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 \overline{Q}). These devices may be used as shift register elements or as type T flip-flops for counter and toggle applications.

Features

- 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
- These Devices are Pb-Free, Halogen Free and are RoHS Compliant
- NLV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q100 Qualified and PPAP Capable

MAXIMUM RATINGS (Voltages Referenced to VSS)

Symbol	Parameter	Value	Unit
V_{DD}	DC Supply Voltage Range	-0.5 to +18.0	V
V _{in} , V _{out}	Input or Output Voltage Range (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 (Note 1)	500	mW
T _A	Ambient Temperature Range	-55 to +125	°C
T _{stg}	Storage Temperature Range	-65 to +150	°C
TL	Lead Temperature (8–Second Soldering)	260	°C

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

Temperature Derating:

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

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.



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MARKING DIAGRAMS



PDIP-14 P SUFFIX CASE 646





SOIC-14 D SUFFIX CASE 751A



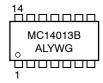


TSSOP-14 DT SUFFIX CASE 948G





SOEIAJ-14 F SUFFIX CASE 965



A = Assembly Location

WL, L = Wafer Lot YY, Y = Year WW, W = Work Week G or ■ = Pb-Free Package

(Note: Microdot may be in either location)

ORDERING INFORMATION

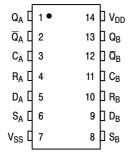
See detailed ordering and shipping information in the package dimensions section on page 2 of this data sheet.

TRUTH TABLE

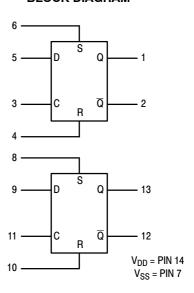
	Inp	Outp	outs		
Clock [†]	Data	Reset	Set	Q	Q
	0	0	0	0	1
	1	0	0	1	0
~	Х	0	0	Q	Q
Х	X	1	0	0	1
Х	Х	0	1	1	0
Х	Х	1	1	1	1

No Change

PIN ASSIGNMENT



BLOCK DIAGRAM



ORDERING INFORMATION

Device	Package	Shipping [†]	
MC14013BCPG	PDIP-14	OF Heire / Deil	
NLV14013BCPG*	(Pb-Free)	25 Units / Rail	
MC14013BDG	SOIC-14	SS Units / Dail	
NLV14013BDG*	(Pb-Free)	55 Units / Rail	
MC14013BDR2G	SOIC-14		
NLV14013BDR2G*	(Pb-Free)	OFOO Haita / Tana & Baal	
MC14013BDTR2G	TSSOP-14	2500 Units / Tape & Reel	
NLV14013BDTR2G*	(Pb-Free)		
MC14013BFG	SOEIAJ-14	50 Units / Rail	
MC14013BFELG	(Pb-Free)	2000 Units / Tape & Reel	

[†]For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

X = Don't Care

^{† =} Level Change

^{*}NLV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q100 Qualified and PPAP Capable.

ELECTRICAL CHARACTERISTICS (Voltages Referenced to V_{SS})

			V _{DD}	- 5	5°C		25°C		125	5°C	
Characteristic		Symbol	Vdc	Min	Max	Min	Typ ⁽²⁾	Max	Min	Max	Unit
Output Voltage "0)" Level	V _{OL}	5.0 10 15	- - -	0.05 0.05 0.05	- - -	0 0 0	0.05 0.05 0.05	- - -	0.05 0.05 0.05	Vdc
$V_{in} = 0 \text{ or } V_{DD}$ "-	1" Level	V _{OH}	5.0 10 15	4.95 9.95 14.95	- - -	4.95 9.95 14.95	5.0 10 15	- - -	4.95 9.95 14.95	- - -	Vdc
Input Voltage "((V _O = 4.5 or 0.5 Vdc) (V _O = 9.0 or 1.0 Vdc) (V _O = 13.5 or 1.5 Vdc))" Level	V _{IL}	5.0 10 15	- - -	1.5 3.0 4.0	- - -	2.25 4.50 6.75	1.5 3.0 4.0	- - -	1.5 3.0 4.0	Vdc
$(V_O = 0.5 \text{ or } 4.5 \text{ Vdc})$ "" $(V_O = 1.0 \text{ or } 9.0 \text{ Vdc})$ $(V_O = 1.5 \text{ or } 13.5 \text{ Vdc})$	1" Level	V _{IH}	5.0 10 15	3.5 7.0 11	- - -	3.5 7.0 11	2.75 5.50 8.25	- - -	3.5 7.0 11	- - -	Vdc
Output Drive Current $ (V_{OH} = 2.5 \text{ Vdc}) $ $ (V_{OH} = 4.6 \text{ Vdc}) $ $ (V_{OH} = 9.5 \text{ Vdc}) $ $ (V_{OH} = 13.5 \text{ Vdc}) $	Source	Іон	5.0 5.0 10 15	- 3.0 - 0.64 - 1.6 - 4.2	- - -	- 2.4 - 0.51 - 1.3 - 3.4	- 4.2 - 0.88 - 2.25 - 8.8	- - -	- 1.7 - 0.36 - 0.9 - 2.4	- - -	mAdc
$(V_{OL} = 0.4 \text{ Vdc})$ $(V_{OL} = 0.5 \text{ Vdc})$ $(V_{OL} = 1.5 \text{ Vdc})$	Sink	l _{OL}	5.0 10 15	0.64 1.6 4.2	- - -	0.51 1.3 3.4	0.88 2.25 8.8	- - -	0.36 0.9 2.4	- - -	mAdc
Input Current		l _{in}	15	-	± 0.1	_	±0.00001	± 0.1	-	± 1.0	μAdc
Input Capacitance (V _{in} = 0)		C _{in}	-	_	-	-	5.0	7.5	-	-	pF
Quiescent Current (Per Package)		I _{DD}	5.0 10 15	- - -	1.0 2.0 4.0	- - -	0.002 0.004 0.006	1.0 2.0 4.0	- - -	30 60 120	μAdc
Total Supply Current ⁽³⁾ ⁽⁴⁾ (Dynamic plus Quiescent Per Package) (C _L = 50 pF on all outputs buffers switching)	•	lτ	5.0 10 15			I _T = (.75 μA/kHz) 1.5 μA/kHz) f 2.3 μA/kHz) f	+ I _{DD} + I _{DD}			μAdc

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:

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

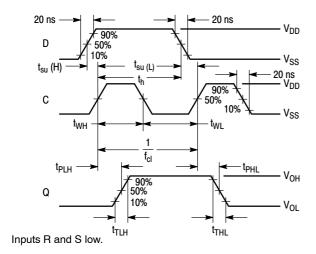
where: I_T is in μA (per package), C_L in pF, $V = (V_{DD} - V_{SS})$ in volts, f in kHz is input frequency, and k = 0.002.

SWITCHING CHARACTERISTICS ⁽⁵⁾ (C_L = 50 pF, T_A = 25°C)

Characteristic	Symbol	V_{DD}	Min	Typ ⁽⁶⁾	Max	Unit
Output Rise and Fall Time	t _{TLH} ,					ns
t_{TLH} , t_{THL} = (1.5 ns/pF) C_L + 25 ns	t _{THL}	5.0	_	100	200	
t_{TLH} , $t_{THL} = (0.75 \text{ ns/pF}) C_L + 12.5 \text{ ns}$		10	_	50	100	
t_{TLH} , $t_{THL} = (0.55 \text{ ns/pF}) C_L + 9.5 \text{ ns}$		15	_	40	80	
Propagation Delay Time	t _{PLH}					ns
Clock to Q, Q	t _{PHL}					
t_{PLH} , t_{PHL} = (1.7 ns/pF) C_L + 90 ns		5.0	_	175	350	
t_{PLH} , t_{PHL} = (0.66 ns/pF) C_L + 42 ns		10	_	75	150	
t_{PLH} , t_{PHL} = (0.5 ns/pF) C_L + 25 ns		15	_	50	100	
Set to Q, Q						
t_{PLH} , t_{PHL} = (1.7 ns/pF) C_L + 90 ns		5.0	_	175	350	
t_{PLH} , $t_{PHL} = (0.66 \text{ ns/pF}) C_L + 42 \text{ ns}$		10	_	75	150	
t_{PLH} , t_{PHL} = (0.5 ns/pF) C_L + 25 ns		15	_	50	100	
Reset to Q, Q						
t_{PLH} , $t_{PHL} = (1.7 \text{ ns/pF}) C_L + 265 \text{ ns}$		5.0	_	225	450	
t_{PLH} , $t_{PHL} = (0.66 \text{ ns/pF}) C_L + 67 \text{ ns}$		10	_	100	200	
t_{PLH} , t_{PHL} = (0.5 ns/pF) C_L + 50 ns		15	_	75	150	
Setup Times ⁽⁷⁾	t _{su}	5.0	40	20	-	ns
		10	20	10	-	
!		15	15	7.5	-	
Hold Times (7)	t _h	5.0	40	20	-	ns
		10	20	10	-	
		15	15	7.5	-	
Clock Pulse Width	t_{WL} , t_{WH}	5.0	250	125	-	ns
		10	100	50	-	
!		15	70	35	-	
Clock Pulse Frequency	f _{cl}	5.0	_	4.0	2.0	MHz
		10	_	10	5.0	
!		15	_	14	7.0	
Clock Pulse Rise and Fall Time	t _{TLH}	5.0	_	-	15	μs
	t _{THL}	10	_	-	5.0	
		15	_	_	4.0	
Set and Reset Pulse Width	t _{WL} , t _{WH}	5.0	250	125	-	ns
		10	100	50	_	
!		15	70	35	-	
Removal Times	t _{rem}					ns
Set		5	80	0	-	
		10	45	5	-	
!		15	35	5	-	
Reset		5	50	- 35	-	
		10	30	- 10	-	
i '						

- 5. The formulas given are for the typical characteristics only at 25°C.
 6. Data labelled "Typ" is not to be used for design purposes but is intended as an indication of the IC's potential performance.
 7. 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)



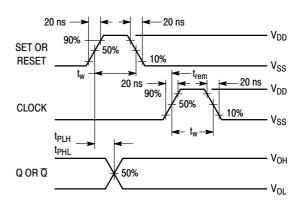
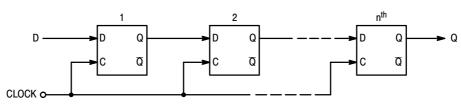


Figure 1. Dynamic Signal Waveforms (Data, Clock, and Output)

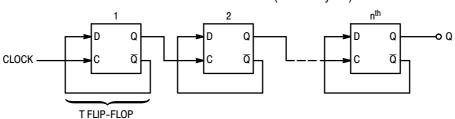
Figure 2. Dynamic Signal Waveforms (Set, Reset, Clock, and Output)

TYPICAL APPLICATIONS

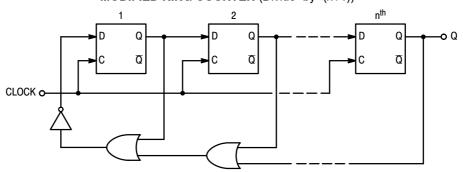
n-STAGE SHIFT REGISTER



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

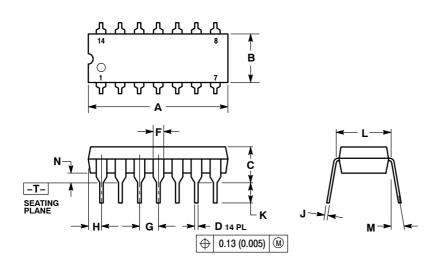


MODIFIED RING COUNTER (Divide-by-(n+1))



PACKAGE DIMENSIONS

PDIP-14 CASE 646-06 ISSUE P

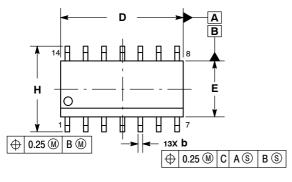


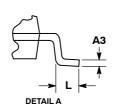
- NOTES:
 1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 2. CONTROLLING DIMENSION: INCH.
 3. DIMENSION L TO CENTER OF LEADS WHEN FORMED PARALLEL.
 4. DIMENSION B DOES NOT INCLUDE MOLD FLASH.
 5. ROUNDED CORNERS OPTIONAL.

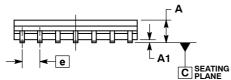
	INC	HES	MILLIM	IETERS
DIM	MIN	MAX	MIN	MAX
Α	0.715	0.770	18.16	19.56
В	0.240	0.260	6.10	6.60
С	0.145	0.185	3.69	4.69
D	0.015	0.021	0.38	0.53
F	0.040	0.070	1.02	1.78
G	0.100	BSC	2.54	BSC
Н	0.052	0.095	1.32	2.41
J	0.008	0.015	0.20	0.38
K	0.115	0.135	2.92	3.43
L	0.290	0.310	7.37	7.87
М		10 °		10 °
N	0.015	0.039	0.38	1.01

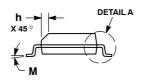
PACKAGE DIMENSIONS

SOIC-14 NB CASE 751A-03 ISSUE K



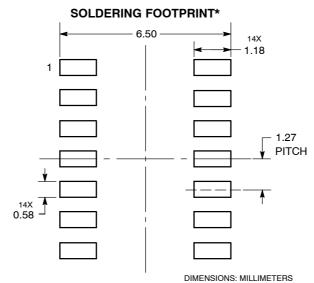






- NOTES:
 1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
 2. CONTROLLING DIMENSION: MILLIMETERS.
 3. DIMENSION & DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE PROTRUSION SHALL BE 0.13 TOTAL IN EXCESS OF AT MAXIMUM MATERIAL CONDITION.
 4. DIMENSIONS D AND E DO NOT INCLUDE MOLD PROTRUSIONS.
 5. MAXIMUM MOLD PROTRUSION 0.15 PER SIDE.

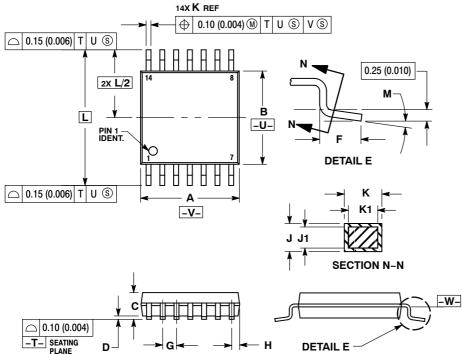
	MILLIN	IETERS	INC	HES
DIM	MIN	MAX	MIN	MAX
Α	1.35	1.75	0.054	0.068
A 1	0.10	0.25	0.004	0.010
АЗ	0.19	0.25	0.008	0.010
b	0.35	0.49	0.014	0.019
D	8.55	8.75	0.337	0.344
Е	3.80	4.00	0.150	0.157
е	1.27	BSC	0.050	BSC
Н	5.80	6.20	0.228	0.244
h	0.25	0.50	0.010	0.019
L	0.40	1.25	0.016	0.049
М	0 °	7°	0 °	7°



^{*}For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

PACKAGE DIMENSIONS

TSSOP-14 CASE 948G **ISSUE B**



NOTES:

- DTES:

 1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.

 2. CONTROLLING DIMENSION: MILLIMETER.

 3. DIMENSION A DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH OR GATE BURRS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.

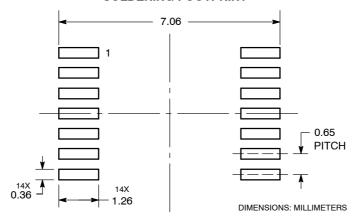
 4. DIMENSION B DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.25 (0.010) PER SIDE.

 5. DIMENSION K DOES NOT INCLUDE DAMBAR PROTRUSION. SHALL WAS EXCEED 0.25 (0.010) PER SIDE.

 5. DIMENSION K DOES NOT INCLUDE DAMBAR PROTRUSION SHALL BE 0.08 (0.003) TOTAL IN EXCESS OF THE K DIMENSION AT MAXIMUM MATERIAL CONDITION.
- DIMENSION AT MAAINTON MALELIAGE
 CONDITION.
 6. TERMINAL NUMBERS ARE SHOWN FOR
 REFERENCE ONLY.
 7. DIMENSION A AND B ARE TO BE

\rightarrow	HAMINIL) AL DA	HUM PL	$\Delta NI = -1AA$
	MILLIN	IÉTERS		HÈS
DIM	MIN	MAX	MIN	MAX
Α	4.90	5.10	0.193	0.200
В	4.30	4.50	0.169	0.177
C		1.20		0.047
D	0.05	0.15	0.002	0.006
F	0.50	0.75	0.020	0.030
G	0.65	BSC	0.026 BSC	
Н	0.50	0.60	0.020	0.024
7	0.09	0.20	0.004	0.008
J1	0.09	0.16	0.004	0.006
Κ	0.19	0.30	0.007	0.012
K1	0.19	0.25	0.007	0.010
L	6.40		0.252	BSC
М	0°	8 °	0°	8 °

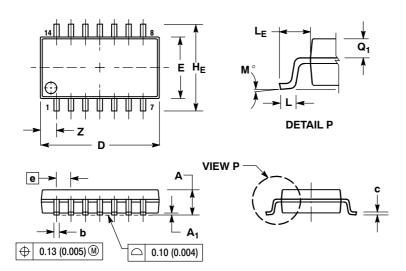
SOLDERING FOOTPRINT*



*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

PACKAGE DIMENSIONS

SOEIAJ-14 **CASE 965 ISSUE B**



NOTES:

- DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.

 CONTROLLING DIMENSION: MILLIMETER.
- DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS AND ARE MEASURED AT THE PARTING LINE, MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
- TERMINAL NUMBERS ARE SHOWN FOR
- REFERENCE ONLY.

 THE LEAD WIDTH DIMENSION (b) DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 (0.003) TOTAL IN EXCESS OF THE LEAD WIDTH
 DIMENSION AT MAXIMUM MATERIAL CONDITION.
 DAMBAR CANNOT BE LOCATED ON THE LOWER RADIUS OR THE FOOT. MINIMUM SPACE BETWEEN PROTRUSIONS AND ADJACENT LEAD TO BE 0.46 (0.018).

	MILLIN	IETERS	INC	HES
DIM	MIN	MAX	MIN	MAX
Α		2.05		0.081
A ₁	0.05	0.20	0.002	0.008
b	0.35	0.50	0.014	0.020
С	0.10	0.20	0.004	0.008
D	9.90	10.50	0.390	0.413
Е	5.10	5.45	0.201	0.215
е	1.27	BSC	0.050 BSC	
HE	7.40	8.20	0.291	0.323
L	0.50	0.85	0.020	0.033
LE	1.10	1.50	0.043	0.059
M	0 °	10 °	0 °	10°
Q ₁	0.70	0.90	0.028	0.035
Z		1.42		0.056

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