

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

# TC4024BP, TC4024BF

## TC4024B 7 Stage Ripple-Carry Binary Counter/Dividers

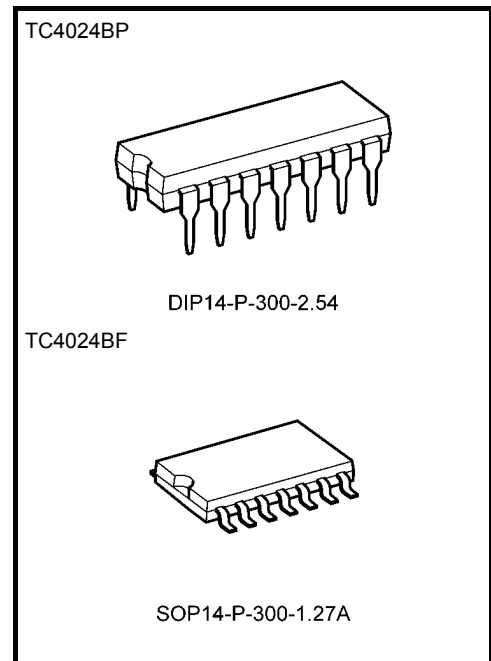
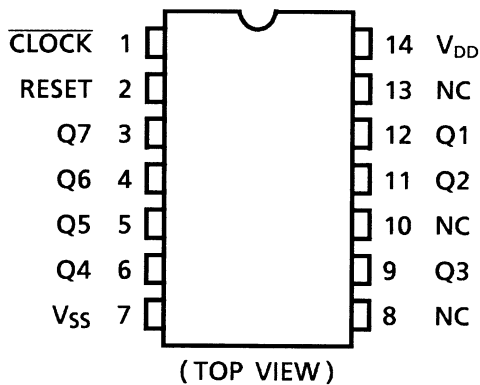
TC4024B is 7 stage ripple carry type binary counter having asynchronous clear function.

The counter advances its counting state by falling edge of  $\overline{\text{CLOCK}}$  input.

When RESET input is placed at "H", all the internal flip-flop are reset making all the outputs Q1 through Q7 to be "L" regardless of  $\overline{\text{CLOCK}}$  input.

This is suitable for frequency divider circuits and control circuits.

### Pin Assignment



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

### Truth Table

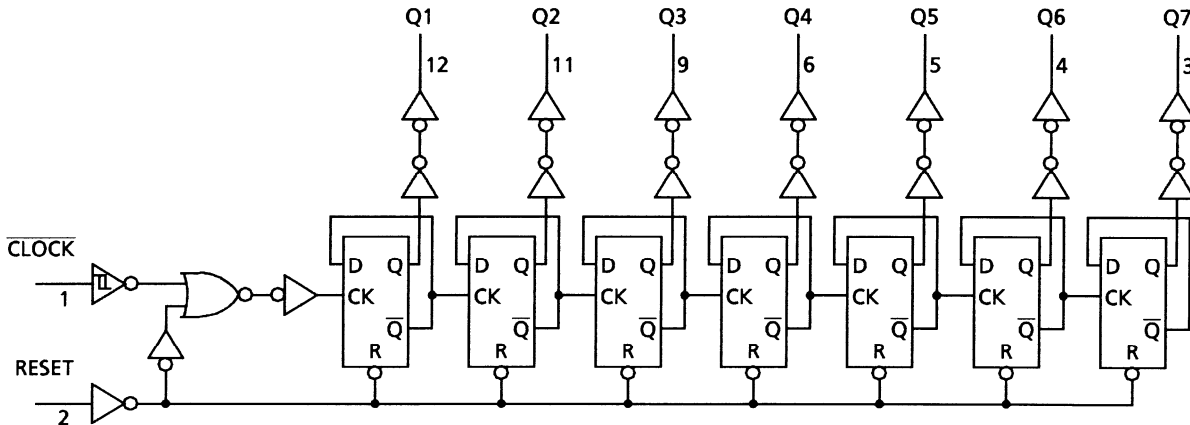
$\overline{\text{CLOCK}} \Delta$	RESET	Output State
*	H	All Outputs = "L"
	L	No Change
	L	Advance to Next State

$\Delta$ : Level change

\*: Don't care

Start of commercial production  
1978-07

**Logic Diagram**



**Absolute Maximum Ratings (Note)**

Characteristics	Symbol	Rating	Unit
DC supply voltage	$V_{DD}$	$V_{SS} - 0.5$ to $V_{SS} + 20$	V
Input voltage	$V_{IN}$	$V_{SS} - 0.5$ to $V_{DD} + 0.5$	V
Output voltage	$V_{OUT}$	$V_{SS} - 0.5$ to $V_{DD} + 0.5$	V
DC input current	$I_{IN}$	$\pm 10$	mA
Power dissipation	$P_D$	300 (DIP)/180 (SOP)	mW
Operating temperature range	$T_{opr}$	-40 to 85	°C
Storage temperature range	$T_{stg}$	-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 ( $V_{SS} = 0$  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<sub>SS</sub> = 0 V)

Characteristics	Sym- bol	Test Condition	V <sub>DD</sub> (V)	-40°C		25°C			85°C		Unit
				Min	Max	Min	Typ.	Max	Min	Max	
High-level output voltage	V <sub>OH</sub>	I <sub>OUT</sub>   < 1 μA V <sub>IN</sub> = V <sub>SS</sub> , V <sub>DD</sub>	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 <sub>OL</sub>	I <sub>OUT</sub>   < 1 μA V <sub>IN</sub> = V <sub>SS</sub> , V <sub>DD</sub>	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 <sub>OH</sub>	V <sub>OH</sub> = 4.6 V V <sub>OH</sub> = 2.5 V V <sub>OH</sub> = 9.5 V V <sub>OH</sub> = 13.5 V V <sub>IN</sub> = V <sub>SS</sub> , V <sub>DD</sub>	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 <sub>OL</sub>	V <sub>OL</sub> = 0.4 V V <sub>OL</sub> = 0.5 V V <sub>OL</sub> = 1.5 V V <sub>IN</sub> = V <sub>SS</sub> , V <sub>DD</sub>	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 <sub>IH</sub>	V <sub>OUT</sub> = 0.5 V, 4.5 V V <sub>OUT</sub> = 1.0 V, 9.0 V V <sub>OUT</sub> = 1.5 V, 13.5 V  I <sub>OUT</sub>   < 1 μA	5	3.5	—	3.5	2.75	—	3.5	—	V
			10	7.0	—	7.0	5.50	—	7.0	—	
			15	11.0	—	11.0	8.25	—	11.0	—	
			—	—	—	—	—	—	—	—	
Input low voltage	V <sub>IL</sub>	V <sub>OUT</sub> = 0.5 V, 4.5 V V <sub>OUT</sub> = 1.0 V, 9.0 V V <sub>OUT</sub> = 1.5 V, 13.5 V  I <sub>OUT</sub>   < 1 μA	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 <sub>IH</sub>	V <sub>IH</sub> = 18 V	18	—	0.1	—	10 <sup>-5</sup>	0.1	—	μA
	"L" level	I <sub>IL</sub>	V <sub>IL</sub> = 0 V	18	—	-0.1	—	-10 <sup>-5</sup>	-0.1	—	
Quiescent supply current	I <sub>DD</sub>	V <sub>IN</sub> = V <sub>SS</sub> , V <sub>DD</sub> (Note)	5	—	5	—	0.005	5	—	150	μA
			10	—	10	—	0.010	10	—	300	
			15	—	20	—	0.015	20	—	600	

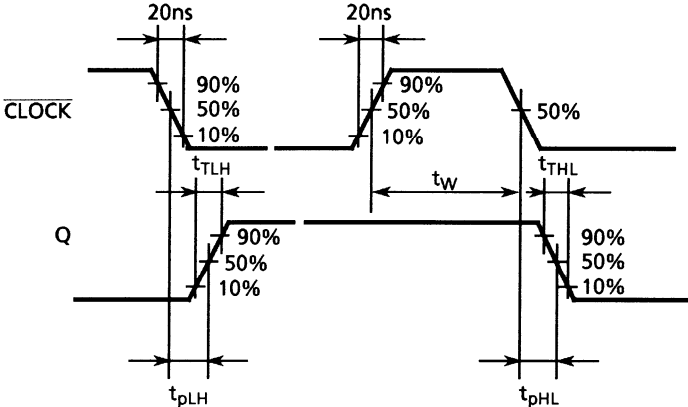
Note: All valid input combinations.

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

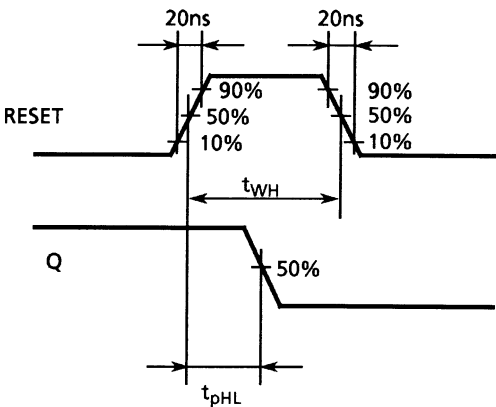
Characteristics	Symbol	Test Condition	VDD (V)	Min	Typ.	Max	Unit
Output transition time (low to high)	t <sub>TLH</sub>	—	5	—	70	200	ns
			10	—	35	100	
			15	—	30	80	
Output transition time (high to low)	t <sub>THL</sub>	—	5	—	70	200	ns
			10	—	35	100	
			15	—	30	80	
Propagation delay time ( $\overline{\text{CLOCK}}$ -Q1)	t <sub>pLH</sub>	—	5	—	140	360	ns
			10	—	70	160	
			15	—	50	130	
Propagation delay time ( $\overline{\text{CLOCK}}$ -Q1)	t <sub>pHL</sub>	—	5	—	140	360	ns
			10	—	70	160	
			15	—	50	130	
Propagation delay time ( $\overline{\text{CLOCK}}$ -Q7)	t <sub>pLH</sub>	—	5	—	400	1200	ns
			10	—	160	520	
			15	—	115	430	
Propagation delay time ( $\overline{\text{CLOCK}}$ -Q7)	t <sub>pHL</sub>	—	5	—	400	1200	ns
			10	—	160	520	
			15	—	115	430	
Propagation delay time (RESET-Q)	t <sub>pHL</sub>	—	5	—	140	280	ns
			10	—	70	120	
			15	—	50	100	
Max clock frequency	f <sub>CL</sub>	—	5	3.5	14	—	MHz
			10	8.0	30	—	
			15	12.0	40	—	
Max clock input rise time Max clock input fall time	t <sub>rCL</sub> t <sub>rCL</sub>	—	5	No limit			μs
			10				
			15				
Max clock pulse width	t <sub>w</sub>	—	5	—	40	140	ns
			10	—	20	60	
			15	—	15	40	
Max pulse width (RESET)	t <sub>WH</sub>	—	5	—	40	200	ns
			10	—	20	80	
			15	—	15	60	
Minimum removal time	t <sub>rem</sub>	—	5	—	0	350	ns
			10	—	0	150	
			15	—	0	100	
Input capacitance	C <sub>IN</sub>	—	—	5	7.5	pF	

Waveforms for Measurement of Dynamic Characteristics

Waveform 1



Waveform 2



## Package Dimensions

DIP14-P-300-2.54

Unit : mm



Weight: 0.96 g (typ.)

## Package Dimensions

SOP14-P-300-1.27A

Unit: mm



Weight: 0.18 g (typ.)

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