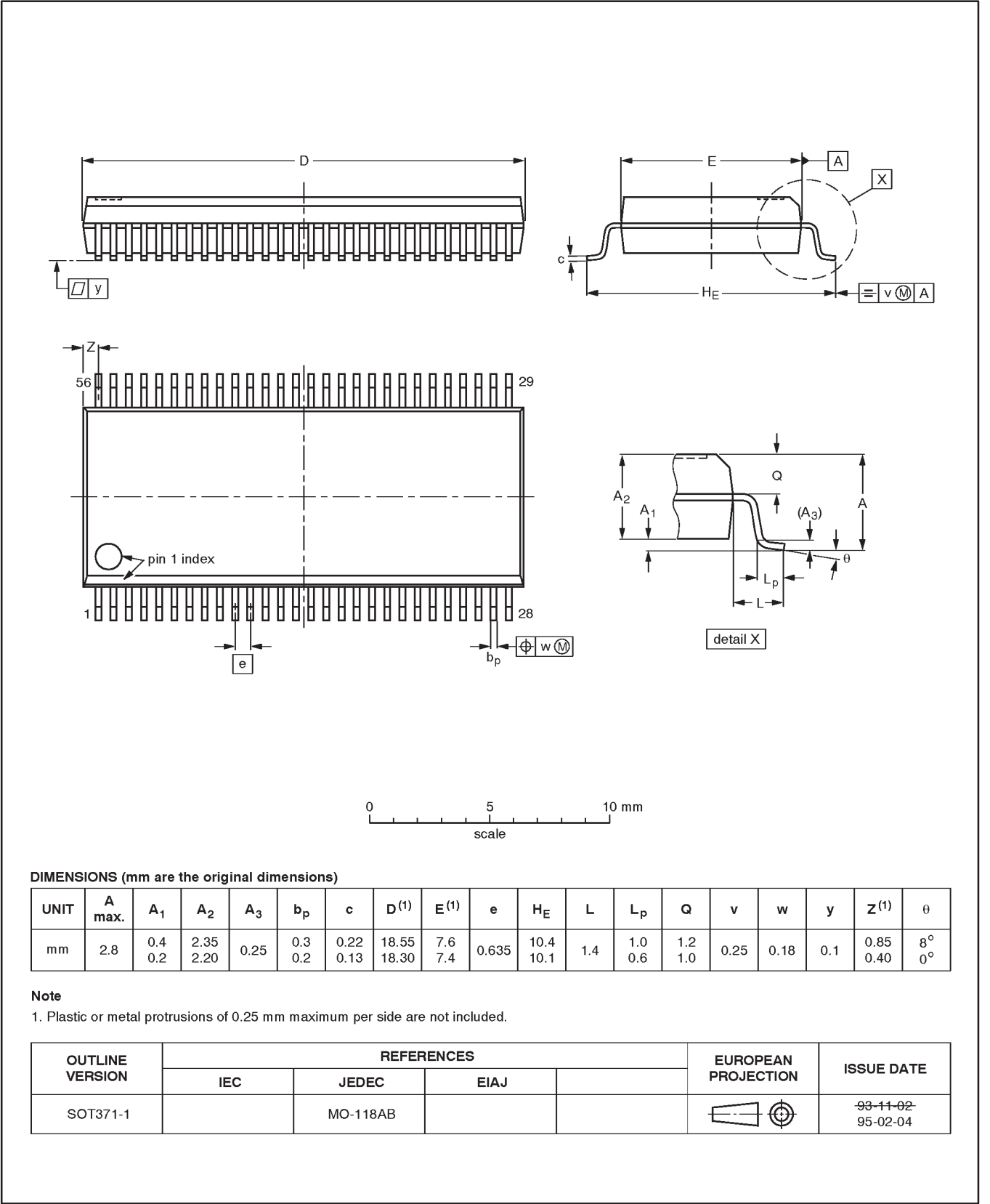
SW00025

20-bit bus-interface D-type flip-flop;
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SSOP56: plastic shrink small outline package; 56 leads; body width 7.5 mm

SOT371-1

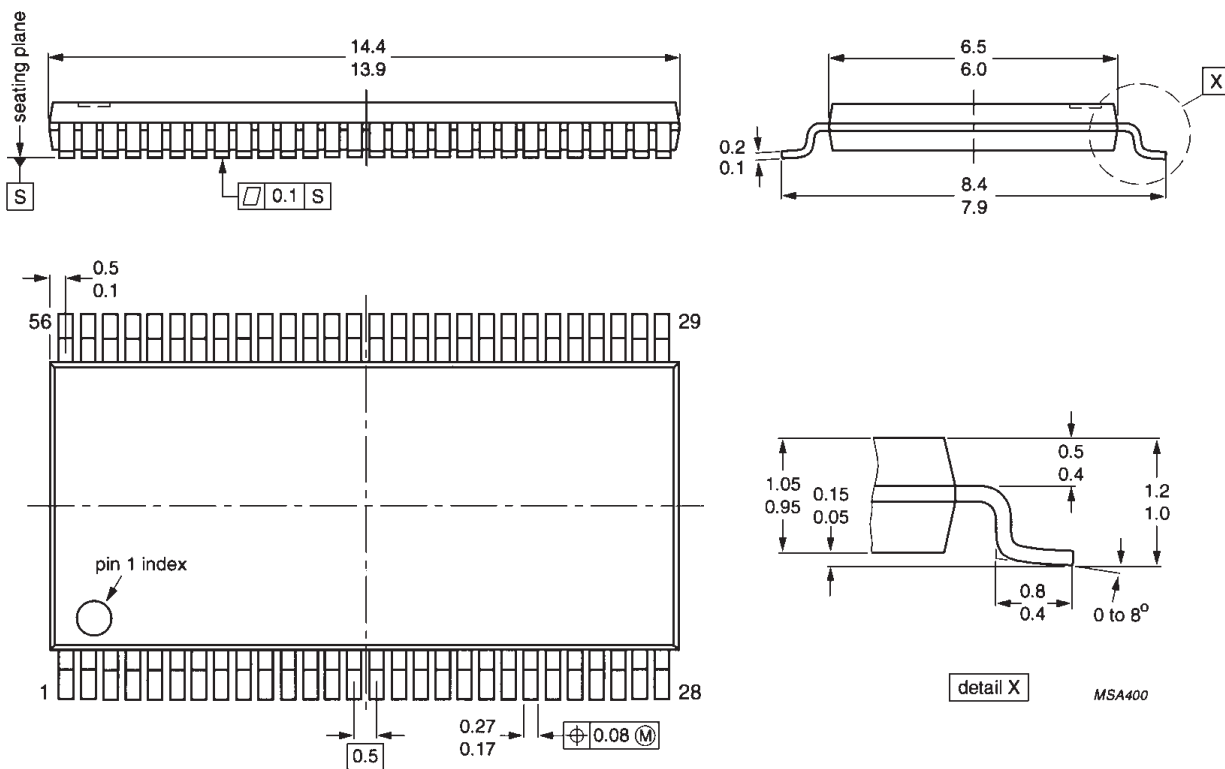


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TSSOP56: plastic thin shrink small outline package; 56 leads; body width 6.1mm

SOT364-1



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NOTES

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Data sheet status

Data sheet status	Product status	Definition [1]
Objective specification	Development	This data sheet contains the design target or goal specifications for product development. Specification may change in any manner without notice.
Preliminary specification	Qualification	This data sheet contains preliminary data, and supplementary data will be published at a later date. Philips Semiconductors reserves the right to make changes at any time without notice in order to improve design and supply the best possible product.
Product specification	Production	This data sheet contains final specifications. Philips Semiconductors reserves the right to make changes at any time without notice in order to improve design and supply the best possible product.

[1] Please consult the most recently issued datasheet before initiating or completing a design.

Definitions

Short-form specification — The data in a short-form specification is extracted from a full data sheet with the same type number and title. For detailed information see the relevant data sheet or data handbook.

Limiting values definition — Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.

Application information — Applications that are described herein for any of these products are for illustrative purposes only. Philips Semiconductors make no representation or warranty that such applications will be suitable for the specified use without further testing or modification.

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