

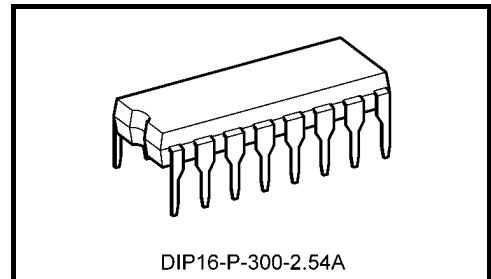
# TC4521BP

## TC4521BP 24-Stage Frequency Divider

TC4521BP is frequency divider consisting of 24 stages of flip-flop. The input section is equipped with an inverter to enable to use either RC oscillator circuit or crystal oscillator circuit and to accept pulse from external clock source.

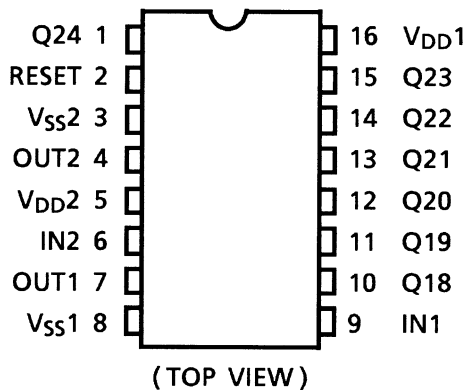
Each flip-flop is inverted by the falling edge of the output of previous stage flip-flop and this can count up to the maximum of  $2^{24} = 16,777,216$ .

Since six outputs,  $2^{18}$ ,  $2^{19}$ ,  $2^{20}$ ,  $2^{21}$ ,  $2^{22}$ , and  $2^{23}$  are available besides of  $2^{24}$ , adjustment of frequency divided output can be achieved.



Weight: 1.00 g (typ.)

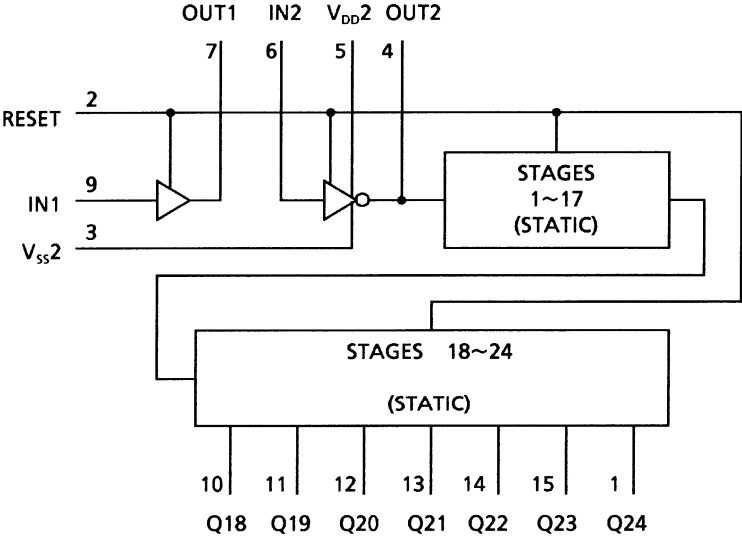
### Pin Assignment



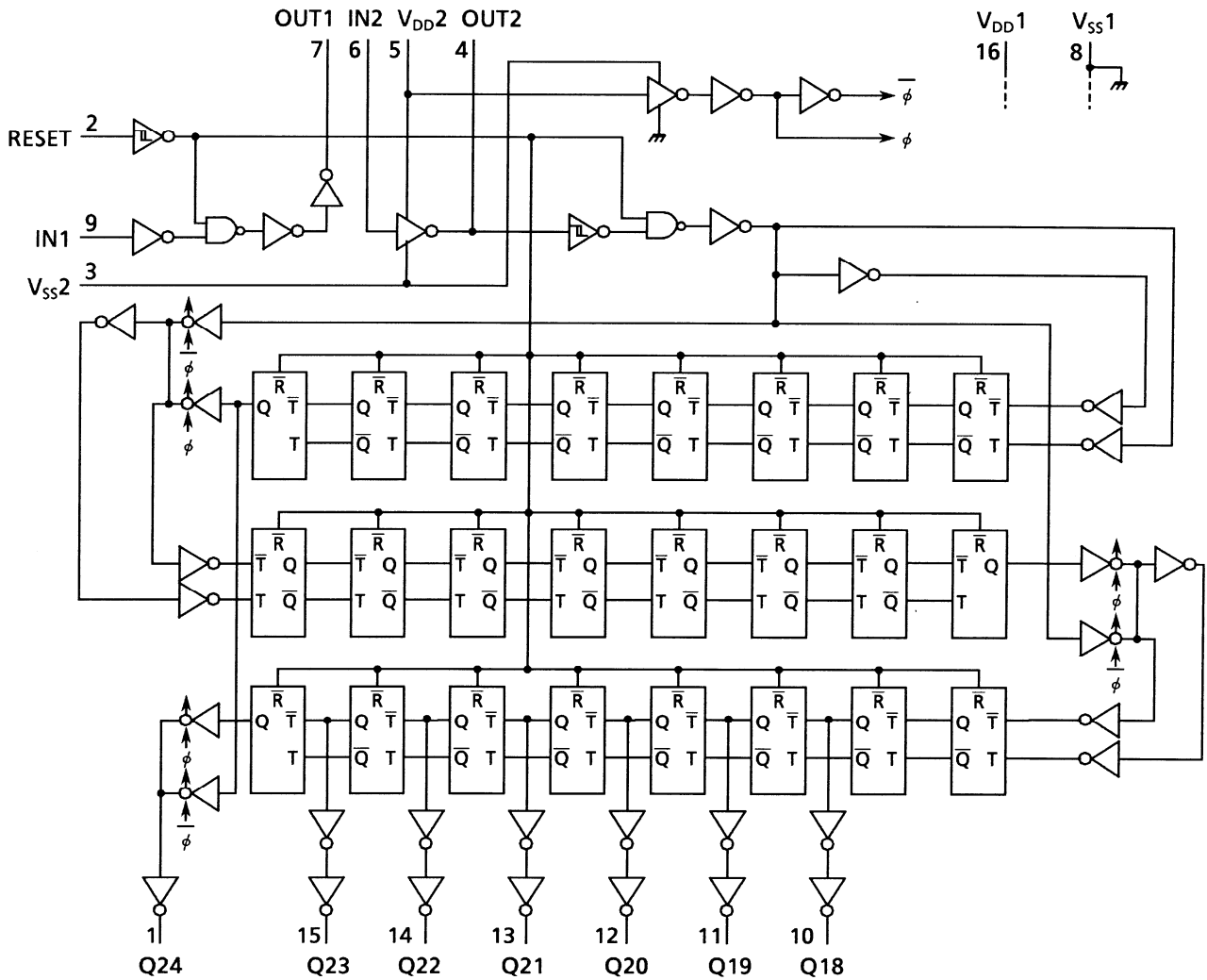
### Count Capacity

Output	Count Capacity
Q18	$2^{18} = 262,144$
Q19	$2^{19} = 524,288$
Q20	$2^{20} = 1,048,576$
Q21	$2^{21} = 2,097,152$
Q22	$2^{22} = 4,194,304$
Q23	$2^{23} = 8,388,608$
Q24	$2^{24} = 16,777,216$

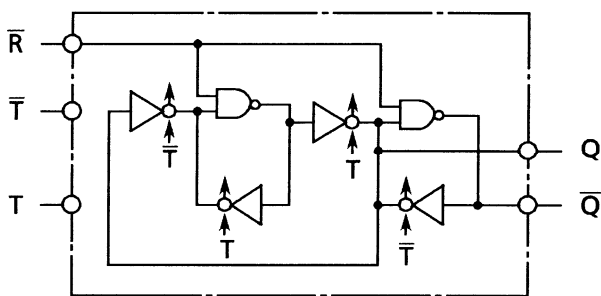
Block Diagram



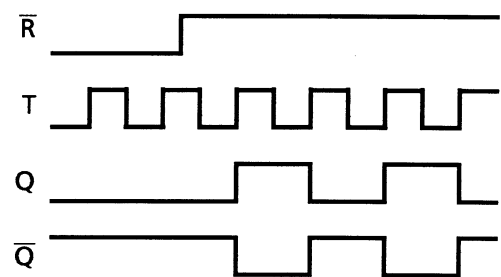
**Logic Diagram**



**Internal Flip Flop Logic Diagram**



**Flip Flop Timing Chart**



## Absolute Maximum Ratings (Note)

Characteristics	Symbol	Rating	Unit
DC supply voltage	$V_{DD1}$	$V_{SS1} - 0.5 \sim V_{SS1} + 20$	V
	$V_{DD2}$	$V_{SS1} - 0.5 \sim V_{DD1} + 0.5$	
Input voltage	$V_{IN}$	$V_{SS1} - 0.5 \sim V_{DD1} + 0.5$	V
Output voltage	$V_{OUT}$	$V_{SS1} - 0.5 \sim V_{DD1} + 0.5$	V
DC input current	$I_{IN}$	$\pm 10$	mA
Power dissipation	$P_D$	300	mW
Operating temperature range	$T_{opr}$	-40~85	°C
Storage temperature range	$T_{stg}$	-65~150	°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 ( $V_{SS1} = V_{SS2} = 0$ V) (Note)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
DC supply voltage	$V_{DD1}, V_{DD2}$	—	3	—	18	V
Input voltage	$V_{IN}$	—	0	—	$V_{DD1}$	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>SS1</sub> = V<sub>SS2</sub> = 0 V, V<sub>DD1</sub> = V<sub>DD2</sub>)

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	-2.5	—	-2.1	-4.0	—	-1.7	—		
			10	-1.5	—	-1.3	-2.2	—	-1.1	—		
			15	-4.0	—	-3.4	-9.0	—	-2.8	—		
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	1.5	—	1.3	3.2	—	1.1	—		
			15	4.0	—	3.4	12.0	—	2.8	—		
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	5.5	—	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	—	4.5	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	—	1.0	μA
	"L" level	I <sub>IL</sub>	V <sub>IL</sub> = 0 V	18	—	-0.1	—	-10 <sup>-5</sup>	-0.1	—	-1.0	
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		

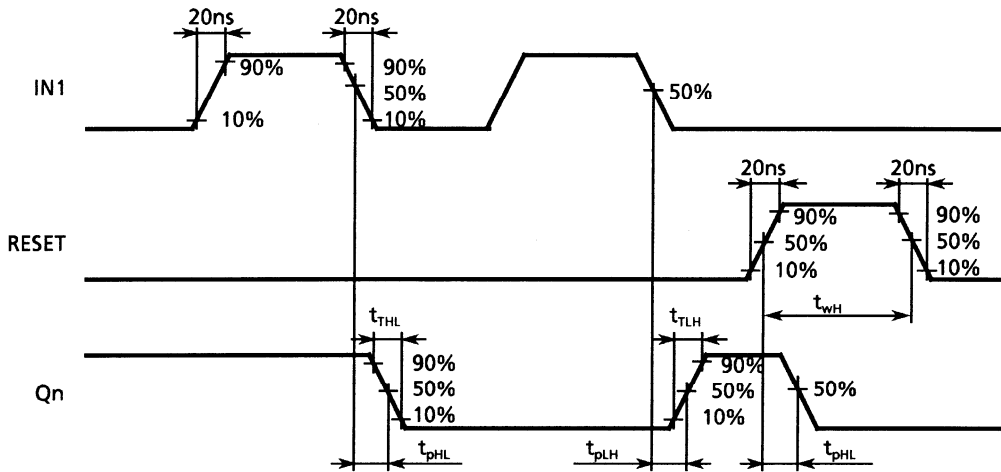
Note: All valid input combinations.

## Dynamic Electrical Characteristics

( $T_a = 25^\circ\text{C}$ ,  $V_{SS1} = V_{SS2} = 0\text{ V}$ ,  $V_{DD1} = V_{DD2}$ ,  $C_L = 50\text{ pF}$ )

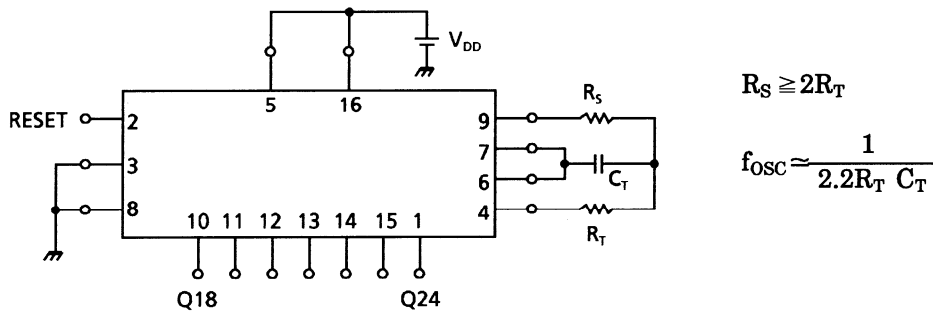
Characteristics	Symbol	Test Condition	V <sub>DD</sub> (V)	Min	Typ.	Max	Unit
Output transition time (low to high)	t <sub>TLH</sub>	—	5	—	70	200	ns
			10	—	35	100	
			15	—	30	80	
Output transition time (high to low)	t <sub>THL</sub>	—	5	—	70	200	ns
			10	—	35	100	
			15	—	30	80	
Propagation delay time (IN2-Q18)	t <sub>pLH</sub> t <sub>pHL</sub>	—	5	—	1.1	9.0	μs
			10	—	0.5	3.5	
			15	—	0.3	2.7	
Propagation delay time (IN2-Q24)	t <sub>pLH</sub> t <sub>pHL</sub>	—	5	—	1.4	12	μs
			10	—	0.6	4.5	
			15	—	0.4	3.5	
Propagation delay time (RESET-Qn)	t <sub>pHL</sub>	—	5	—	220	2600	ns
			10	—	100	1000	
			15	—	70	750	
Max clock frequency	f <sub>CL</sub>	—	5	3	9.5	—	MHz
			10	6	17.5	—	
			15	8	23.5	—	
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 clock pulse width	t <sub>w</sub>	—	5	—	55	385	ns
			10	—	25	150	
			15	—	16	120	
Min pulse width (RESET)	t <sub>WH</sub>	—	5	—	60	385	ns
			10	—	26	150	
			15	—	20	120	
Input capacitance	C <sub>IN</sub>	—	—	5	7.5	pF	

**Waveforms for Measurement of Dynamic Characteristics**



**Application Circuit**

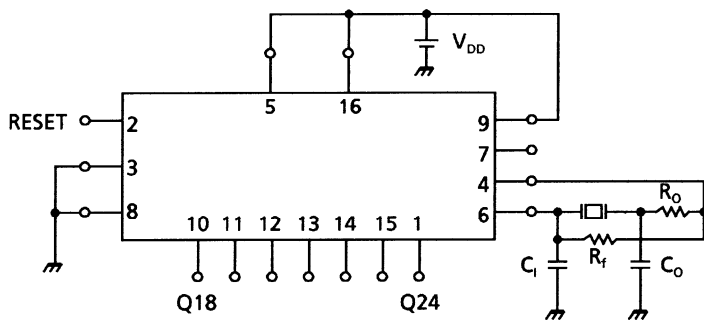
**When CR Oscillation is Used as Time Reference**



$$R_S \geq 2R_T$$

$$f_{osc} \approx \frac{1}{2.2R_T C_T}$$

**When Crystal Oscillation is Used as the Time Reference**



**Typical Data**

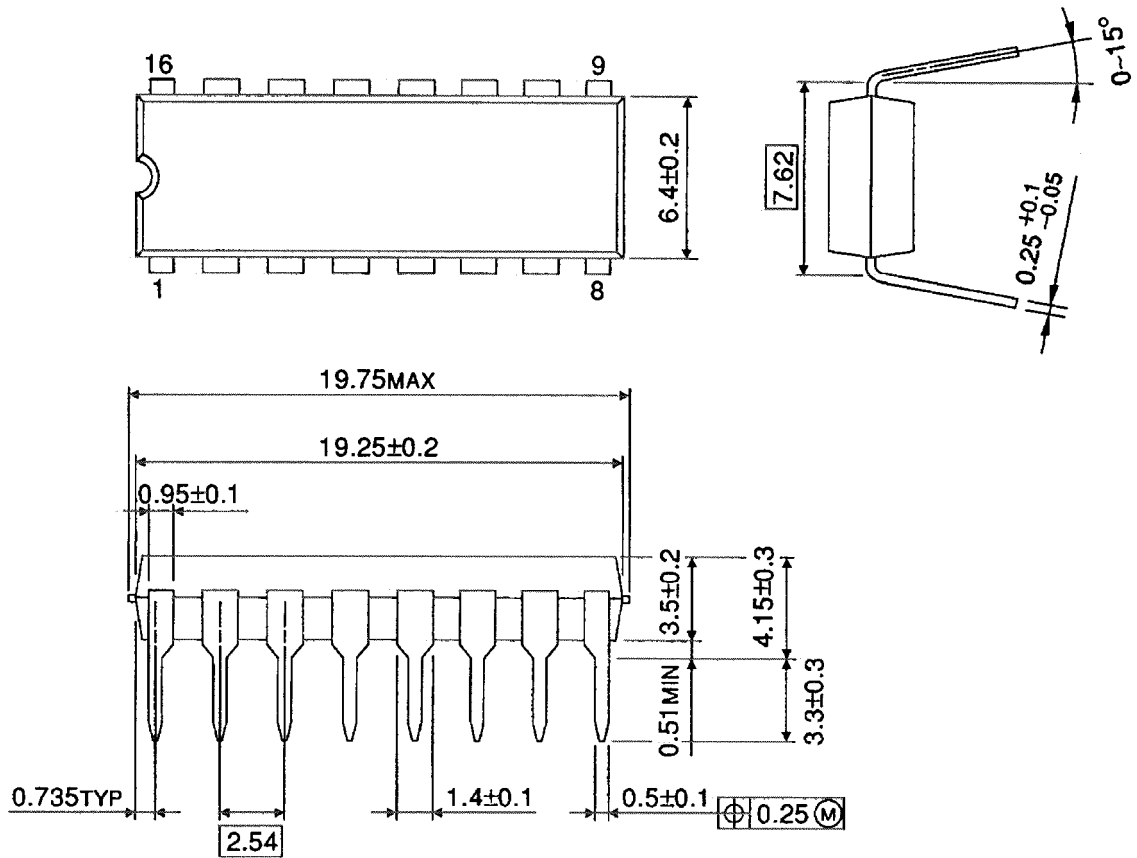
X'tal (Hz)	$C_1, C_0$ (pF)	$R_0$ ( $\Omega$ )
32.768 k	23	500 k
100 k	60	100 k
1 M	45~50	100
4.194304 M	12~15	0

$R_f = 10 M\Omega$

## Package Dimensions

DIP16-P-300-2.54A

Unit : mm



Weight: 1.00 g (typ.)

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