TOSHIBA CMOS DIGITAL INTEGRATED CIRCUIT SILICON MONOLITHIC

# TC9198P, TC9198F

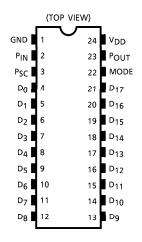
# PROGRAMMABLE COUNTER

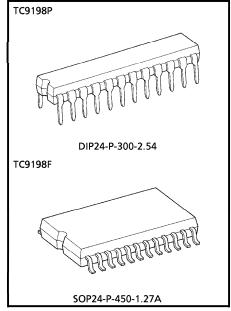
TC9198P, TC9198F are high speed programmable counters developed for dividing PLL circuits and other various circuits.

#### **FEATURES**

- Setting of number of divisions can be made directly from the input terminals.
- The counter allows changing-over of swallow system/ simple division.
- At simple division, changing-over of BCD code/BINARY code can be performed.
- The number of division is 262, 143 in maximum in swallow mode, and can be 5 to 65,535 at BINARY in simple division mode and can be 5 to 15,999 at BCD
- Owing to CMOS construction, the operating power voltage range is wide, and the power consumption is
- The package is DIP-24PIN for TC9198P and SOP-24PIN for TC9198F.

#### PIN CONNECTION





Weight

DIP24-P-300-2.54 : 1.2g (Typ.) SOP24-P-450-1.27A : 0.48g (Typ.)

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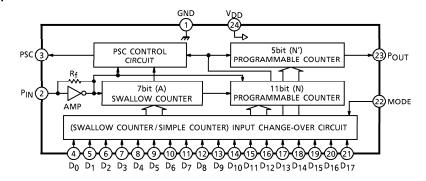
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1999-03-19

#### **BLOCK DIAGRAM**



## PIN FUNCTION

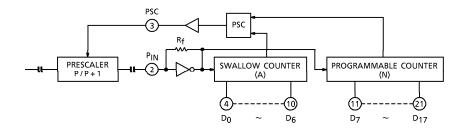
PIN No.	SYMBOL	PIN NAME	FUNCTION AND OPERATION	NOTE
1	GND	Ground Terminal	_	
24	$V_{DD}$	Power Supply Terminal	_	_
<sub>2</sub>	PIN	Programmable	Programmable counter input terminal.	Amp. Circuit
	1111	Counter Input	Prescaler output is input by the capacitor coupling.	built in
3	PSC	Prescaler Control	No. of division control signal output prescaler. It	_
		Output	becomes P in "H" level, and P+1 in "L" level.	
22	MODE	Counter Operation Change-over Input	Change-over input for swallow counter operation and simple counter operation.  It becomes swallow counter at "L" level, or open and simple counter operation at "H" level.	
4	D <sub>0</sub>		Input terminal for setting number of division of	
5	D <sub>1</sub>		programmable counter.	
6	D <sub>2</sub>		(1) MODE (22PIN) = at "L" level	
7	D <sub>3</sub>		D <sub>0</sub> ~D <sub>6</sub> →Swallow counter : A	
8	D <sub>4</sub>		<ul> <li>D<sub>7</sub>~D<sub>17</sub>→Programmable counter: N</li> </ul>	
9	D <sub>5</sub>		(2) MODE = at "H" and D <sub>17</sub> = at "L" level	Pull down
10	D <sub>6</sub>		<ul> <li>Simple counter operation in setting BINARY</li> </ul>	resistance
11	D <sub>7</sub>		code.	built in
12	D <sub>8</sub>	Number of Division	D <sub>0</sub> ~D <sub>15</sub> →Programmable counter: N	
13	Dg	Setting Input	● D <sub>16</sub> →NC	
14	D <sub>10</sub>		(3) MODE = at "H" and D <sub>17</sub> = at "H" level  ■ Simple counter operation in setting BCD	
15	D <sub>11</sub>		code.	
16	D <sub>12</sub>		<ul> <li>D<sub>0</sub>~D<sub>3</sub>→N = 1~9 setting</li> </ul>	
17	D <sub>13</sub>		• D <sub>4</sub> ~D <sub>7</sub> →N = 10~90 setting	
18 19	D <sub>14</sub>		• $D_8 \sim D_{11} \rightarrow N = 100 \sim 900 \text{ setting}$	
20	D <sub>15</sub>		D <sub>12</sub> ~D <sub>15</sub> →N = 1000~15000 setting	
21	D <sub>16</sub>		• D <sub>16</sub> →NC	
41	D <sub>17</sub>	Programmable		
23	POUT	Programmable Counter Output Terminal	1/N of P <sub>IN</sub> input frequency is output pulse width corresponds to 4 cycles of input frequency.	_

#### **DESCRIPTION ON FUNCTION AND OPERATION**

1. Programmable counter

When the MODE INPUT (Pin 22) is set to "L" level (or opened), the programmable counter becomes swallow system.

The system consists of a 7bit swallow counter, 11bit programmable counter and a prescaler logic which change-over the number of divisions of the 2-module prescaler connected to the outside.



• Total number of divisions can be determined by the following formula

Number of divisions = 
$$(P + 1) \cdot A + P \cdot (N - A)$$
  
=  $N \cdot P + A$  Where,  $N > A$ 

- The prescaler used requires to be the number of divisions of P+1 when the PSC terminal is in "L" level and of P when it is in "H" level.
- The input for setting the number of divisions of the programmable counter consists of 18bits, but it should be cared that it changes by the number of divisions P of the prescaler used. (P≤128)
  - (1) When prescaler is P = 128

D <sub>0</sub>	D <sub>1</sub>	D <sub>2</sub>	D <sub>3</sub>	D <sub>4</sub>	D <sub>5</sub>	D <sub>6</sub>	D <sub>7</sub>	D <sub>8</sub>	D9	D <sub>10</sub>	D <sub>11</sub>	D <sub>12</sub>	D <sub>13</sub>	D <sub>14</sub>	D <sub>15</sub>	D <sub>16</sub>	D <sub>17</sub>
<b>2</b> <sup>0</sup>	<b>2</b> <sup>1</sup>	<b>2</b> <sup>2</sup>	<b>2</b> <sup>3</sup>	2 <sup>4</sup>	<b>2</b> <sup>5</sup>	<b>2</b> <sup>6</sup>	<b>2</b> <sup>7</sup>	<b>2</b> <sup>8</sup>	<b>2</b> <sup>9</sup>	<b>2</b> <sup>10</sup>	2 <sup>11</sup>	<b>2</b> <sup>12</sup>	<b>2</b> <sup>13</sup>	2 <sup>14</sup>	2 <sup>15</sup>	2 <sup>16</sup>	2 <sup>17</sup>

- (\*) The BINARY code D of the number of division is  $16,384 \le D \le 262,143$ , as a rule.
- (2) When prescaler is P = 64

D <sub>0</sub>	D <sub>1</sub>	D <sub>2</sub>	D <sub>3</sub>	D <sub>4</sub>	D <sub>5</sub>	D <sub>6</sub>	D <sub>7</sub>	D <sub>8</sub>	D9	D <sub>10</sub>	D <sub>11</sub>	D <sub>12</sub>	D <sub>13</sub>	D <sub>14</sub>	D <sub>15</sub>	D <sub>16</sub>	D <sub>17</sub>
<b>2</b> <sup>0</sup>	<b>2</b> <sup>1</sup>	<b>2</b> <sup>2</sup>	<b>2</b> <sup>3</sup>	2 <sup>4</sup>	<b>2</b> <sup>5</sup>	"0"	<b>2</b> <sup>6</sup>	<b>2</b> <sup>7</sup>	<b>2</b> <sup>8</sup>	<b>2</b> <sup>9</sup>	<b>2</b> <sup>10</sup>	2 <sup>11</sup>	<b>2</b> <sup>12</sup>	<b>2</b> <sup>13</sup>	2 <sup>14</sup>	<b>2</b> <sup>15</sup>	2 <sup>16</sup>

- (\*) The BINARY code D of the number of divisions is  $4,096 \le D \le 131,071$ , as a rule.
- (\*) D<sub>6</sub> (Pin 10) is used as GND or in open.

(3) When prescaler is P = 32

D <sub>0</sub>	D <sub>1</sub>	D <sub>2</sub>	D <sub>3</sub>	D <sub>4</sub>	D <sub>5</sub>	D <sub>6</sub>	D <sub>7</sub>	D <sub>8</sub>	D9	D <sub>10</sub>	D <sub>11</sub>	D <sub>12</sub>	D <sub>13</sub>	D <sub>14</sub>	D <sub>15</sub>	D <sub>16</sub>	D <sub>17</sub>
<b>2</b> <sup>0</sup>	<b>2</b> <sup>1</sup>	<b>2</b> <sup>2</sup>	<b>2</b> <sup>3</sup>	24	"0	)"	<b>2</b> <sup>5</sup>	<b>2</b> <sup>6</sup>	<b>2</b> <sup>7</sup>	<b>2</b> <sup>8</sup>	<b>2</b> 9	<b>2</b> <sup>10</sup>	2 <sup>11</sup>	<b>2</b> <sup>12</sup>	<b>2</b> <sup>13</sup>	2 <sup>14</sup>	<b>2</b> <sup>15</sup>

- (\*) The BINARY code D of the number of divisions is  $1,024 \le D \le 65,535$ , as a rule.
- (\*) D<sub>5</sub> (Pin 9) and D<sub>6</sub> (Pin 10) are used as GND or in open.
- (4) When prescaler is P = 16

ı	D <sub>0</sub>	D <sub>1</sub>	D <sub>2</sub>	D <sub>3</sub>	D <sub>4</sub>	D <sub>5</sub>	D <sub>6</sub>	D <sub>7</sub>	D <sub>8</sub>	D9	D <sub>10</sub>	D <sub>11</sub>	D <sub>12</sub>	D <sub>13</sub>	D <sub>14</sub>	D <sub>15</sub>	D <sub>16</sub>	D <sub>17</sub>
	<b>2</b> 0	2 <sup>1</sup>	<b>2</b> <sup>2</sup>	<b>2</b> <sup>3</sup>		"0"		<b>2</b> <sup>4</sup>	<b>2</b> <sup>5</sup>	<b>2</b> <sup>6</sup>	<b>2</b> <sup>7</sup>	<b>2</b> <sup>8</sup>	<b>2</b> 9	<b>2</b> <sup>10</sup>	2 <sup>11</sup>	<b>2</b> <sup>12</sup>	<b>2</b> <sup>13</sup>	2 <sup>14</sup>

- (\*) The BINARY code D of the number of divisions is  $256 \le D \le 32,767$ , as a rule.
- (\*) D<sub>4</sub>~D<sub>6</sub> (Pin 8~Pin 9) are used as GND or in open.

## 2. Simple program counter

When the MODE INPUT (Pin 22) is set to "H" level, the simple counter system is established. When  $D_{17}$  (Pin 21) is made to "H" level, the system operates in BCD mode, and to "L" level, in BINARY mode.

(1) Operation in BINARY MODE :  $D_{17}$  (Pin 21) =  $D_{16}$  (Pin 20) = "L" level or in open

D <sub>0</sub>	D <sub>1</sub>	D <sub>2</sub>	D <sub>3</sub>	D <sub>4</sub>	D <sub>5</sub>	D <sub>6</sub>	D <sub>7</sub>	D <sub>8</sub>	D9	D <sub>10</sub>	D <sub>11</sub>	D <sub>12</sub>	D <sub>13</sub>	D <sub>14</sub>	D <sub>15</sub>
<b>2</b> <sup>0</sup>	2 <sup>1</sup>	<b>2</b> <sup>2</sup>	<b>2</b> <sup>3</sup>	<b>2</b> <sup>4</sup>	<b>2</b> <sup>5</sup>	<b>2</b> <sup>6</sup>	<b>2</b> <sup>7</sup>	<b>2</b> <sup>8</sup>	<b>2</b> 9	<b>2</b> <sup>10</sup>	2 <sup>11</sup>	<b>2</b> <sup>12</sup>	<b>2</b> <sup>13</sup>	2 <sup>14</sup>	<b>2</b> <sup>15</sup>

- % The BINARY code D of number of divisions becomes 5≤D≤65,535
- (2) Operation in BCD MODE:  $D_{17}$  (Pin 21) = "H",  $D_{16}$  (Pin 20) = "L" level or open

	D <sub>0</sub>	D <sub>1</sub>	D <sub>2</sub>	D <sub>3</sub>	D <sub>4</sub>	D <sub>5</sub>	D <sub>6</sub>	D <sub>7</sub>	D <sub>8</sub>	D9	D <sub>10</sub>	D <sub>11</sub>	D <sub>12</sub>	D <sub>13</sub>	D <sub>14</sub>	D <sub>15</sub>
	1	2	4	8	1	2	4	8	1	2	4	8	1	2	4	8
i	1   2   4   8   1					— ×	10 —	•		— x	100 —			— × 1	000 —	

- (\*)  $D_0 \sim D_3$ ,  $D_4 \sim D_7$ ,  $D_8 \sim D_{11}$  set number of divisions by BCD code. It should be cared that it does not operate when it is set N = 10 or more.
- (\*) In  $D_{12}\sim D_{15}$ , the number of division can be set by the BINARY code.

 $D_{12} \sim D_{15} = 0101 (A) \rightarrow N = 10,000$ 

 $D_{12} \sim D_{15} = 1101 (B) \rightarrow N = 11,000$ 

 $D_{12} \sim D_{15} = 0011 (C) \rightarrow N = 12,000$ 

 $D_{12} \sim D_{15} = 1011 (D) \rightarrow N = 13,000$ 

 $D_{12} \sim D_{15} = 0111 (E) \rightarrow N = 14,000$ 

 $D_{12} \sim D_{15} = 1111 (F) \rightarrow N = 15,000$ 

(\*) The BCD code of the number of divisions becomes  $5 \le D \le 15,999$ 

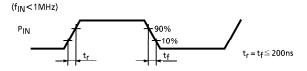
# **MAXIMUM RATINGS** (Ta = 25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Power Supply Voltage	$V_{DD}$	-0.3~7.0	<b>V</b>
Input Voltage	VIN	-0.3~V <sub>DD</sub> +0.3	V
Power Dissipation	PD	300	mW
Operating Temperature	T <sub>opr</sub>	- 40~85	°C
Storage Temperature	T <sub>stg</sub>	<b>-65∼150</b>	°C

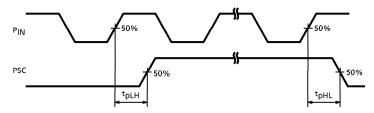
# **ELECTRICAL CHARACTERISTICS** (Unless otherwise specified, $Ta = -40 \sim 85^{\circ}C$ , $V_{DD} = 5.0V$ )

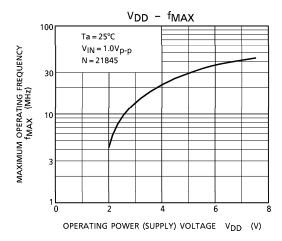
CHARACTI	ERISTIC	SYMBOL	TEST CIR- CUIT	TEST CON	DITION	MIN.	TYP.	MAX.	UNIT
Operating Sup	ply Voltage	$V_{DD}$	_	f 1 EN / U = \/.	1 0\/	4.0	5.0	6.0	٧
Operating Sup	ply Current	lDD	_	$f_{IN} = 15MHz, V_I$	N = 1.0Vp-p	_	5.0	10	mΑ
Maximum Ope	rating	f <sub>opr (1)</sub>	_	V <sub>IN</sub> = 1.0V <sub>p-p</sub> , BINARY mode		1.0	_	15	MHz
Frequency		f <sub>opr</sub> (2)	_	$V_{IN} = 1.0V_{p-p}$ , B	CD mode	1.0	_	15	
Minimum Oper Frequency	rating	fMIN	_	$V_{IN} = 1.0V_{p-p}$	(Note 1)		0.5	1.0	kHz
Operating Inpu	ut	V <sub>IN</sub>	_	f <sub>IN</sub> = 15MHz		1.0	~	V <sub>DD</sub> – 0.1	V <sub>p-p</sub>
Input Voltage	"H" Level	VIH	_	D D (	-1	$V_{DD} \times 0.7$	~	$V_{DD}$	V
Imput voitage	"L" Level	V <sub>IL</sub>	_	D <sub>0</sub> ~D <sub>17</sub> termin		0	~	$V_{DD} \times 0.3$	٧
Pull-down Resi	stance	R <sub>DW</sub>	_	WIODE terminal		32	47	62	kΩ
Output	"H" Level	O H	_	PSC, POUT	$V_{OH} = 4.0V$	0.5	1.0	_	mΑ
Current	"L" Level	οΓ	_	terminal	$V_{OL} = 1.0V$	0.5	1.0	_	ША
Input Resistance		R <sub>f</sub>	_	P <sub>IN</sub> terminal		82	125	250	kΩ
Transfer	Transfer "H" Level		_	P <sub>IN</sub> →PSC transf	_	100	200	nc	
Time	"L" Level	t <sub>pHL</sub>	_	$C_L = 15pF$	(Note 2)	_	100	200	ns

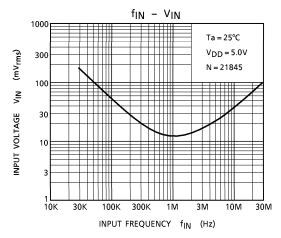
(Note 1) At the test of the minimum operating frequency, the input waveform is specified as follows.

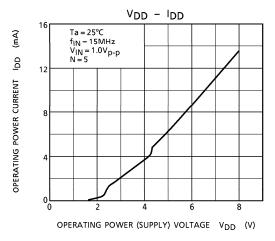


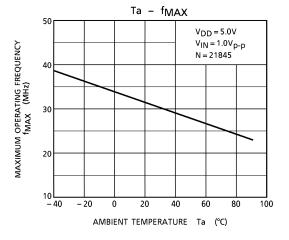
(Note 2)  $P_{IN} \rightarrow P_{SC}$  transfer time





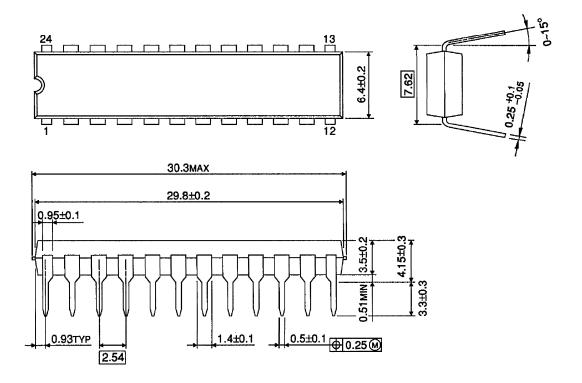




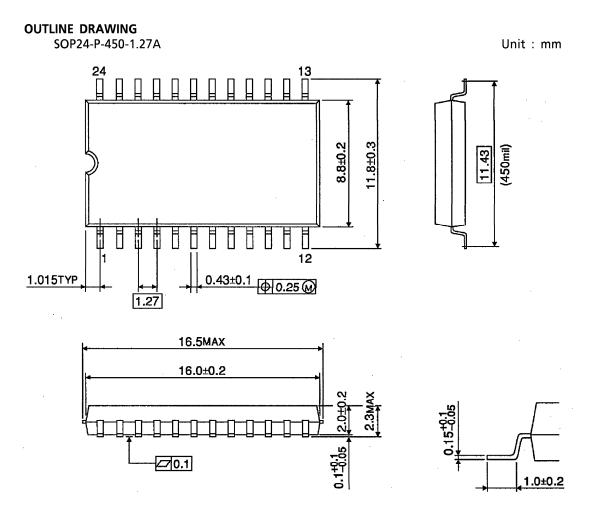


# OUTLINE DRAWING DIP24-P-300-2.54

Unit: mm



Weight: 1.2g (Typ.)



Weight: 0.48g (Typ.)