

MC14013B

Dual Type D Flip-Flop

The MC14013B dual type D flip-flop is constructed with MOS P-channel and N-channel enhancement mode devices in a single monolithic structure. Each flip-flop has independent Data, (D), Direct Set, (S), Direct Reset, (R), and Clock (C) inputs and complementary outputs (Q and $\bar{Q}$). These devices may be used as shift register elements or as type T flip-flops for counter and toggle applications.

- Static Operation
- Diode Protection on All Inputs
- Supply Voltage Range = 3.0 Vdc to 18 Vdc
- Logic Edge-Clocked Flip-Flop Design
Logic state is retained indefinitely with clock level either high or low; information is transferred to the output only on the positive-going edge of the clock pulse
- Capable of Driving Two Low-power TTL Loads or One Low-power Schottky TTL Load Over the Rated Temperature Range
- Pin-for-Pin Replacement for CD4013B

MAXIMUM RATINGS* (Voltages Referenced to V_{SS})

Symbol	Parameter	Value	Unit
V_{DD}	DC Supply Voltage	- 0.5 to + 18.0	V
V_{in}, V_{out}	Input or Output Voltage (DC or Transient)	- 0.5 to $V_{DD} + 0.5$	V
I_{in}, I_{out}	Input or Output Current (DC or Transient), per Pin	± 10	mA
P_D	Power Dissipation, per Package†	500	mW
T_{stg}	Storage Temperature	- 65 to + 150	°C
T_L	Lead Temperature (8-Second Soldering)	260	°C

* Maximum Ratings are those values beyond which damage to the device may occur.

† Temperature Derating:

Plastic "P and D/DW" Packages: - 7.0 mW/°C From 65°C To 125°C

Ceramic "L" Packages: - 12 mW/°C From 100°C To 125°C

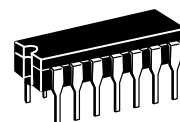
TRUTH TABLE

Inputs				Outputs	
Clock†	Data	Reset	Set	Q	$\bar{Q}$
	0	0	0	0	1
	1	0	0	1	0
	X	0	0	Q	$\bar{Q}$
X	X	1	0	0	1
X	X	0	1	1	0
X	X	1	1	1	1

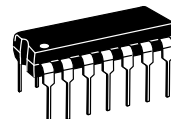
X = Don't Care

† = Level Change

No
Change



L SUFFIX
CERAMIC
CASE 632



P SUFFIX
PLASTIC
CASE 646



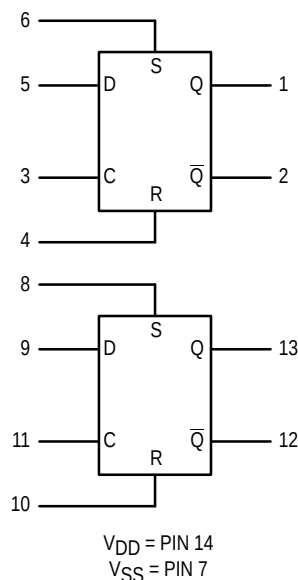
D SUFFIX
SOIC
CASE 751A

ORDERING INFORMATION

MC14XXXBCP Plastic
MC14XXXBCL Ceramic
MC14XXXBD SOIC

$T_A = -55^\circ$ to 125°C for all packages.

BLOCK DIAGRAM



ELECTRICAL CHARACTERISTICS (Voltages Referenced to V_{SS})

Characteristic	Symbol	V_{DD} Vdc	– 55°C		25°C			125°C		Unit
			Min	Max	Min	Typ #	Max	Min	Max	
Output Voltage “0” Level $V_{in} = V_{DD}$ or 0	V_{OL}	5.0	—	0.05	—	0	0.05	—	0.05	Vdc
		10	—	0.05	—	0	0.05	—	0.05	
		15	—	0.05	—	0	0.05	—	0.05	
	V_{OH}	5.0	4.95	—	4.95	5.0	—	4.95	—	Vdc
		10	9.95	—	9.95	10	—	9.95	—	
		15	14.95	—	14.95	15	—	14.95	—	
Input Voltage “0” Level ($V_O = 4.5$ or 0.5 Vdc) ($V_O = 9.0$ or 1.0 Vdc) ($V_O = 13.5$ or 1.5 Vdc)	V_{IL}	5.0	—	1.5	—	2.25	1.5	—	1.5	Vdc
		10	—	3.0	—	4.50	3.0	—	3.0	
		15	—	4.0	—	6.75	4.0	—	4.0	
	V_{IH}	5.0	3.5	—	3.5	2.75	—	3.5	—	Vdc
		10	7.0	—	7.0	5.50	—	7.0	—	
		15	11	—	11	8.25	—	11	—	
Output Drive Current ($V_{OH} = 2.5$ Vdc) ($V_{OH} = 4.6$ Vdc) ($V_{OH} = 9.5$ Vdc) ($V_{OH} = 13.5$ Vdc) ($V_{OL} = 0.4$ Vdc) ($V_{OL} = 0.5$ Vdc) ($V_{OL} = 1.5$ Vdc)	Source I_{OH}	5.0	– 3.0	—	– 2.4	– 4.2	—	– 1.7	—	mAdc
		5.0	– 0.64	—	– 0.51	– 0.88	—	– 0.36	—	
		10	– 1.6	—	– 1.3	– 2.25	—	– 0.9	—	
		15	– 4.2	—	– 3.4	– 8.8	—	– 2.4	—	
	Sink I_{OL}	5.0	0.64	—	0.51	0.88	—	0.36	—	mAdc
		10	1.6	—	1.3	2.25	—	0.9	—	
		15	4.2	—	3.4	8.8	—	2.4	—	
Input Current	I_{in}	15	—	± 0.1	—	± 0.00001	± 0.1	—	± 1.0	μ Adc
Input Capacitance ($V_{in} = 0$)	C_{in}	—	—	—	—	5.0	7.5	—	—	pF
Quiescent Current (Per Package) I_{DD}		5.0	—	1.0	—	0.002	1.0	—	30	μ Adc
		10	—	2.0	—	0.004	2.0	—	60	
		15	—	4.0	—	0.006	4.0	—	120	
Total Supply Current**† (Dynamic plus Quiescent, Per Package) ($C_L = 50$ pF on all outputs, all buffers switching)	I_T	5.0 10 15	$I_T = (0.75 \mu A/kHz) f + I_{DD}$ $I_T = (1.5 \mu A/kHz) f + I_{DD}$ $I_T = (2.3 \mu A/kHz) f + I_{DD}$							μ Adc

#Data labelled “Typ” is not to be used for design purposes but is intended as an indication of the IC’s potential performance.

**The formulas given are for the typical characteristics only at 25°C.

†To calculate total supply current at loads other than 50 pF:

$$I_T(C_L) = I_T(50 \text{ pF}) + (C_L - 50) Vfk$$

where: I_T is in μA (per package), C_L in pF, $V = (V_{DD} - V_{SS})$ in volts, f in kHz is input frequency, and $k = 0.002$.

This device contains protection circuitry to guard against damage due to high static voltages or electric fields. However, precautions must be taken to avoid applications of any voltage higher than maximum rated voltages to this high-impedance circuit. For proper operation, V_{in} and V_{out} should be constrained to the range $V_{SS} \leq (V_{in} \text{ or } V_{out}) \leq V_{DD}$.

Unused inputs must always be tied to an appropriate logic voltage level (e.g., either V_{SS} or V_{DD}). Unused outputs must be left open.

PIN ASSIGNMENT

Q_A	1	14	V_{DD}
$\overline{Q}_A$	2	13	Q_B
C_A	3	12	$\overline{Q}_B$
R_A	4	11	C_B
D_A	5	10	R_B
S_A	6	9	D_B
V_{SS}	7	8	S_B

SWITCHING CHARACTERISTICS* ($C_L = 50 \text{ pF}$, $T_A = 25^\circ\text{C}$)

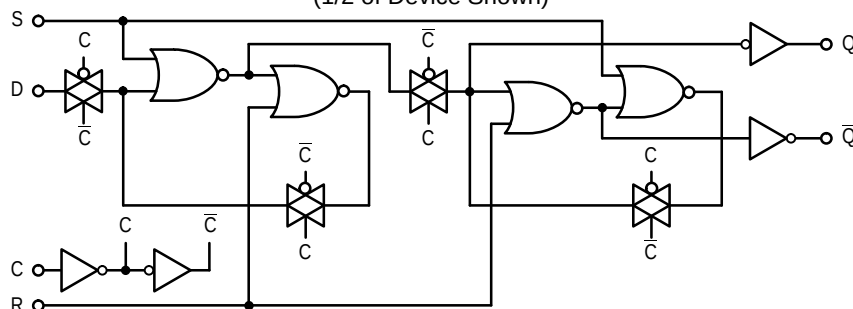
Characteristic	Symbol	V_{DD}	Min	Typ #	Max	Unit
Output Rise and Fall Time $t_{TLH}, t_{THL} = (1.5 \text{ ns/pF}) C_L + 25 \text{ ns}$ $t_{TLH}, t_{THL} = (0.75 \text{ ns/pF}) C_L + 12.5 \text{ ns}$ $t_{TLH}, t_{THL} = (0.55 \text{ ns/pF}) C_L + 9.5 \text{ ns}$	t_{TLH}, t_{THL}	5.0 10 15	— — —	100 50 40	200 100 80	ns
Propagation Delay Time Clock to Q, $\bar{Q}$ $t_{PLH}, t_{PHL} = (1.7 \text{ ns/pF}) C_L + 90 \text{ ns}$ $t_{PLH}, t_{PHL} = (0.66 \text{ ns/pF}) C_L + 42 \text{ ns}$ $t_{PLH}, t_{PHL} = (0.5 \text{ ns/pF}) C_L + 25 \text{ ns}$ Set to Q, $\bar{Q}$ $t_{PLH}, t_{PHL} = (1.7 \text{ ns/pF}) C_L + 90 \text{ ns}$ $t_{PLH}, t_{PHL} = (0.66 \text{ ns/pF}) C_L + 42 \text{ ns}$ $t_{PLH}, t_{PHL} = (0.5 \text{ ns/pF}) C_L + 25 \text{ ns}$ Reset to Q, $\bar{Q}$ $t_{PLH}, t_{PHL} = (1.7 \text{ ns/pF}) C_L + 265 \text{ ns}$ $t_{PLH}, t_{PHL} = (0.66 \text{ ns/pF}) C_L + 67 \text{ ns}$ $t_{PLH}, t_{PHL} = (0.5 \text{ ns/pF}) C_L + 50 \text{ ns}$	t_{PLH}, t_{PHL}	5.0 10 15 5.0 10 15 5.0 10 15	— — — — — — — — —	175 75 50 175 75 50 225 100 75	350 150 100 350 150 100 450 200 150	ns
Setup Times**	t_{su}	5.0 10 15	40 20 15	20 10 7.5	— — —	ns
Hold Times**	t_h	5.0 10 15	40 20 15	20 10 7.5	— — —	ns
Clock Pulse Width	t_{WL}, t_{WH}	5.0 10 15	250 100 70	125 50 35	— — —	ns
Clock Pulse Frequency	f_{cl}	5.0 10 15	— — —	4.0 10 14	2.0 5.0 7.0	MHz
Clock Pulse Rise and Fall Time	t_{TLH}, t_{THL}	5.0 10 15	— — —	— — —	15 5.0 4.0	μs
Set and Reset Pulse Width	t_{WL}, t_{WH}	5.0 10 15	250 100 70	125 50 35	— — —	ns
Removal Times Set	t_{rem}	5 10 15	80 45 35	0 5 5	— — —	ns
Reset		5 10 15	50 30 25	–35 –10 –5	— — —	

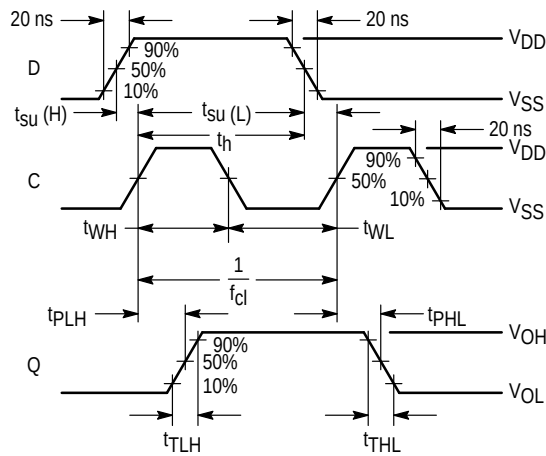
* The formulas given are for the typical characteristics only at 25°C .

#Data labelled "Typ" is not to be used for design purposes but is intended as an indication of the IC's potential performance.

**Data must be valid for 250 ns with a 5 V supply, 100 ns with 10 V, and 70 ns with 15 V.

LOGIC DIAGRAM
(1/2 of Device Shown)





Inputs R and S low.

**Figure 1. Dynamic Signal Waveforms
(Data, Clock, and Output)**

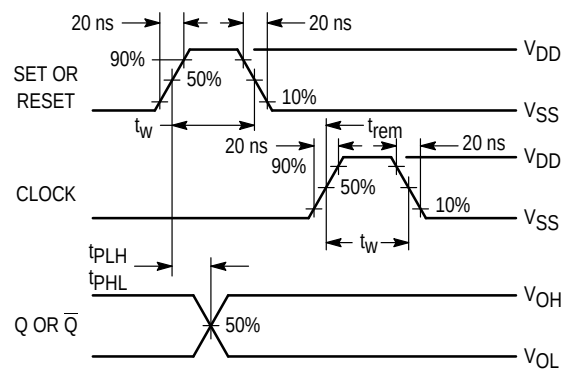
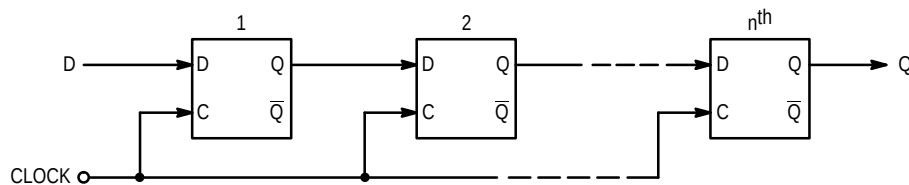


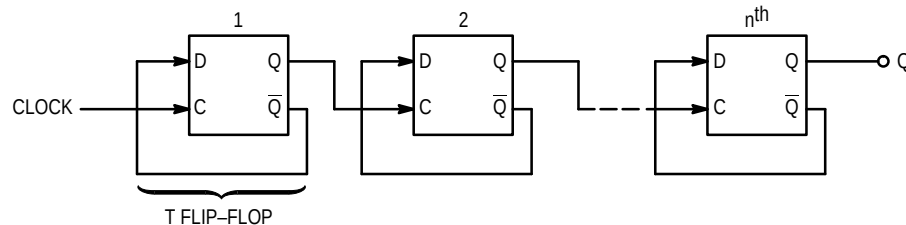
**Figure 2. Dynamic Signal Waveforms
(Set, Reset, Clock, and Output)**

TYPICAL APPLICATIONS

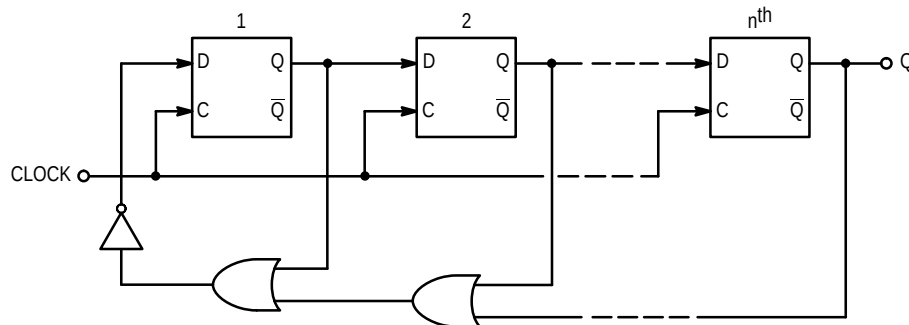
n-STAGE SHIFT REGISTER



BINARY RIPPLE UP-COUNTER (Divide-by- 2^n)

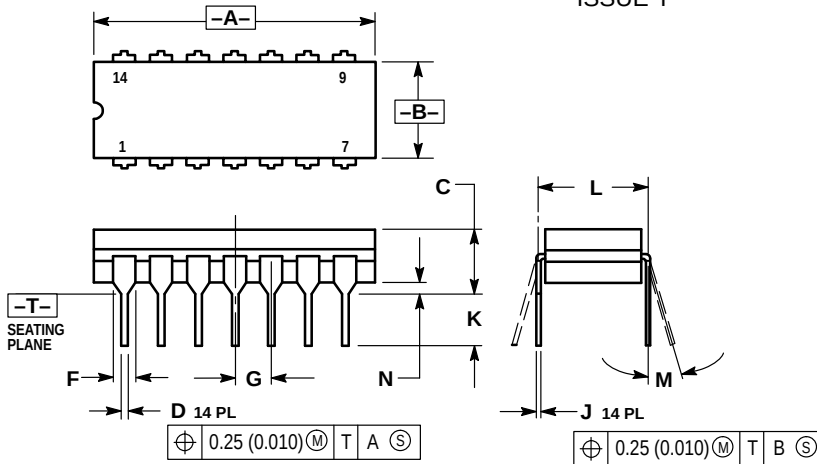


MODIFIED RING COUNTER (Divide-by- $(n+1)$)



OUTLINE DIMENSIONS

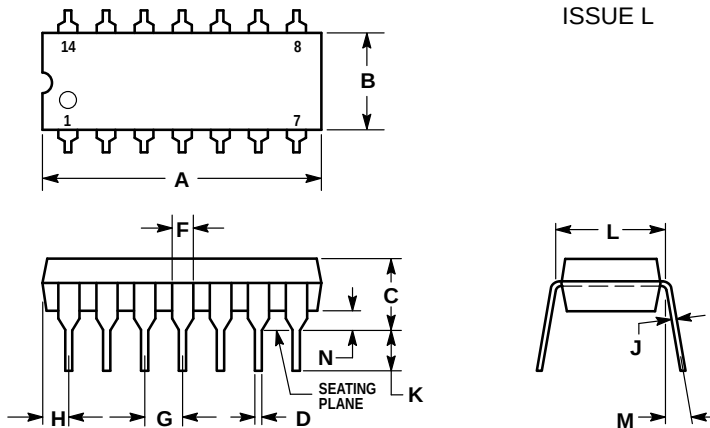
L SUFFIX CERAMIC DIP PACKAGE CASE 632-08 ISSUE Y



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 2. CONTROLLING DIMENSION: INCH.
 3. DIMENSION L TO CENTER OF LEAD WHEN FORMED PARALLEL.
 4. DIMENSION F MAY NARROW TO 0.76 (0.030) WHERE THE LEAD ENTERS THE CERAMIC BODY.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.750	0.785	19.05	19.94
B	0.245	0.280	6.23	7.11
C	0.155	0.200	3.94	5.08
D	0.015	0.020	0.39	0.50
F	0.055	0.065	1.40	1.65
G	0.100 BSC		2.54 BSC	
J	0.008	0.015	0.21	0.38
K	0.125	0.170	3.18	4.31
L	0.300 BSC		7.62 BSC	
M	0°	15°	0°	15°
N	0.020	0.040	0.51	1.01

P SUFFIX PLASTIC DIP PACKAGE CASE 646-06 ISSUE L

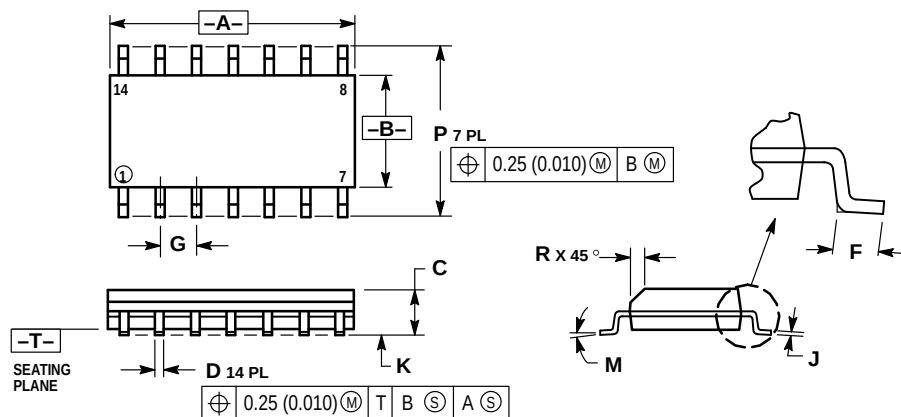


- NOTES:
1. LEADS WITHIN 0.13 (0.005) RADIUS OF TRUE POSITION AT SEATING PLANE AT MAXIMUM MATERIAL CONDITION.
 2. DIMENSION L TO CENTER OF LEADS WHEN FORMED PARALLEL.
 3. DIMENSION B DOES NOT INCLUDE MOLD FLASH.
 4. ROUNDED CORNERS OPTIONAL.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.715	0.770	18.16	19.56
B	0.240	0.260	6.10	6.60
C	0.145	0.185	3.69	4.69
D	0.015	0.021	0.38	0.53
F	0.040	0.070	1.02	1.78
G	0.100 BSC		2.54 BSC	
H	0.052	0.095	1.32	2.41
J	0.008	0.015	0.20	0.38
K	0.115	0.135	2.92	3.43
L	0.300 BSC		7.62 BSC	
M	0°	10°	0°	10°
N	0.015	0.039	0.39	1.01

OUTLINE DIMENSIONS

D SUFFIX PLASTIC SOIC PACKAGE CASE 751A-03 ISSUE F



NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	8.55	8.75	0.337	0.344
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.054	0.068
D	0.35	0.49	0.014	0.019
E	0.40	1.25	0.016	0.049
F	1.27 BSC		0.050 BSC	
J	0.19	0.25	0.008	0.009
K	0.10	0.25	0.004	0.009
M	0°	7°	0°	7°
P	5.80	6.20	0.228	0.244
R	0.25	0.50	0.010	0.019

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How to reach us:

USA/EUROPE/Locations Not Listed: Motorola Literature Distribution;
P.O. Box 20912; Phoenix, Arizona 85036. 1-800-441-2447 or 602-303-5454

MFAX: RMFAX0@email.sps.mot.com – TOUCHTONE 602-244-6609
INTERNET: <http://Design-NET.com>

JAPAN: Nippon Motorola Ltd.; Tatsumi-SPD-JLDC, 6F Seibu-Butsuryu-Center,
3-14-2 Tatsumi Koto-Ku, Tokyo 135, Japan. 03-81-3521-8315

ASIA/PACIFIC: Motorola Semiconductors H.K. Ltd.; 8B Tai Ping Industrial Park,
51 Ting Kok Road, Tai Po, N.T., Hong Kong. 852-26629298



MOTOROLA



MC14013B/D

