

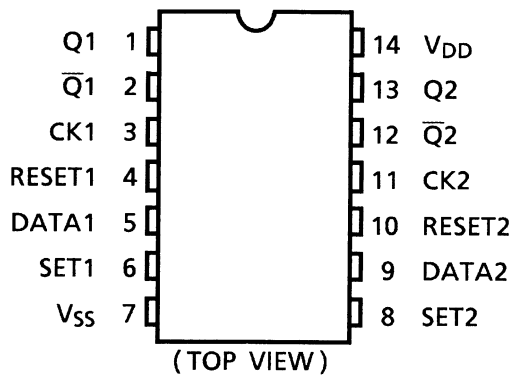
TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

# TC4013BP, TC4013BF

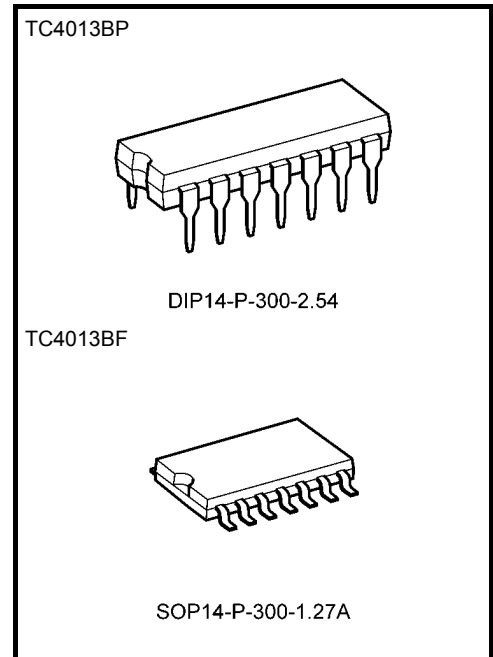
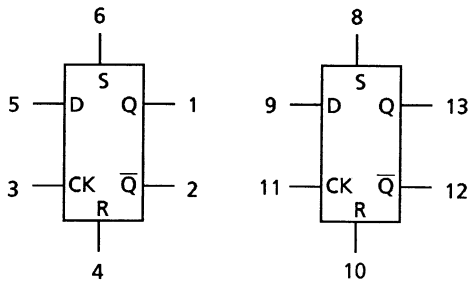
## TC4013B Dual D-Type Flip Flop

TC4013B contains two independent circuits of D type flip-flop. The input level applied to DATA input are transferred to Q and  $\bar{Q}$  output by rising edge of the clock pulse. When SET input is placed at "H", and RESET input is placed at "L", outputs become Q = "H", and  $\bar{Q}$  = "L". When RESET input is placed at "H", and SET input is placed at "L", outputs become Q = "L", and  $\bar{Q}$  = "H". When both of RESET input and SET input are at "H", outputs become Q = "H" and  $\bar{Q}$  = "H".

### Pin Assignment



### Block Diagram



Weight	
DIP14-P-300-2.54	: 0.96 g (typ.)
SOP14-P-300-1.27A	: 0.18 g (typ.)

Start of commercial production  
1985-02

## Truth Table

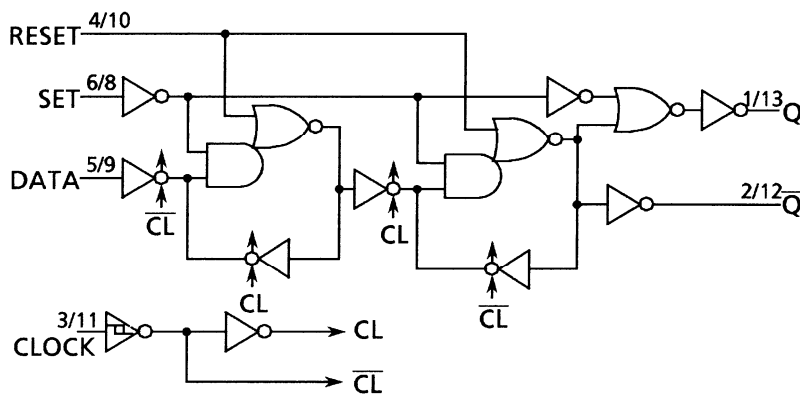
Inputs				Outputs	
RESET	SET	DATA	CK $\Delta$	Q <sub>n+1</sub>	$\bar{Q}_{n+1}$
L	H	*	*	H	L
H	L	*	*	L	H
H	H	*	*	H	H
L	L	L	$\uparrow$	L	H
L	L	H	$\uparrow$	H	L
L	L	*	$\downarrow$	Q <sub>n</sub>	$\bar{Q}_n$

\*: Don't care

$\Delta$ : Level change

$\cdot$ : No change

## Logic Diagram



## Absolute Maximum Ratings (Note)

Characteristics	Symbol	Rating	Unit
DC supply voltage	V <sub>DD</sub>	V <sub>SS</sub> - 0.5 to V <sub>SS</sub> + 20	V
Input voltage	V <sub>IN</sub>	V <sub>SS</sub> - 0.5 to V <sub>DD</sub> + 0.5	V
Output voltage	V <sub>OUT</sub>	V <sub>SS</sub> - 0.5 to V <sub>DD</sub> + 0.5	V
DC input current	I <sub>IN</sub>	±10	mA
Power dissipation	P <sub>D</sub>	300 (DIP)/180 (SOP)	mW
Operating temperature range	T <sub>opr</sub>	-40 to 85	°C
Storage temperature range	T <sub>stg</sub>	-65 to 150	°C

Note: Exceeding any of the absolute maximum ratings, even briefly, lead to deterioration in IC performance or even destruction.

Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) are within the absolute maximum ratings and the operating ranges.

Please design the appropriate reliability upon reviewing the Toshiba Semiconductor Reliability Handbook ("Handling Precautions"/"Derating Concept and Methods") and individual reliability data (i.e. reliability test report and estimated failure rate, etc).

## Operating Ranges ( $V_{SS} = 0\text{ V}$ ) (Note)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
DC supply voltage	$V_{DD}$	—	3	—	18	V
Input voltage	$V_{IN}$	—	0	—	$V_{DD}$	V

Note: The operating ranges must be maintained to ensure the normal operation of the device.  
Unused inputs must be tied to either  $V_{DD}$  or  $V_{SS}$ .

## Static Electrical Characteristics ( $V_{SS} = 0\text{ V}$ )

Characteristics	Sym- bol	Test Condition	$V_{DD}$ (V)	-40°C		25°C			85°C		Unit
				Min	Max	Min	Typ.	Max	Min	Max	
High-level output voltage	$V_{OH}$	$ I_{OUT}  < 1\ \mu\text{A}$ $V_{IN} = V_{SS}, V_{DD}$	5	4.95	—	4.95	5.00	—	4.95	—	V
			10	9.95	—	9.95	10.00	—	9.95	—	
			15	14.95	—	14.95	15.00	—	14.95	—	
Low-level output voltage	$V_{OL}$	$ I_{OUT}  < 1\ \mu\text{A}$ $V_{IN} = V_{SS}, V_{DD}$	5	—	0.05	—	0.00	0.05	—	0.05	V
			10	—	0.05	—	0.00	0.05	—	0.05	
			15	—	0.05	—	0.00	0.05	—	0.05	
Output high current	$I_{OH}$	$V_{OH} = 4.6\text{ V}$ $V_{OH} = 2.5\text{ V}$ $V_{OH} = 9.5\text{ V}$ $V_{OH} = 13.5\text{ V}$ $V_{IN} = V_{SS}, V_{DD}$	5	-0.61	—	-0.51	-1.0	—	-0.42	—	mA
			5	-2.50	—	-2.10	-4.0	—	-1.70	—	
			10	-1.50	—	-1.30	-2.2	—	-1.10	—	
			15	-4.00	—	-3.40	-9.0	—	-2.80	—	
Output low current	$I_{OL}$	$V_{OL} = 0.4\text{ V}$ $V_{OL} = 0.5\text{ V}$ $V_{OL} = 1.5\text{ V}$ $V_{IN} = V_{SS}, V_{DD}$	5	0.61	—	0.51	1.2	—	0.42	—	mA
			10	1.50	—	1.30	3.2	—	1.10	—	
			15	4.00	—	3.40	12.0	—	2.80	—	
			—	—	—	—	—	—	—	—	
Input high voltage	$V_{IH}$	$V_{OUT} = 0.5\text{ V}, 4.5\text{ V}$ $V_{OUT} = 1.0\text{ V}, 9.0\text{ V}$ $V_{OUT} = 1.5\text{ V}, 13.5\text{ V}$ $ I_{OUT}  < 1\ \mu\text{A}$	5	3.5	—	3.5	2.75	—	3.50	—	V
			10	7.0	—	7.0	5.50	—	7.00	—	
			15	11.0	—	11.0	8.25	—	11.00	—	
			—	—	—	—	—	—	—	—	
Input low voltage	$V_{IL}$	$V_{OUT} = 0.5\text{ V}, 4.5\text{ V}$ $V_{OUT} = 1.0\text{ V}, 9.0\text{ V}$ $V_{OUT} = 1.5\text{ V}, 13.5\text{ V}$ $ I_{OUT}  < 1\ \mu\text{A}$	5	—	1.5	—	2.25	1.5	—	1.5	V
			10	—	3.0	—	4.50	3.0	—	3.0	
			15	—	4.0	—	6.75	4.0	—	4.0	
			—	—	—	—	—	—	—	—	
Input current	"H" level	$I_{IH}$	$V_{IH} = 18\text{ V}$	18	—	0.1	—	$10^{-5}$	0.1	—	$\mu\text{A}$
	"L" level	$I_{IL}$	$V_{IL} = 0\text{ V}$	18	—	-0.1	—	$-10^{-5}$	-0.1	—	
Quiescent supply current	$I_{DD}$	$V_{IN} = V_{SS}, V_{DD}$ (Note)	5	—	1	—	0.002	1	—	30	$\mu\text{A}$
			10	—	2	—	0.004	2	—	60	
			15	—	4	—	0.008	4	—	120	

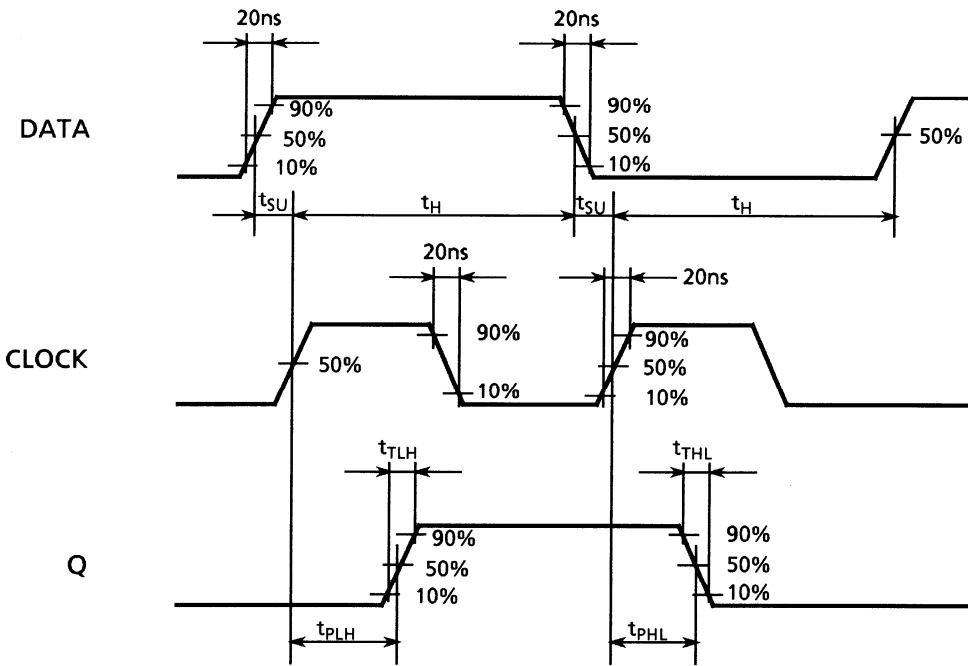
Note: All valid input combinations.

## Dynamic Electrical Characteristics (Ta = 25°C, VSS = 0 V, CL = 50 pF)

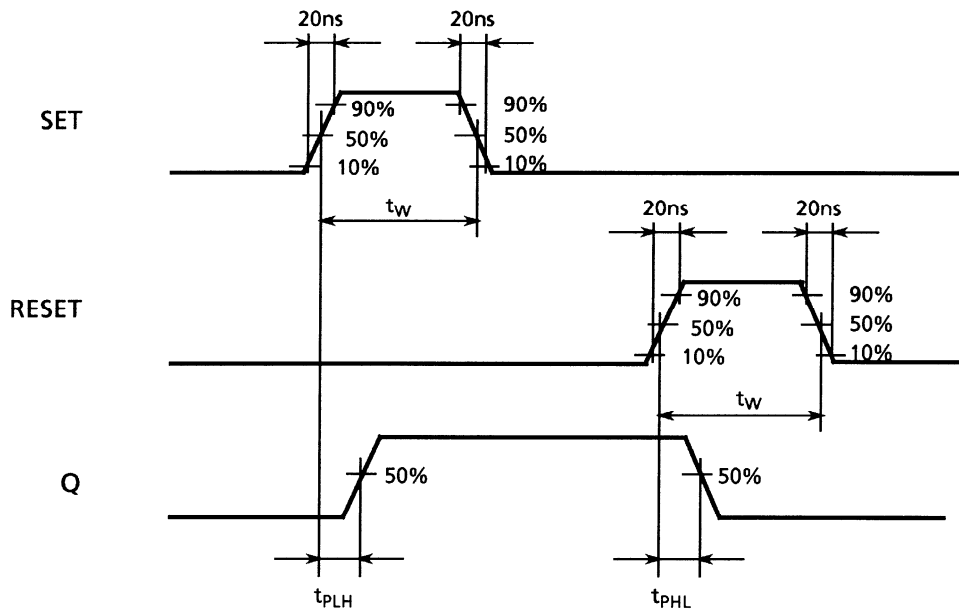
Characteristics	Symbol	Test Condition	VDD (V)	Min	Typ.	Max	Unit
Output transition time (low to high)	t <sub>TLH</sub>	—	5	—	70	200	ns
			10	—	35	100	
			15	—	30	80	
Output transition time (high to low)	t <sub>THL</sub>	—	5	—	70	200	ns
			10	—	35	100	
			15	—	30	80	
Propagation delay time (CK-Q, $\bar{Q}$ )	t <sub>pLH</sub> t <sub>pHL</sub>	—	5	—	130	300	ns
			10	—	65	130	
			15	—	50	90	
Propagation delay time (SET, RESET-Q, $\bar{Q}$ )	t <sub>pLH</sub>	—	5	—	110	300	ns
			10	—	50	130	
			15	—	40	90	
Propagation delay time (SET, RESET-Q, $\bar{Q}$ )	t <sub>pHL</sub>	—	5	—	110	300	ns
			10	—	50	130	
			15	—	40	90	
Max clock frequency	f <sub>CL</sub>	—	5	3.5	8	—	MHz
			10	8.0	16	—	
			15	12.0	20	—	
Max clock input rise time Max clock input fall time	t <sub>rCL</sub> t <sub>fCL</sub>	—	5	No limit			μs
			10				
			15				
Min pulse width (SET, RESET)	t <sub>w</sub>	—	5	—	60	180	ns
			10	—	30	80	
			15	—	25	50	
Min clock pulse width	t <sub>w</sub>	—	5	—	60	140	ns
			10	—	30	60	
			15	—	25	40	
Min set-up time (DATA-CK)	t <sub>su</sub>	—	5	—	—	40	ns
			10	—	—	20	
			15	—	—	15	
Min hold time (DATA-CK)	t <sub>H</sub>	—	5	—	20	40	ns
			10	—	10	20	
			15	—	6	15	
Min removal time (SET, RESET-CK)	t <sub>rem</sub>	—	5	—	—	40	ns
			10	—	—	20	
			15	—	—	15	
Input capacitance	C <sub>IN</sub>	—	—	5	7.5	pF	

**Waveform for Measurement of Dynamic Characteristics**

**Waveform 1**



**Waveform 2**





**Package Dimensions**

SOP14-P-300-1.27A

Unit: mm



Weight: 0.18 g (typ.)

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