High-Speed CMOS 3.3V 16-Bit Register (3-State) with Bus Hold

FEATURES/BENEFITS

- 5V tolerant inputs and outputs
- Industry standard pinouts
- Bus Hold feature holds last active state during 3-state operation
- 10µA I_{CCQ} quiescent power supply current
- Hot insertable
- 2.0V-3.6V V_{CC} supply operation
- ±24mA balanced output drive
- Meets or exceeds JEDEC 36 Standard
- C speed performance: t_{PD} = 5.2ns
- Input hysteresis for noise immunity
- Multiple power and ground pins for low noise
- Operating temperature range: –40°C to 85°C
- Latch-up performance exceeds 500mA
- ESD performance:
  Human body model > 2000V
  Machine model > 200V
- Packages available:
  48-pin TSSOP
  48-pin SSOP

DESCRIPTION

The LCX16H374 is a 16-bit buffered register with three-state output that is ideal for driving address and data buses. The output enable (x$\overline{OE}$) and clock (xCLK) controls are organized to operate each device as two 8-bit registers, or one 16-bit register with common clock. Easy board layout is facilitated by the use of flow-through pinouts and byte enable controls provide architectural flexibility for systems designers. The QS74LCX16H374 provides Bus Hold circuitry on the data inputs retains the last active state during 3-state operation, eliminating the need for external pull-up resistors. The 3.3V LCXPlus family features low power, low switching noise, and fast switching speeds for low power portable applications as well as high-end advanced workstation applications. To accommodate hot-plug or live insertion applications, this product is designed not to load an active bus when V_{CC} is removed.

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Figure 1. Functional Block Diagram

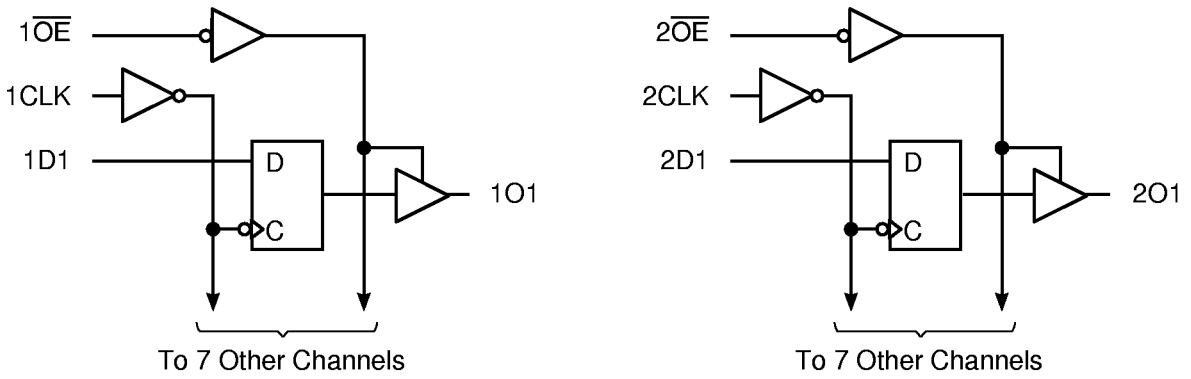

Figure 2. Pin Configuration
(All Pins Top View)
SSOP, TSSOP

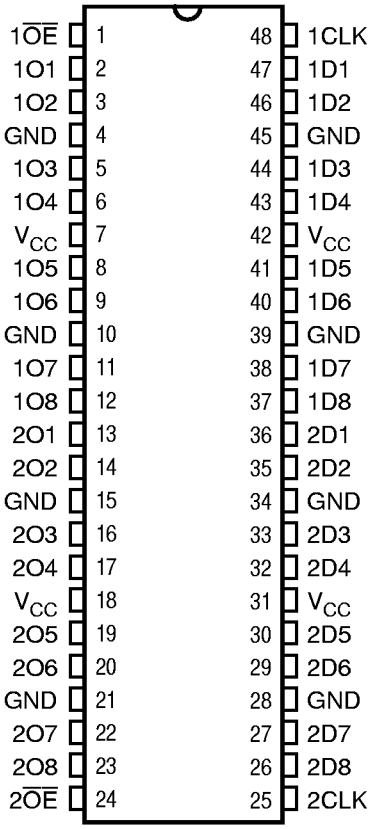

Table 1. Pin Description

Name	I/O	Description
xDx	I	Data Inputs (Bus Hold Inputs)
xOx	O	Data Outputs
xCLK	I	Clock Input
x$\overline{OE}$	I	Output Enable

Table 2. Function Table

Inputs			Internal	Outputs	
x$\overline{OE}$	xCLK	xDx	Q Value	xOx	Function
H	X	X	X	Hi-Z	Disable Outputs
L	↑	L	L	L	Load Input Data
L	↑	H	H	H	Enable Outputs
H	↑	L	L	Hi-Z	Load Input Data
H	↑	H	H	Hi-Z	Disable Outputs

Table 3. Capacitance

Symbol	Pins	Typ	Unit	Conditions
C_{IN}	Input Capacitance	7.0	pF	V_{IN} = 0V, V_{OUT} = 0V, f = 1MHz
$C_{I/O}$	I/O Capacitance	8.0	pF	V_{IN} = 0V, V_{OUT} = 0V, f = 1MHz
C_{PD}	Power Dissipation Capacitance	20	pF	V_{CC} = 3.3V, V_{IN} = 0 or V_{CC} f = 10MHz

Note: Capacitance is characterized but not production tested.

Table 4. Absolute Maximum Ratings

Supply Voltage to Ground ..... –0.5V to 7.0V
DC Output Voltage V_{OUT}
Outputs HIGH-Z ..... –0.5V to 7.0V
Outputs Active ..... –0.5V to V_{CC} + 0.5V
DC Input Voltage V_{IN} ..... –0.5V to 7.0V
DC Input Diode Current with V_{IN} < 0 ..... –50mA
DC Output Diode Current
V_O < 0 ..... –50mA
V_O > V_{CC} 50mA
DC Output Source/Sink Current (I_{OH}/I_{OL}) ..... ±50mA
DC Supply Current per Supply Pin ..... ±100mA
DC Ground Current per Ground Pin ..... ±100mA
T_{STG} Storage Temperature ..... –65° to 150°C

Note: Stresses greater than those listed under ABSOLUTE MAXIMUM RATINGS may cause permanent damage to this device resulting in functional or reliability type failures.

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Table 5. Recommended Operating Conditions

Symbol	Parameter		Min	Max	Unit
V_{CC}	Supply Voltage, Operating		2.0	3.6	V
	Supply Voltage, Data Retention Only		1.5	3.6	
V_{IN}	Input Voltage		0	5.5	V
V_{OUT}	Output Voltage in Active State		0	V_{CC}	V
V_{OUT}	Output Voltage in “OFF” State		0	5.5	V
I_{OH}/I_{OL}	Output Current	V_{CC} = 3.0 –3.6V	—	±24	mA
		V_{CC} = 2.7V	—	±12	
$\Delta t/\Delta v$	Input Transition Slew Rate		—	10	ns/V
T_A	Operating Free Air Temperature		–40	85	°C

Table 6. DC Electrical Characteristics Over Operating Range

Industrial Temperature Range, T_A = –40°C to 85°C

Symbol	Parameter	Test Conditions[1]	Min	Typ[2]	Max	Unit
V_{IH}	Input HIGH Voltage	Logic HIGH for All Inputs	2.0	—	—	V
V_{IL}	Input LOW Voltage	Logic LOW for All Inputs	—	—	0.8	V
V_{OH}	Output HIGH Voltage	V_{CC} = 2.7V, I_{OH} = –100µA V_{CC} = 2.7V, I_{OH} = –12mA V_{CC} = 3.0V, I_{OH} = –18mA V_{CC} = 3.0V, I_{OH} = –24mA	V_{CC}-0.2 2.2 2.4 2.2	— — — —	— — — —	V
V_{OL}	Output LOW Voltage	V_{CC} = 2.7V, I_{OL} = 100µA V_{CC} = 2.7V, I_{OL} = 12mA V_{CC} = 3.0V, I_{OL} = 16mA V_{CC} = 3.0V, I_{OL} = 24mA	— — — —	— — — —	0.2 0.4 0.4 0.5	V
ΔV_T	Input Hysteresis[3]	$V_{TLH} - V_{THL}$ for All Inputs	—	150	—	mV
$\|I_{BH}\|$	Input Current Input High or Low Bus Hold Inputs[3,4]	V_{CC} = 3.6V, V_{IN} = 0V or V_{IN} = V_{CC}	—	—	50	µA
		V_{CC} = 3.6V, 0.8V < V_{IN} < 2.0V	—	—	500[5]	µA
I_{BHH}	Bus Hold Sustaining Current Bus Hold Inputs	V_{CC} = 3V, V_{IN} = 2.0V	–75	—	—	µA
I_{BHL}		V_{IN} = 0.8V	75	—	—	µA
I_I	Input Leakage Current	V_I = 0V, V_I = 5.5V, V_{CC} = 3.6V	—	—	±1.0	µA
I_{OZ}	High-Z I/O Leakage	V_O = 0V, V_O = 5.5V V_I = V_{IH} or V_{IL}, V_{CC} = 3.6V	—	—	±1.0	µA
I_{OS}	Short Circuit Current[3,6]	V_{CC} = 3.6V, V_{OUT} = GND	–60	—	–200	mA
I_{OFF}	Power Off Leakage	V_{CC} = 0V, V_I or V_O = 5.5V	—	—	10	µA
V_{IK}	Input Clamp Voltage	V_{CC} = 2.7V, I_{IN} = –18mA	—	–0.7	–1.2	V

Notes:
1. For conditions shown as Min. or Max. use appropriate value specified under Recommended Operating Conditions for the applicable device type.
2. Typical values are at V_{CC} = 3.3V and T_A = 25°C.
3. These parameters are guaranteed by characterization, but not production tested.
4. Pins with Bus Hold are identified in the Pin Description.
5. An external driver must provide at least | I_{BH} | during transition to guarantee that the Bus Hold input will change state.
6. Not more than one output should be tested at one time. Duration of test should not exceed one second.

Table 7. Power Supply Characteristics

Symbol	Parameter	Test Conditions(1)		Typ(2)	Max	Unit
I_{CC}	Quiescent Power Supply Current	V_{CC} = 3.6V, Freq = 0 V_{IN} = GND or V_{CC}		0.1	10	µA
ΔI_{cc}	Supply Current per Input @ TTL HIGH(3)	V_{CC} = 3.6V, V_{IN} = V_{CC} –0.6V, Freq = 0	Control Inputs	2.0	30	µA
			Bus Hold Inputs	—	500	µA
I_{CCD}	Supply Current per Input per MHz(4)	V_{CC} = 3.6V, Outputs Open One Bit Toggling @ 50% Duty Cycle x$\overline{OE}$ = GND		50	75	µA/ MHz
I_C	Total Power Supply Current(6)	V_{CC} = 3.6V, Outputs Open One Bit Toggling @ 50% Duty Cycle x$\overline{OE}$ = GND, f = 5MHz f_{CP} = 10MHz	V_{IN} = V_{CC}–0.6V V_{IN} = GND	0.5(5)	1.0(5)	mA
		V_{CC} = 3.6V, Outputs Open Sixteen Bits Toggling @ 50% Duty Cycle x$\overline{OE}$ = GND, f = 2.5MHz f_{CP} = 10MHz	V_{IN} = V_{CC}–0.6V V_{IN} = GND	2.7(5)	8.0(5)	mA

Notes:
1. For conditions shown as Min. or Max., use the appropriate values specified under Recommended Operating Conditions for applicable device type.
2. Typical values are at V_{CC} = 3.3V, 25°C ambient.
3. Per TTL driven input. All other inputs at V_{CC} or GND.
4. This parameter is not directly testable, but is derived for use in total power supply calculations.
5. Values for these conditions are examples of the Icc formula. These limits are guaranteed by design but not tested.
6. $I_C = I_{QUIESCENT} + I_{INPUTS} + I_{DYNAMIC}$.
   $I_C = I_{CCQ} + \Delta I_{CC} D_H N_T + I_{CCD} f N_O$.
   I_{CCQ} = Quiescent Current (I_{CCL}, I_{CCH}, and I_{CCZ}).
   ΔI_{CC} = Power Supply Current for a TTL-High Input (V_{IN} = V_{CC} – 0.6V).
   D_H = Duty Cycle for TTL High Inputs.
   N_T = Number of TTL High Inputs.
   I_{CCD} = Dynamic Current Caused by an Input Transition Pair (HLH or LHL).
   f = Average Switching Frequency per Output.
   N_O = Number of Outputs Switching.

Table 8. Dynamic Switching Characteristics (1)

Symbol	Parameter	Conditions	V_{CC} (V)	T_A = 25°C Typical	Units
V_{OLP}	Quiet Output Dynamic Peak V_{OL}	C_L = 50pF, V_{IH} = 3.3, V_{IL} = 0V	3.3	0.8	V
V_{OLV}	Quiet Output Dynamic Peak V_{OL}	C_L = 50pF, V_{IH} = 3.3, V_{IL} = 0V	3.3	0.8	V

Note:
1. Characterized but not production tested.

Table 9. Switching Characteristics Over Operating Range

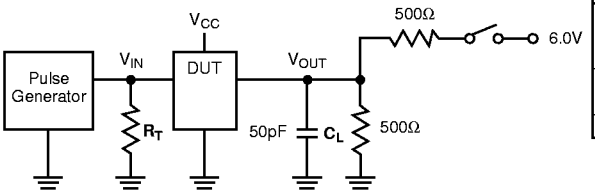
Industrial Temperature Range, T_A = –40°C to 85°
C_{LOAD} = 50pF, R_{LOAD} = 500Ω unless otherwise noted.

Symbol	Description[1]	16H374				16H374C		Unit
		V_{CC} = 3.3 ±0.3V		V_{CC} = 2.7V[2]		V_{CC} = 3.3 ±0.3V		
		Min	Max	Min	Max	Min	Max	
f_{MAX}	Clock Pulse Frequency[2]	170	—	—	—	170	—	MHz
t_{PHL} t_{PLH}	Propagation Delay xCLK to xOx	2.0	6.2	2.0	6.5	2.0	5.2	ns
t_{PZH} t_{PZL}	Output Enable Time x$\overline{OE}$ to xOx	1.5	6.1	1.5	6.3	1.5	5.5	ns
t_{PHZ} t_{PLZ}	Output Disable Time[2] x$\overline{OE}$ to xOx	1.5	6.0	1.5	6.2	1.5	5.0	ns
t_S	Data Setup Time xDx to xCLK	2.5	—	2.5	—	2.0	—	ns
t_H	Data Hold Time xDx to xCLK	1.5	—	1.5	—	1.5	—	ns
t_W	Clock Pulse Width HIGH or LOW[2]	3.0	—	3.0	—	3.0	—	ns
$t_{SK(O)}$	Output Skew[3]	—	0.5	—	—	—	0.5	ns

Notes:
1. Minimums guaranteed but not tested on propagation delays. See Test Circuit and Waveforms.
2. Guaranteed by characterization.
3. Skew between any two outputs of the same package switching in the same direction.
   This parameter is guaranteed by characterization but not production tested.

TEST CIRCUIT AND WAVEFORMS

Figure 3. Test Circuit



SWITCH POSITION

Test	Switch
Open Drain Disable LOW Enable LOW	6V
Disable HIGH Enable HIGH	GND
All Other Inputs	Open

DEFINITIONS:
C_L = Load capacitance: includes jig and probe capacitance.
R_T = Termination resistance: should be equal to Z_{OUT} of the Pulse Generator.

Figure 4. Setup, Hold, and Release Timing

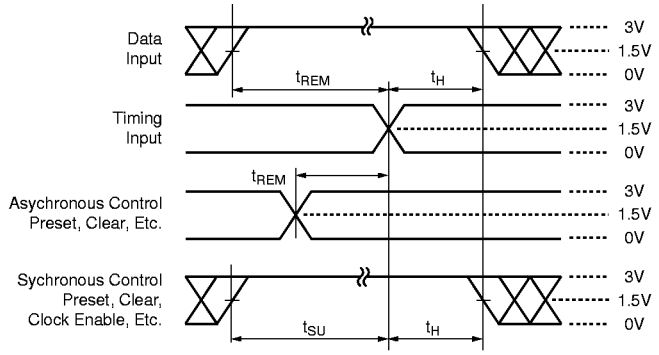
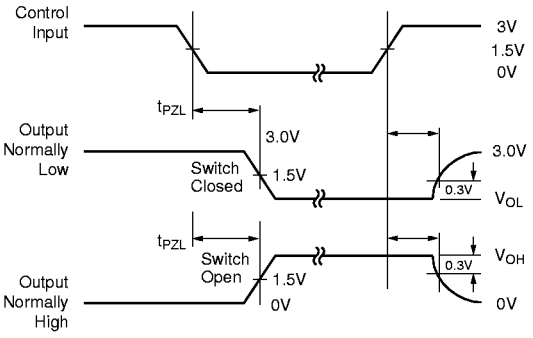


Figure 5. Enable and Disable Timing



Notes:
1. Input Control Enable = LOW and Input Control Disable = HIGH.
2. Pulse Generator for All Pulses: Rate ≤ 1.0MHz; $Z_{OUT} \leq 50\Omega$; t_F, $t_R \leq 2.5$ns.

Figure 6. Pulse Width

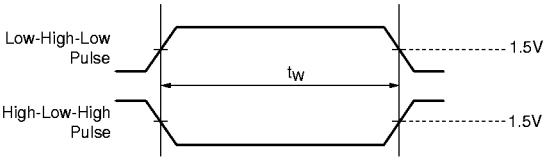
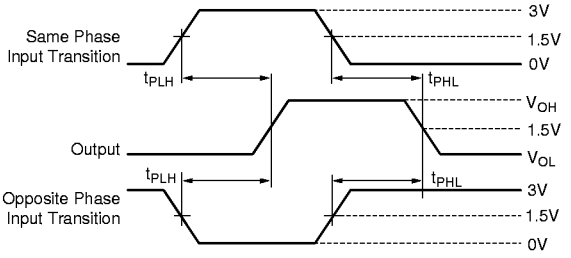


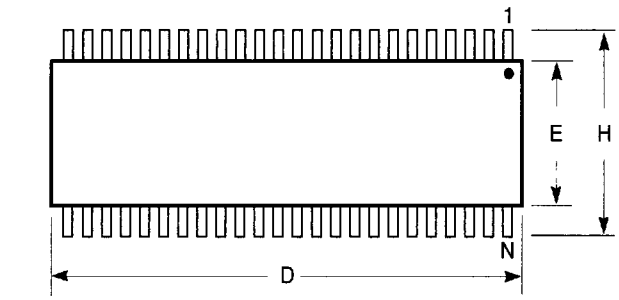
Figure 7. Propagation Delay

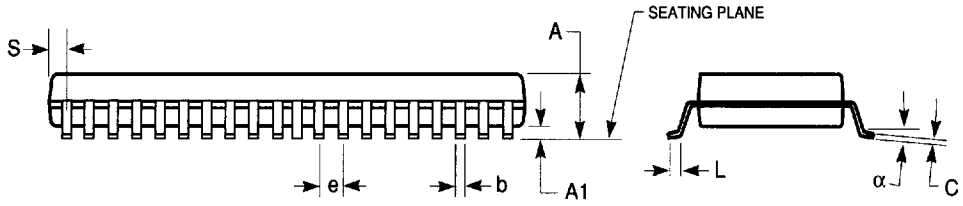


3

300-MIL SSOP - Package Code PV

Shrink Small Outline Package
Plastic Small Outline Gull-Wing



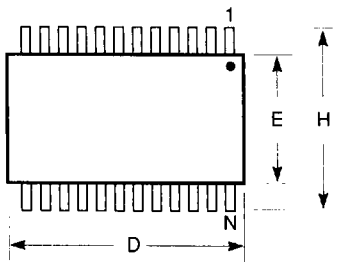


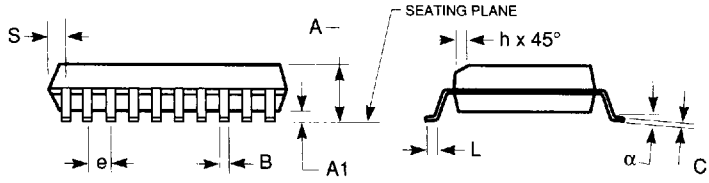
Notes:
1. Refer to applicable symbol list.
2. All dimensions are in inches.
3. N is the number of lead positions.
4. Dimensions D and E are to be measured at maximum material condition but do not include mold flash. Allowable mold flash is 0.006in. per side.
5. Lead coplanarity is 0.004in. maximum.

JEDEC#	MO-118AA			MO-118AB		
DWG#	PSS-48B			PSS-56B		
Symbol	Min	Nom	Max	Min	Nom	Max
A	0.095	0.102	0.110	0.095	0.102	0.110
A1	0.008	0.012	0.016	0.008	0.012	0.016
b	0.008	0.010	0.0135	0.008	0.010	0.0135
C	0.005	0.008	0.010	0.005	0.008	0.010
D	0.620	0.625	0.630	0.720	0.725	0.730
E	0.291	0.295	0.299	0.291	0.295	0.299
e	0.025 BSC			0.025 BSC		
H	0.395	0.410	0.420	0.395	0.410	0.420
L	0.020	0.030	0.040	0.020	0.030	0.040
N	48			56		
α	0°	5°	8°	0°	5°	8°
S	0.022	0.025	0.028	0.022	0.025	0.028

170-MIL TSSOP - Package Code PA

Thin Shrink Small Outline Package
Plastic Small Outline Gull-Wing



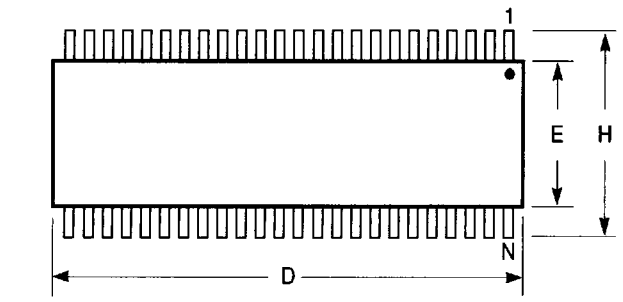


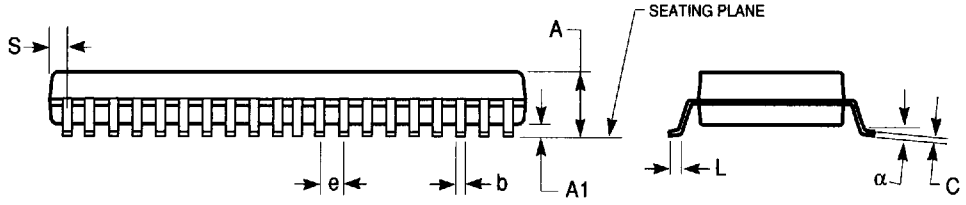
Notes:
1. Refer to applicable symbol list.
2. N is the number of lead positions.
3. Dimensions D and E are to be measured at maximum material condition but do not include mold flash. Allowable mold flash is 0.006in. per side.
4. Lead coplanarity is 0.004in. maximum.

JEDEC#	MO-153AD			MO-153AD		
DWG#	PSS-24C			PSS-24C		
Symbol	Min	Nom	Max	Min	Nom	Max
A	0.045	0.046	0.047	1.14	1.17	1.20
A1	0.002	0.004	0.006	0.05	0.10	0.15
b	0.007	0.010	0.012	0.19	0.25	0.30
C	0.004	0.005	0.006	0.09	0.13	0.16
D	0.303	0.307	0.311	7.7	7.8	7.9
E	0.169	0.173	0.177	4.3	4.4	4.5
e	0.025 BSC			0.65 BSC		
H	0.238	0.252	0.269	6.1	6.4	6.7
L	0.020	0.024	0.030	0.50	0.60	0.75
N	24			24		
α	0°	5°	8°	0°	5°	8°
S	0.007	0.008	0.009	0.18	0.2	0.22
	IN INCHES			IN MILLIMETERS		

240-MIL TSSOP - Package Code PA

Thin Shrink Small Outline Package
Plastic Small Outline Gull-Wing





Notes:
1. Refer to applicable symbol list.
2. N is the number of lead positions.
3. Dimensions D, E, and S are to be measured at maximum material condition but do not include mold flash. Allowable mold flash is 0.006 in. per side.
4. Lead coplanarity is 0.004in. maximum.

JEDEC#	MO-153ED			MO-153EE			MO-153ED			MO-153EE		
DWG#	PSS-48C			PSS-56C			PSS-48C			PSS-56C		
Symbol	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
A	0.039	0.043	0.047	0.039	0.043	0.047	1.00	1.10	1.20	1.00	1.10	1.20
A1	0.002	0.004	0.006	0.002	0.004	0.006	0.05	0.10	0.15	0.05	0.10	0.15
b	0.006	0.008	0.011	0.006	0.008	0.011	0.17	0.20	0.27	0.17	0.20	0.27
C	0.004	0.006	0.008	0.004	0.006	0.008	0.09	0.15	0.20	0.09	0.15	0.20
D	0.488	0.492	0.496	0.547	0.551	0.555	12.40	12.50	12.60	13.90	14.00	14.10
E	0.236	0.240	0.244	0.236	0.240	0.244	6.00	6.10	6.20	6.00	6.10	6.20
e	0.0197 BSC			0.0197 BSC			0.50 BSC			0.50 BSC		
H	0.315	0.319	0.323	0.315	0.319	0.323	8.00	8.10	8.20	8.00	8.10	8.20
L	0.018	0.024	0.030	0.018	0.024	0.030	0.45	0.60	0.75	0.45	0.60	0.75
N	48			56			48			56		
α	0°	5°	8°	0°	5°	8°	0°	5°	8°	0°	5°	8°
S	0.015	0.020	0.025	0.006	0.010	0.014	0.38	0.50	0.65	0.15	0.25	0.35

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