

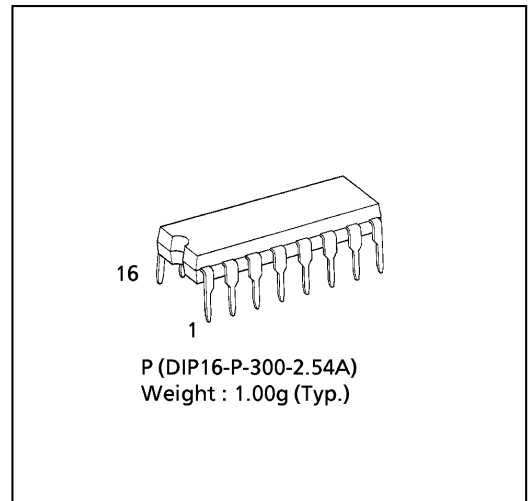
# TC4521BP

## 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  $2^{24} = 16,777,216$ .

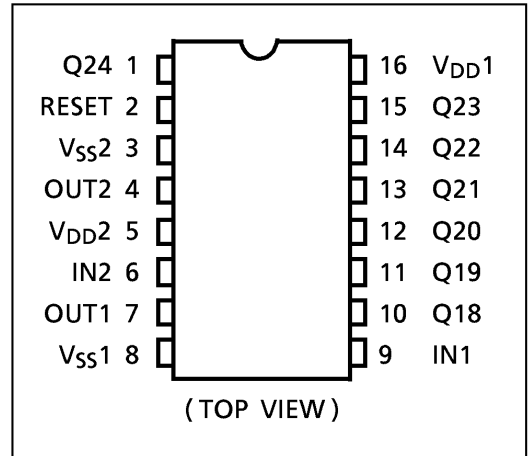
Since six outputs,  $2^{18}$ ,  $2^{19}$ ,  $2^{20}$ ,  $2^{21}$ ,  $2^{22}$ , and  $2^{23}$  are available besides of  $2^{24}$ , adjustment of frequency divided output can be achieved.



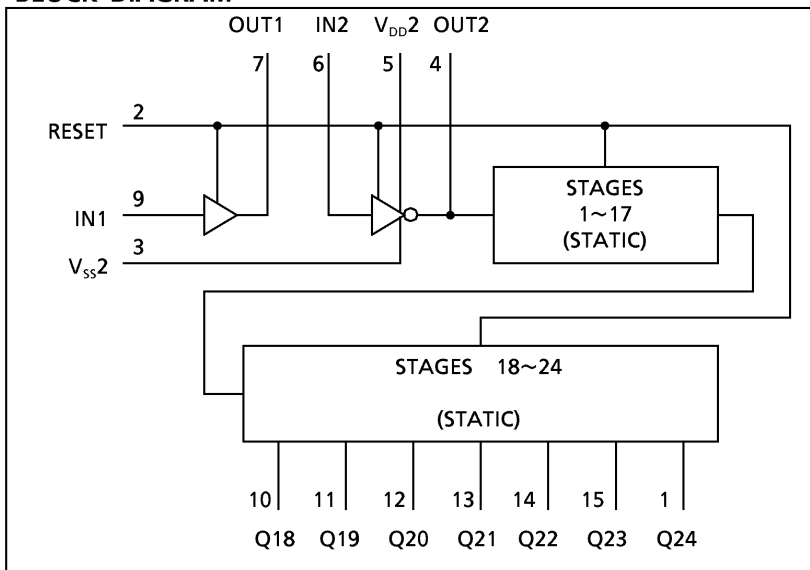
### MAXIMUM RATINGS

CHARACTERISTIC	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	$T_{opr}$	$-40 \sim 85$	$^{\circ}C$
Storage Temperature Range	$T_{stg}$	$-65 \sim 150$	$^{\circ}C$

### PIN ASSIGNMENT



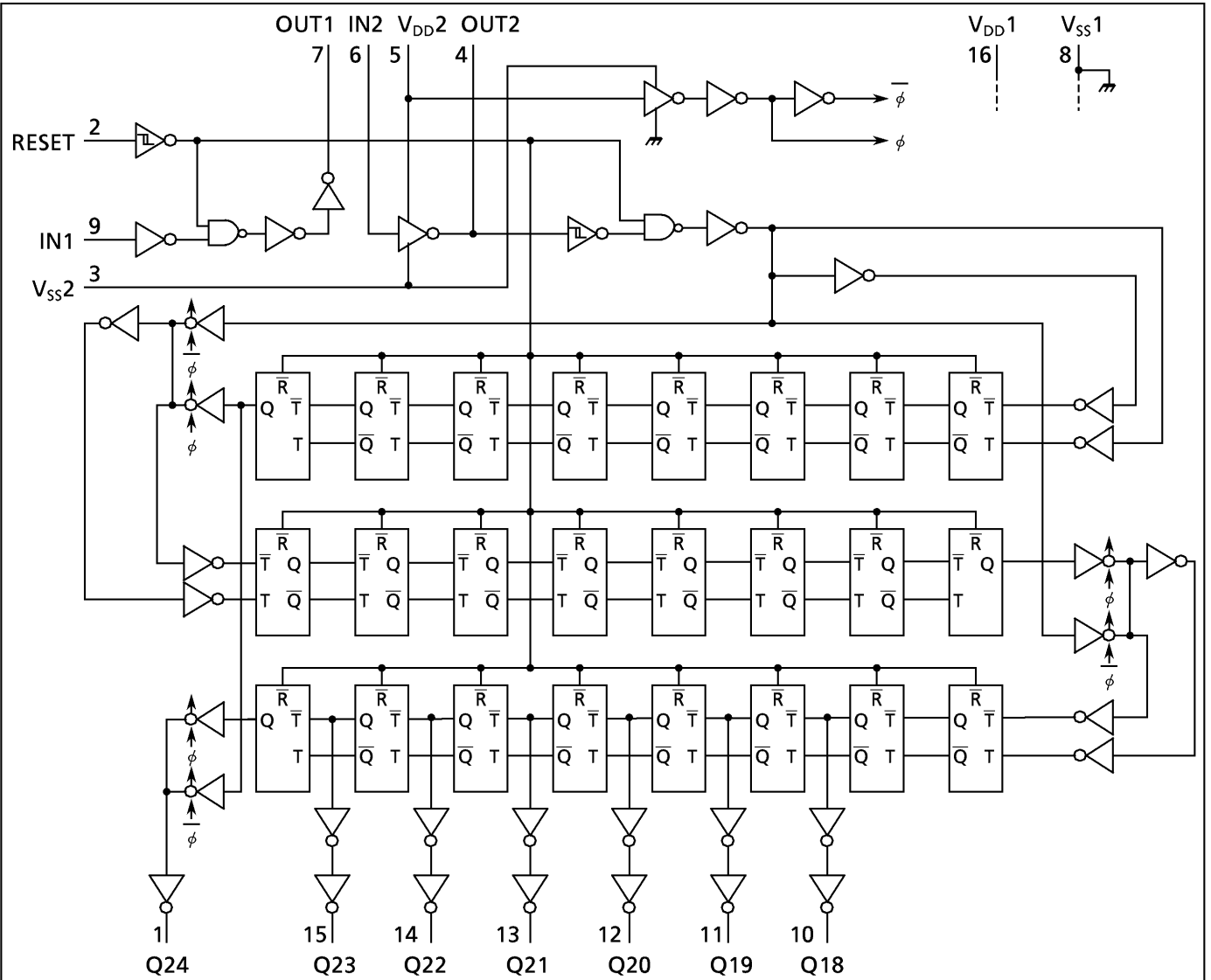
### BLOCK DIAGRAM



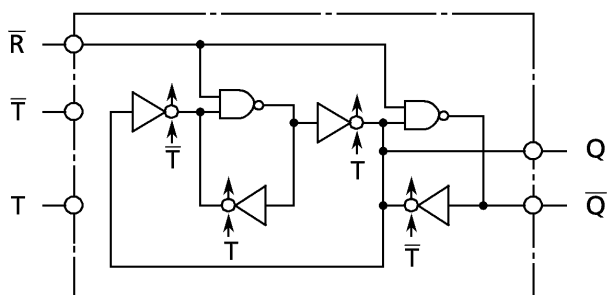
### COUNT CAPACITY

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	$2^{24} = 16,777,216$

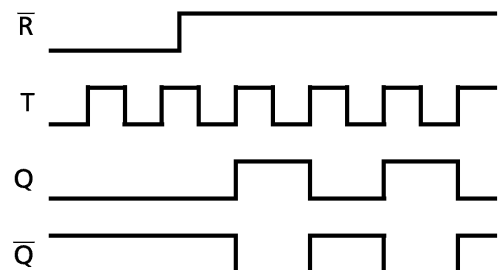
LOGIC DIAGRAM



INTERNAL FLIP FLOP LOGIC DIAGRAM



FLIP FLOP TIMING CHART



RECOMMENDED OPERATING CONDITIONS ( $V_{SS1} = V_{SS2} = 0V$ )

CHARACTERISTIC	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

STATIC ELECTRICAL CHARACTERISTICS ( $V_{SS1} = V_{SS2} = 0V, V_{DD1} = V_{DD2}$ )

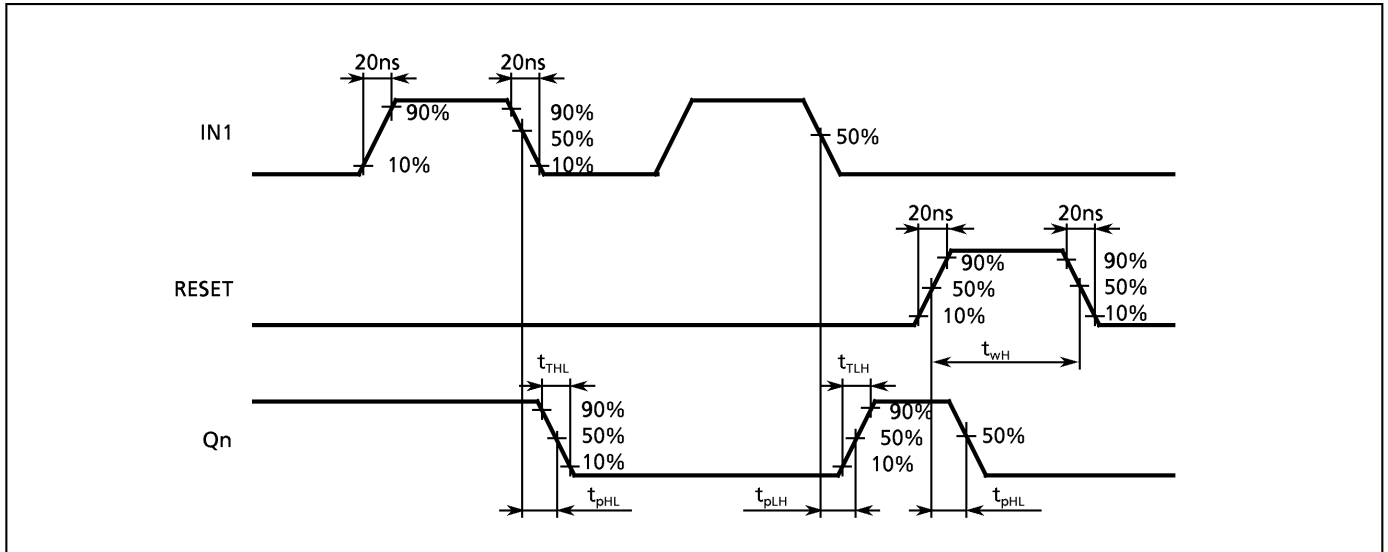
CHARACTERISTIC	SYM-BOL	TEST CONDITION	$V_{DD}$ (V)	-40°C		25°C			85°C		UNIT	
				MIN.	MAX.	MIN.	TYP.	MAX.	MIN.	MAX.		
High-Level Output Voltage	$V_{OH}$	$ I_{OUT}  < 1\mu A$ $V_{IN} = V_{SS}, V_{DD}$	5	4.95	—	4.95	5.00	—	4.95	—	V	
			10	9.95	—	9.95	10.00	—	9.95	—		
			15	14.95	—	14.95	15.00	—	14.95	—		
Low-Level Output Voltage	$V_{OL}$	$ I_{OUT}  < 1\mu 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	$I_{OH}$	$V_{OH} = 4.6V$ $V_{OH} = 2.5V$ $V_{OH} = 9.5V$ $V_{OH} = 13.5V$ $V_{IN} = V_{SS}, V_{DD}$	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	$I_{OL}$	$V_{OL} = 0.4V$ $V_{OL} = 0.5V$ $V_{OL} = 1.5V$ $V_{IN} = V_{SS}, V_{DD}$	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	$V_{IH}$	$V_{OUT} = 0.5V, 4.5V$ $V_{OUT} = 1.0V, 9.0V$ $V_{OUT} = 1.5V, 13.5V$ $ I_{OUT}  < 1\mu A$	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	$V_{IL}$	$V_{OUT} = 0.5V, 4.5V$ $V_{OUT} = 1.0V, 9.0V$ $V_{OUT} = 1.5V, 13.5V$ $ I_{OUT}  < 1\mu A$	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	$I_{IH}$	$V_{IH} = 18V$	18	—	0.1	—	$10^{-5}$	0.1	—	1.0	$\mu A$
	"L" Level	$I_{IL}$	$V_{IL} = 0V$	18	—	-0.1	—	$-10^{-5}$	-0.1	—	-1.0	
Quiescent Supply Current	$I_{DD}$	$V_{IN} = V_{SS}, V_{DD} *$	5	—	5	—	0.005	5	—	150	$\mu A$	
			10	—	10	—	0.010	10	—	300		
			15	—	20	—	0.015	20	—	600		

\* All valid input combinations.

DYNAMIC ELECTRICAL CHARACTERISTICS (Ta = 25°C, V<sub>SS1</sub> = V<sub>SS2</sub> = 0V, V<sub>DD1</sub> = V<sub>DD2</sub>, C<sub>L</sub> = 50pF)

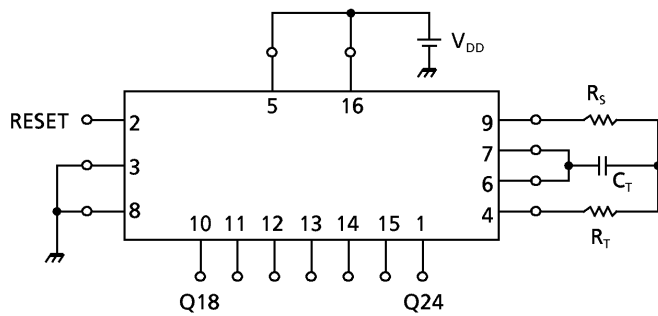
CHARACTERISTIC	SYMBOL	TEST CONDITION	V <sub>DD</sub> (V)	MIN.	TYP.	MAX.	UNIT
Output Transition Time (Low to High)	t <sub>TLH</sub>		5	—	70	200	ns
			10	—	35	100	
			15	—	30	80	
Output Transition Time (High to Low)	t <sub>THL</sub>		5	—	70	200	
			10	—	35	100	
			15	—	30	80	
Propagation Delay Time (IN2 - 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	
			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	
			10	—	26	150	
			15	—	20	120	
Input Capacitance	C <sub>IN</sub>			—	5	7.5	pF

WAVEFORM FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS



APPLICATION CIRCUIT

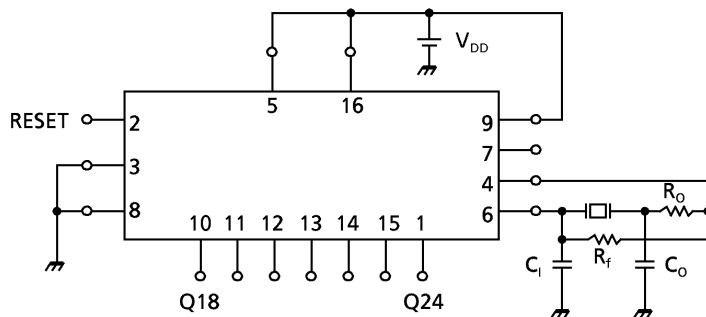
\* When CR oscillation is used as time reference



$$R_S \geq 2R_T$$

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

\* When crystal oscillation circuit is used as the time reference



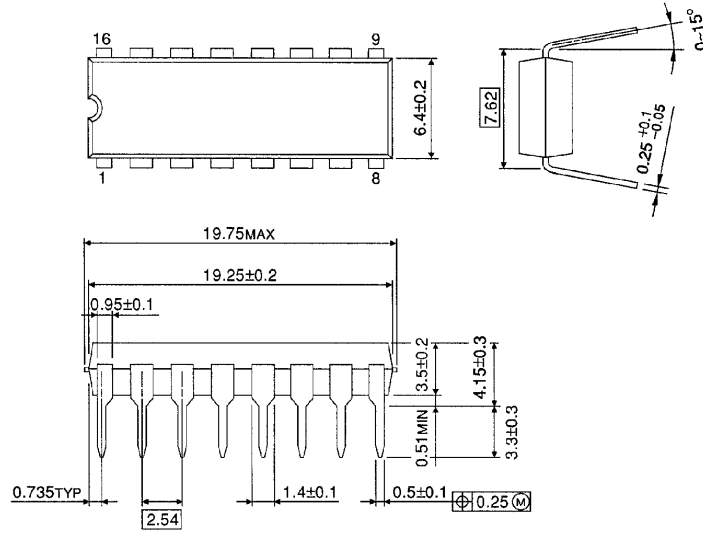
Typical data

X'tal (Hz)	C <sub>1</sub> , C <sub>0</sub> (pF)	R <sub>0</sub> (Ω)
32.768k	23	500k
100k	60	100k
1M	45~50	100
4.194304M	12~15	0

$$R_f = 10M\Omega$$

DIP 16PIN PACKAGE DIMENSIONS (DIP16-P-300-2.54A)

Unit in mm



Weight : 1.00g (Typ.)

**RESTRICTIONS ON PRODUCT USE**

000707EBA

- TOSHIBA is continually working to improve the quality and reliability of its products. Nevertheless, semiconductor devices in general can malfunction or fail due to their inherent electrical sensitivity and vulnerability to physical stress. It is the responsibility of the buyer, when utilizing TOSHIBA products, to comply with the standards of safety in making a safe design for the entire system, and to avoid situations in which a malfunction or failure of such TOSHIBA products could cause loss of human life, bodily injury or damage to property. In developing your designs, please ensure that TOSHIBA products are used within specified operating ranges as set forth in the most recent TOSHIBA products specifications. Also, please keep in mind the precautions and conditions set forth in the "Handling Guide for Semiconductor Devices," or "TOSHIBA Semiconductor Reliability Handbook" etc..
- The TOSHIBA products listed in this document are intended for usage in general electronics applications (computer, personal equipment, office equipment, measuring equipment, industrial robotics, domestic appliances, etc.). These TOSHIBA products are neither intended nor warranted for usage in equipment that requires extraordinarily high quality and/or reliability or a malfunction or failure of which may cause loss of human life or bodily injury ("Unintended Usage"). Unintended Usage include atomic energy control instruments, airplane or spaceship instruments, transportation instruments, traffic signal instruments, combustion control instruments, medical instruments, all types of safety devices, etc.. Unintended Usage of TOSHIBA products listed in this document shall be made at the customer's own risk.
- The products described in this document are subject to the foreign exchange and foreign trade laws.
- The information contained herein is presented only as a guide for the applications of our products. No responsibility is assumed by TOSHIBA CORPORATION for any infringements of intellectual property or other rights of the third parties which may result from its use. No license is granted by implication or otherwise under any intellectual property or other rights of TOSHIBA CORPORATION or others.
- The information contained herein is subject to change without notice.