National Semiconductor

August 1989

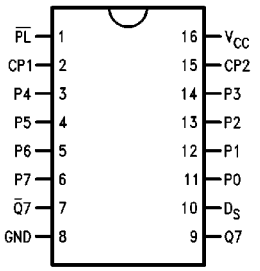
54165/DM74165
8-Bit Parallel-to-Serial Converter

General Description

The '165 is an 8-bit parallel load or serial-in register with complementary outputs available from the last stage. Parallel inputting occurs asynchronously when the Parallel Load ($\overline{PL}$) input is LOW. With $\overline{PL}$ HIGH, serial shifting occurs on the rising edge of the clock; new data enters via the Serial Data (D_S) input. The 2-input OR clock can be used to combine two independent clock sources, or one input can act as an active LOW clock enable.

Connection Diagram

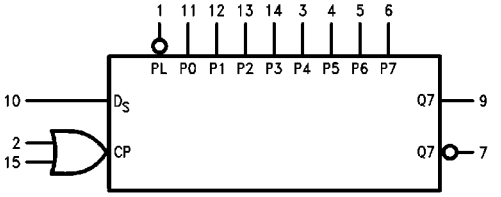
Dual-In-Line-Package



TL/F/9782–1

Order Number 54165DMQB, 54165FMQB or DM74165N
See NS Package Number J16A, N16E or W16A

Logic Symbol



TL/F/9782–2

V_{CC} = Pin 16
GND = Pin 8

Pin Names	Description
CP1, CP2	Clock Pulse Inputs (Active Rising Edge)
D_S	Serial Data Input
$\overline{PL}$	Asynchronous Parallel Load Input (Active LOW)
P0–P7	Parallel Data Inputs
Q7	Serial Output from Last Stage
$\overline{Q7}$	Complementary Output

Absolute Maximum Ratings (Note)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Supply Voltage	7V
Input Voltage	5.5V
Operating Free Air Temperature Range	
54	−55°C to +125°C
DM74	0°C to +70°C
Storage Temperature Range	−65°C to +150°C

Note: *The "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. The device should not be operated at these limits. The parametric values defined in the "Electrical Characteristics" table are not guaranteed at the absolute maximum ratings. The "Recommended Operating Conditions" table will define the conditions for actual device operation.*

Recommended Operating Conditions

Symbol	Parameter	54165			DM74165			Units
		Min	Nom	Max	Min	Nom	Max	
V_{CC}	Supply Voltage	4.5	5	5.5	4.75	5	5.25	V
V_{IH}	High Level Input Voltage	2			2			V
V_{IL}	Low Level Input Voltage			0.8			0.8	V
I_{OH}	High Level Output Current			−0.8			−0.8	mA
I_{OL}	Low Level Output Current			16			16	mA
T_A	Free Air Operating Temperature	−55		125	0		70	°C
$t_s(H)$ $t_s(L)$	Setup Time HIGH or LOW P_n to $\overline{PL}$	10 10			10 10			ns
$t_h(H)$ $t_h(L)$	Hold Time HIGH or LOW P_n to $\overline{PL}$	10 10			0 0			ns
$t_s(H)$ $t_s(L)$	Setup Time HIGH or LOW D_S to CP_n	20 20			20 20			ns
$t_h(H)$ $t_h(L)$	Hold Time HIGH or LOW D_S to CP_n	0 0			0 0			ns
$t_s(H)$	Setup Time HIGH CP1 to CP2 or CP2 to CP1	30			30			ns
$t_w(H)$	CP_n Pulse Width HIGH	25			25			ns
$t_w(L)$	$\overline{PL}$ Pulse Width LOW	15			15			ns
t_{rec}	Recovery Time, $\overline{PL}$ to CP_n	45			45			ns

Electrical Characteristics

Over recommended operating free air temperature range (unless otherwise noted)

Symbol	Parameter	Conditions		Min	Typ (Note 1)	Max	Units
V_I	Input Clamp Voltage	V_{CC} = Min, I_I = −12 mA				−1.5	V
V_{OH}	High Level Output Voltage	V_{CC} = Min, I_{OH} = Max, V_{IL} = Max		2.4	3.4		V
V_{OL}	Low Level Output Voltage	V_{CC} = Min, V_{IH} = Min			0.2	0.4	V
I_I	Input Current @ Max Input Voltage	V_{CC} = Max, V_I = 5.5V				1	mA
I_{IH}	High Level Input Current	V_{CC} = Max, V_I = 2.4V	$\overline{PL}$			80	μA
			Inputs			40	
I_{IL}	Low Level Input Current	V_{CC} = Max, V_I = 0.4V	$\overline{PL}$			−3.2	mA
			Inputs			−1.6	
I_{OS}	Short Circuit Output Current	V_{CC} = Max (Note 2)	54	−20		−55	mA
			DM74	−18		−55	
I_{CC}	Supply Current	V_{CC} = Max, $\overline{PL}$ = ⌐⌐ P_n = ⌐, CP_1, CP_2 = 4.5V				63	mA

Switching Characteristics

V_{CC} = +5.0V, T_A = +25°C (See Section 1 for waveforms and load configurations)

Symbol	Parameter	C_L = 15 pF, R_L = 400Ω		Units
		Min	Max	
f_{max}	Maximum Clock Frequency	20		MHz
t_{PLH} t_{PHL}	Propagation Delay $\overline{PL}$ to Q7 or $\overline{Q7}$		31 40	ns
t_{PLH} t_{PHL}	Propagation Delay CP1 to Q7 or $\overline{Q7}$		24 31	ns
t_{PLH} t_{PHL}	Propagation Delay P7 to Q7		17 36	ns
t_{PLH} t_{PHL}	Propagation Delay P7 to $\overline{Q7}$		27 27	ns

Note 1: All typicals are at V_{CC} = 5V, T_A = 25°C.

Note 2: Not more than one output should be shorted at a time.

Functional Description

The '165 contains eight clocked master/slave RS flip-flops connected as a shift register with auxiliary gating to provide overriding asynchronous parallel entry. Parallel data enters when the $\overline{PL}$ signal is LOW. The parallel data can change while $\overline{PL}$ is LOW provided that the recommended setup and hold times are observed.

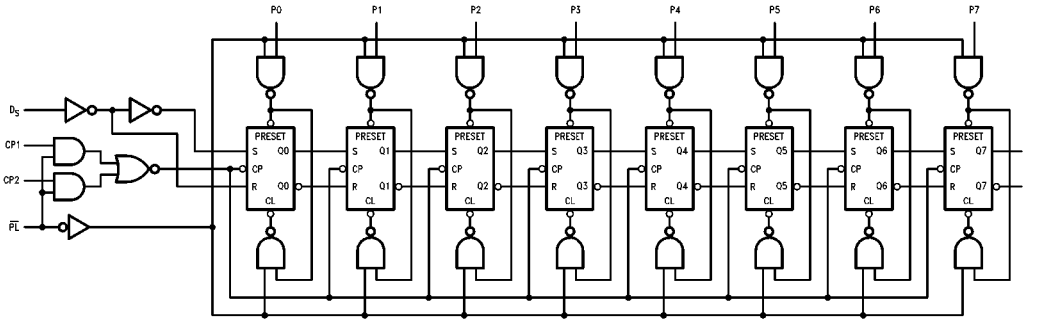
For clocked operation, $\overline{PL}$ must be HIGH. The two clock inputs perform identically; one can be used as a clock inhibit by applying a HIGH signal. To avoid double clocking, however, the inhibit signal should only go HIGH while the clock is HIGH. Otherwise, the rising inhibit signal will cause the same response as a rising clock edge. The flip-flops are edge-triggered for serial operations. The serial input data can change at any time, provided only that the recommended setup and hold times are observed, with respect to the rising edge of the clock.

Truth Table

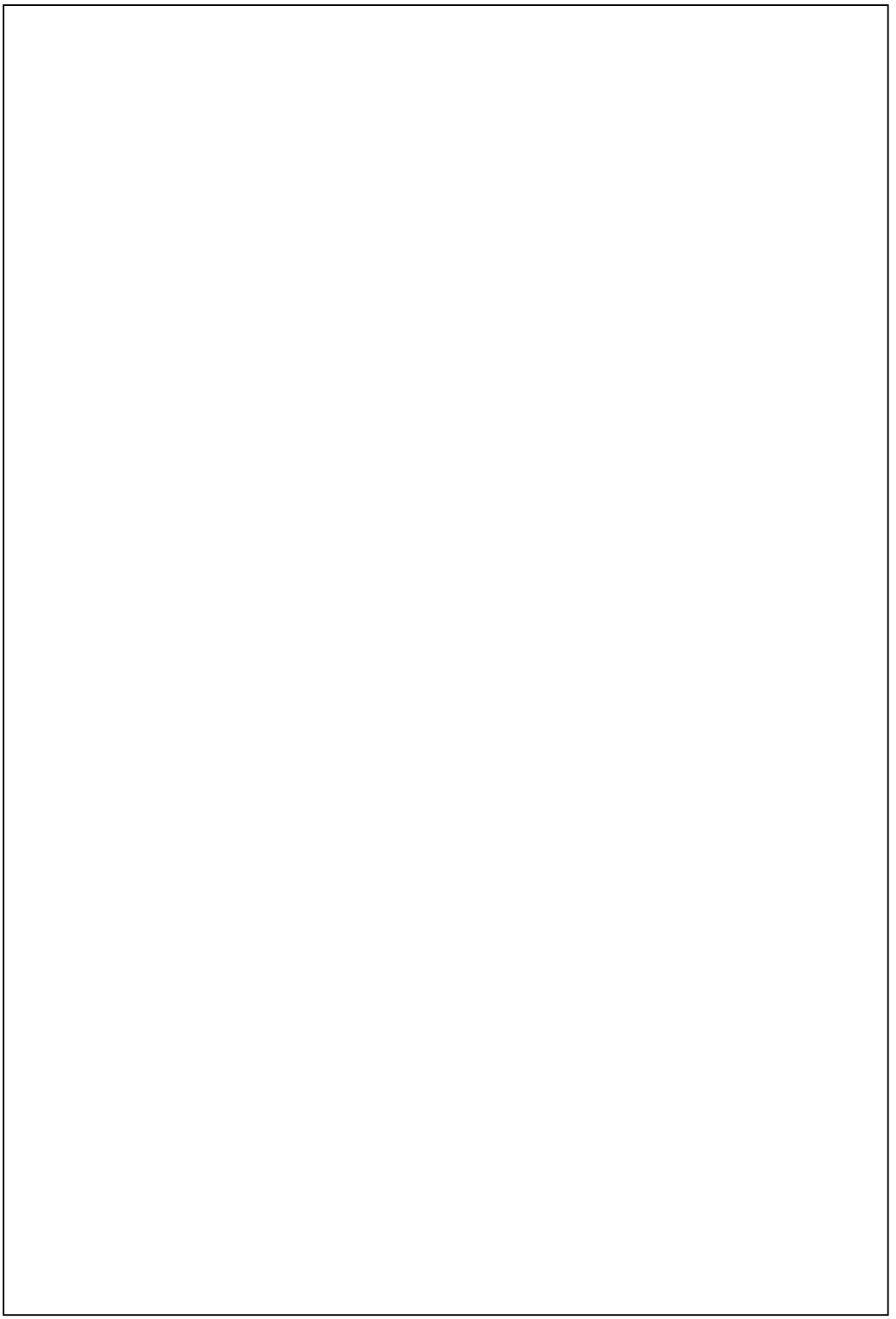
$\overline{PL}$	CP		Contents								Response
	1	2	Q0	Q1	Q2	Q3	Q4	Q5	Q6	Q7	
L	X	X	P0	P1	P2	P3	P4	P5	P6	P7	Parallel Entry
H	L	↗	D_S	Q0	Q1	Q2	Q3	Q4	Q5	Q6	Right Shift
H	H	↗	Q0	Q1	Q2	Q3	Q4	Q5	Q6	Q7	No Change
H	↗	L	D_S	Q0	Q1	Q2	Q3	Q4	Q5	Q6	Right Shift
H	↗	H	Q0	Q1	Q2	Q3	Q4	Q5	Q6	Q7	No Change

H = HIGH Voltage Level
L = LOW Voltage Level
X = Immaterial
↗ = Positive Rising Edge

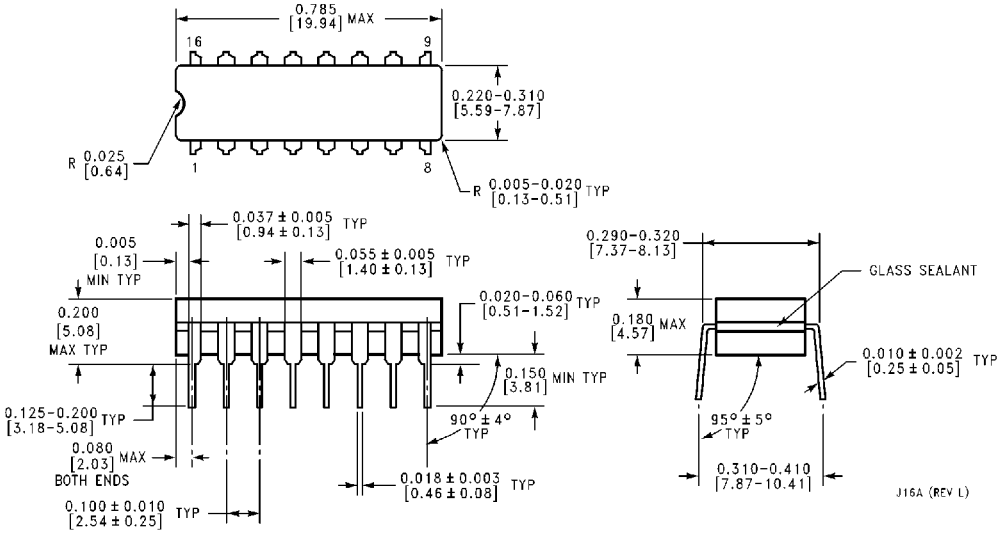
Logic Diagram



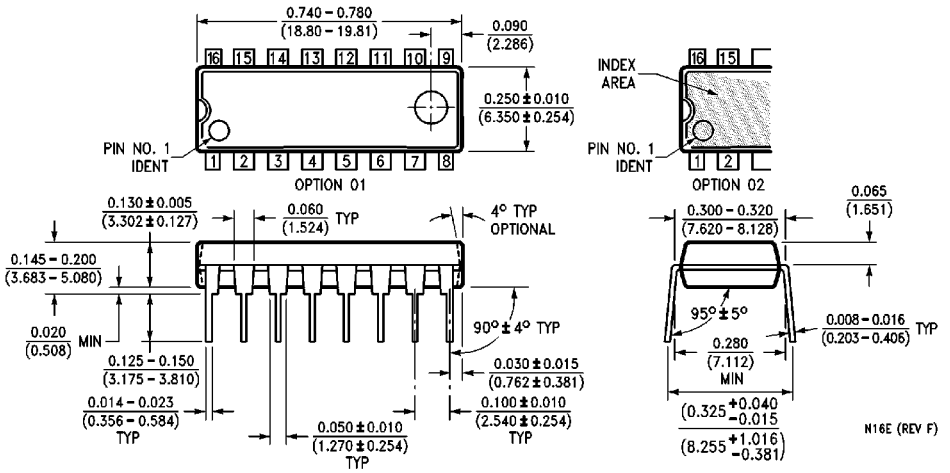
TL/F/9782–3



Physical Dimensions inches (millimeters)

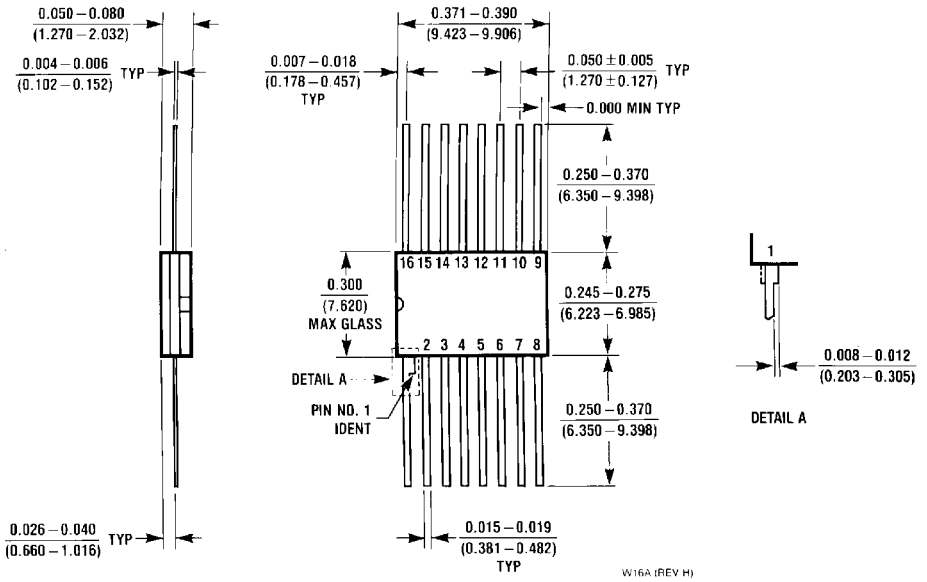


16-Lead Ceramic Dual-In-Line Package (J)
Order Number 54165DMQB
NS Package Number J16A



16-Lead Molded Dual-In-Line Package (N)
Order Number DM74165N
NS Package Number N16E

Physical Dimensions inches (millimeters) (Continued)



16-Lead Ceramic Flat Package (W)
Order Number 54165FMQB
NS Package Number W16A

LIFE SUPPORT POLICY

NATIONAL'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT OF NATIONAL SEMICONDUCTOR CORPORATION. As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform, when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.
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.

National Semiconductor Corporation
1111 West Bardin Road
Arlington, TX 76017
Tel: 1(800) 272-9959
Fax: 1(800) 737-7018

National Semiconductor Europe
Fax: (+49) 0-180-530 85 86
Email: cnjwge@tevm2.nsc.com
Deutsch Tel: (+49) 0-180-530 85 85
English Tel: (+49) 0-180-532 78 32
Français Tel: (+49) 0-180-532 93 58
Italiano Tel: (+49) 0-180-534 16 80

National Semiconductor Hong Kong Ltd.
13th Floor, Straight Block,
Ocean Centre, 5 Canton Rd.
Tsimshatsui, Kowloon
Hong Kong
Tel: (852) 2737-1600
Fax: (852) 2736-9960

National Semiconductor Japan Ltd.
Tel: 81-043-299-2309
Fax: 81-043-299-2408