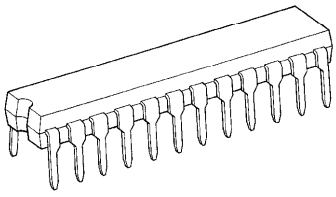
TOSHIBA CMOS DIGITAL INTEGRATED CIRCUIT SILICON MONOLITHIC

# TC9198P, TC9198F

## PROGRAMMABLE COUNTER

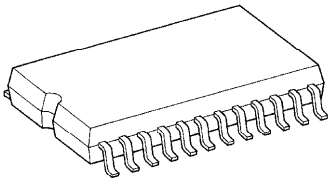
TC9198P, TC9198F are high speed programmable counters developed for dividing PLL circuits and other various circuits.

TC9198P



DIP24-P-300-2.54

TC9198F



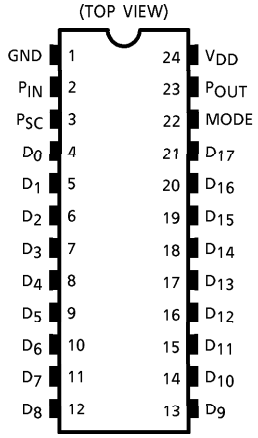
SOP24-P-450-1.27A

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

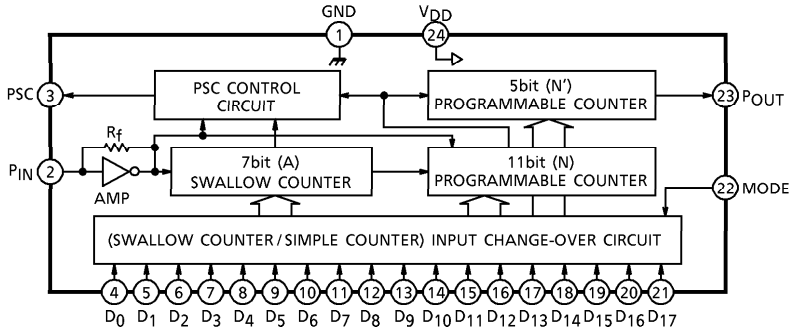
### FEATURES

- 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 code.
- Owing to CMOS construction, the operating power voltage range is wide, and the power consumption is low.
- The package is DIP-24PIN for TC9198P and SOP-24PIN for TC9198F.

### PIN CONNECTION



## BLOCK DIAGRAM



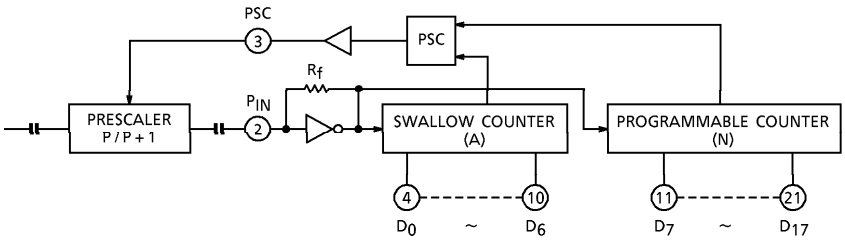

## PIN FUNCTION

| PIN No. | SYMBOL | PIN NAME | FUNCTION AND OPERATION | NOTE |
|---|---|---|---|---|
| 1 | GND | Ground Terminal | — | — |
| 24 | $V_{DD}$ | Power Supply Terminal | | |
| 2 | $P_{IN}$ | Programmable Counter Input | Programmable counter input terminal. Prescaler output is input by the capacitor coupling. | Amp. Circuit built in |
| 3 | PSC | Prescaler Control Output | No. of division control signal output prescaler. It 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. | Pull down resistance built in |
| 4 | $D_0$ | Number of Division Setting Input | Input terminal for setting number of division of programmable counter.<br>(1) MODE (22PIN) = at "L" level<br>● $D_0$~$D_6$→Swallow counter : A<br>● $D_7$~$D_{17}$→Programmable counter : N<br>(2) MODE = at "H" and $D_{17}$ = at "L" level<br>● Simple counter operation in setting BINARY code.<br>● $D_0$~$D_{15}$→Programmable counter : N<br>● $D_{16}$→NC<br>(3) MODE = at "H" and $D_{17}$ = at "H" level<br>● Simple counter operation in setting BCD code.<br>● $D_0$~$D_3$→N = 1~9 setting<br>● $D_4$~$D_7$→N = 10~90 setting<br>● $D_8$~$D_{11}$→N = 100~900 setting<br>● $D_{12}$~$D_{15}$→N = 1000~15000 setting<br>● $D_{16}$→NC | |
| 5 | $D_1$ | | | |
| 6 | $D_2$ | | | |
| 7 | $D_3$ | | | |
| 8 | $D_4$ | | | |
| 9 | $D_5$ | | | |
| 10 | $D_6$ | | | |
| 11 | $D_7$ | | | |
| 12 | $D_8$ | | | |
| 13 | $D_9$ | | | |
| 14 | $D_{10}$ | | | |
| 15 | $D_{11}$ | | | |
| 16 | $D_{12}$ | | | |
| 17 | $D_{13}$ | | | |
| 18 | $D_{14}$ | | | |
| 19 | $D_{15}$ | | | |
| 20 | $D_{16}$ | | | |
| 21 | $D_{17}$ | | | |
| 23 | $P_{OUT}$ | Programmable Counter Output Terminal | 1 / N of $P_{IN}$ 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

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

- 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. ($P \leqq 128$)

(1) When prescaler is P = 128

| $D_0$ | $D_1$ | $D_2$ | $D_3$ | $D_4$ | $D_5$ | $D_6$ | $D_7$ | $D_8$ | $D_9$ | $D_{10}$ | $D_{11}$ | $D_{12}$ | $D_{13}$ | $D_{14}$ | $D_{15}$ | $D_{16}$ | $D_{17}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $2^0$ | $2^1$ | $2^2$ | $2^3$ | $2^4$ | $2^5$ | $2^6$ | $2^7$ | $2^8$ | $2^9$ | $2^{10}$ | $2^{11}$ | $2^{12}$ | $2^{13}$ | $2^{14}$ | $2^{15}$ | $2^{16}$ | $2^{17}$ |

(*) The BINARY code D of the number of division is $16{,}384 \leqq D \leqq 262{,}143$, as a rule.

(2) When prescaler is P = 64

| $D_0$ | $D_1$ | $D_2$ | $D_3$ | $D_4$ | $D_5$ | $D_6$ | $D_7$ | $D_8$ | $D_9$ | $D_{10}$ | $D_{11}$ | $D_{12}$ | $D_{13}$ | $D_{14}$ | $D_{15}$ | $D_{16}$ | $D_{17}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $2^0$ | $2^1$ | $2^2$ | $2^3$ | $2^4$ | $2^5$ | "0" | $2^6$ | $2^7$ | $2^8$ | $2^9$ | $2^{10}$ | $2^{11}$ | $2^{12}$ | $2^{13}$ | $2^{14}$ | $2^{15}$ | $2^{16}$ |

(*) The BINARY code D of the number of divisions is $4{,}096 \leqq D \leqq 131{,}071$, as a rule.
(*) $D_6$ (Pin 10) is used as GND or in open.

(3) When prescaler is P = 32

| $D_0$ | $D_1$ | $D_2$ | $D_3$ | $D_4$ | $D_5$ | $D_6$ | $D_7$ | $D_8$ | $D_9$ | $D_{10}$ | $D_{11}$ | $D_{12}$ | $D_{13}$ | $D_{14}$ | $D_{15}$ | $D_{16}$ | $D_{17}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $2^0$ | $2^1$ | $2^2$ | $2^3$ | $2^4$ | "0" | | $2^5$ | $2^6$ | $2^7$ | $2^8$ | $2^9$ | $2^{10}$ | $2^{11}$ | $2^{12}$ | $2^{13}$ | $2^{14}$ | $2^{15}$ |

(*) The BINARY code D of the number of divisions is $1,024 \leqq D \leqq 65,535$, as a rule.
(*) $D_5$ (Pin 9) and $D_6$ (Pin 10) are used as GND or in open.

(4) When prescaler is P = 16

| $D_0$ | $D_1$ | $D_2$ | $D_3$ | $D_4$ | $D_5$ | $D_6$ | $D_7$ | $D_8$ | $D_9$ | $D_{10}$ | $D_{11}$ | $D_{12}$ | $D_{13}$ | $D_{14}$ | $D_{15}$ | $D_{16}$ | $D_{17}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $2^0$ | $2^1$ | $2^2$ | $2^3$ | "0" | | | $2^4$ | $2^5$ | $2^6$ | $2^7$ | $2^8$ | $2^9$ | $2^{10}$ | $2^{11}$ | $2^{12}$ | $2^{13}$ | $2^{14}$ |

(*) The BINARY code D of the number of divisions is $256 \leqq D \leqq 32,767$, as a rule.
(*) $D_4 \sim D_6$ (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

| $D_0$ | $D_1$ | $D_2$ | $D_3$ | $D_4$ | $D_5$ | $D_6$ | $D_7$ | $D_8$ | $D_9$ | $D_{10}$ | $D_{11}$ | $D_{12}$ | $D_{13}$ | $D_{14}$ | $D_{15}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $2^0$ | $2^1$ | $2^2$ | $2^3$ | $2^4$ | $2^5$ | $2^6$ | $2^7$ | $2^8$ | $2^9$ | $2^{10}$ | $2^{11}$ | $2^{12}$ | $2^{13}$ | $2^{14}$ | $2^{15}$ |

※ The BINARY code D of number of divisions becomes $5 \leqq D \leqq 65,535$

(2) Operation in BCD MODE : $D_{17}$ (Pin 21) = "H", $D_{16}$ (Pin 20) = "L" level or open

| $D_0$ | $D_1$ | $D_2$ | $D_3$ | $D_4$ | $D_5$ | $D_6$ | $D_7$ | $D_8$ | $D_9$ | $D_{10}$ | $D_{11}$ | $D_{12}$ | $D_{13}$ | $D_{14}$ | $D_{15}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 4 | 8 | 1 | 2 | 4 | 8 | 1 | 2 | 4 | 8 | 1 | 2 | 4 | 8 |
| × 1 | | | | × 10 | | | | × 100 | | | | × 1000 | | | |

(*) $D_0 \sim D_3$, $D_4 \sim D_7$, $D_8 \sim D_{11}$ 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 $5 \leqq D \leqq 15,999$

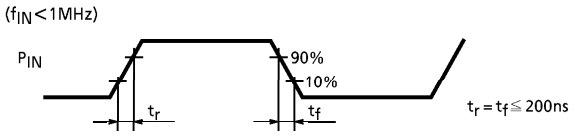
**MAXIMUM RATINGS** (Ta = 25°C)

| CHARACTERISTIC | SYMBOL | RATING | UNIT |
|---|---|---|---|
| Power Supply Voltage | $V_{DD}$ | −0.3~7.0 | V |
| Input Voltage | $V_{IN}$ | −0.3~$V_{DD}$ +0.3 | V |
| Power Dissipation | $P_D$ | 300 | mW |
| Operating Temperature | $T_{opr}$ | −40~85 | °C |
| Storage Temperature | $T_{stg}$ | −65~150 | °C |

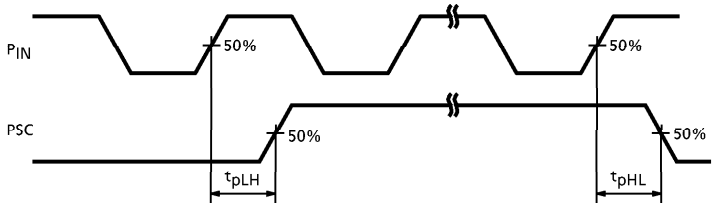
**ELECTRICAL CHARACTERISTICS** (Unless otherwise specified, Ta = −40~85°C, $V_{DD}$ = 5.0V)

| CHARACTERISTIC | | SYMBOL | TEST CIR-CUIT | TEST CONDITION | | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|---|---|---|
| Operating Supply Voltage | | $V_{DD}$ | — | $f_{IN}$ = 15MHz, $V_{IN}$ = 1.0$V_{p-p}$ | | 4.0 | 5.0 | 6.0 | V |
| Operating Supply Current | | $I_{DD}$ | — | | | — | 5.0 | 10 | mA |
| Maximum Operating Frequency | | $f_{opr}$ (1) | — | $V_{IN}$ = 1.0$V_{p-p}$, BINARY mode | | 1.0 | — | 15 | MHz |
| | | $f_{opr}$ (2) | — | $V_{IN}$ = 1.0$V_{p-p}$, BCD mode | | 1.0 | — | 15 | |
| Minimum Operating Frequency | | $f_{MIN}$ | — | $V_{IN}$ = 1.0$V_{p-p}$ (Note 1) | | — | 0.5 | 1.0 | kHz |
| Operating Input Amplitude | | $V_{IN}$ | — | $f_{IN}$ = 15MHz | | 1.0 | ~ | $V_{DD}$ − 0.1 | $V_{p-p}$ |
| Input Voltage | "H" Level | $V_{IH}$ | — | $D_0$~$D_{17}$ terminal MODE terminal | | $V_{DD}$ × 0.7 | ~ | $V_{DD}$ | V |
| | "L" Level | $V_{IL}$ | — | | | 0 | ~ | $V_{DD}$ × 0.3 | |
| Pull-down Resistance | | $R_{DW}$ | — | | | 32 | 47 | 62 | kΩ |
| Output Current | "H" Level | $I_{OH}$ | — | PSC, $P_{OUT}$ terminal | $V_{OH}$ = 4.0V | 0.5 | 1.0 | — | mA |
| | "L" Level | $I_{OL}$ | — | | $V_{OL}$ = 1.0V | 0.5 | 1.0 | — | |
| Input Resistance | | $R_f$ | — | $P_{IN}$ terminal | | 82 | 125 | 250 | kΩ |
| Transfer Time | "H" Level | $t_{pLH}$ | — | $P_{IN}$→PSC transfer time | | — | 100 | 200 | ns |
| | "L" Level | $t_{pHL}$ | — | $C_L$ = 15pF (Note 2) | | — | 100 | 200 | |

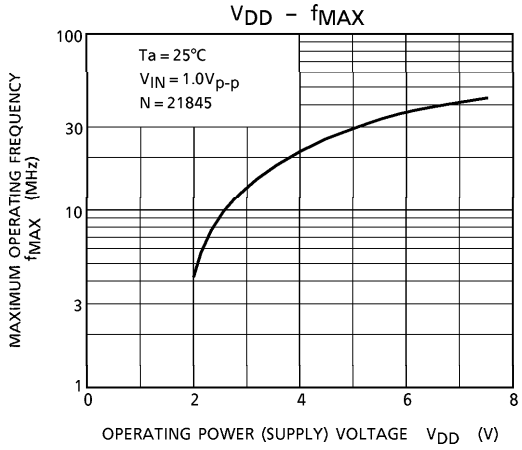
(Note 1) At the test of the minimum operating frequency, the input waveform is specified as follows.



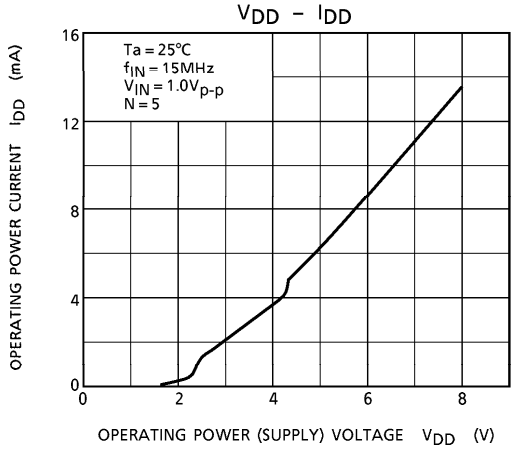

(Note 2) $P_{IN}$→$P_{SC}$ transfer time



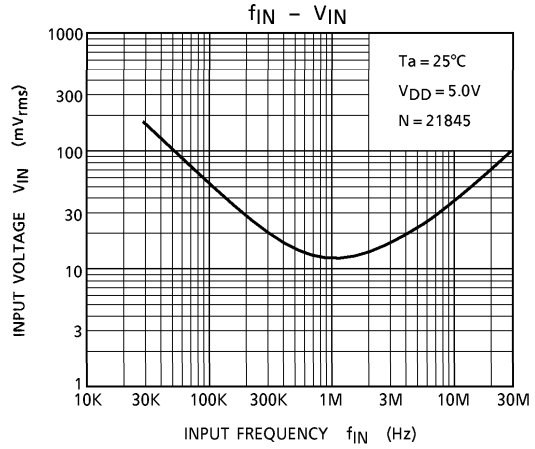
$V_{DD}$ – $f_{MAX}$



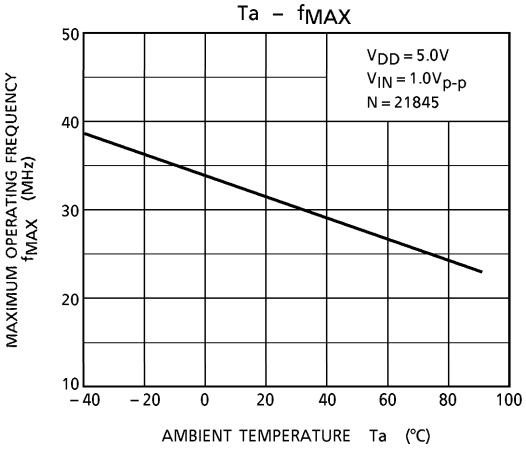

$V_{DD}$ – $I_{DD}$




$f_{IN}$ – $V_{IN}$

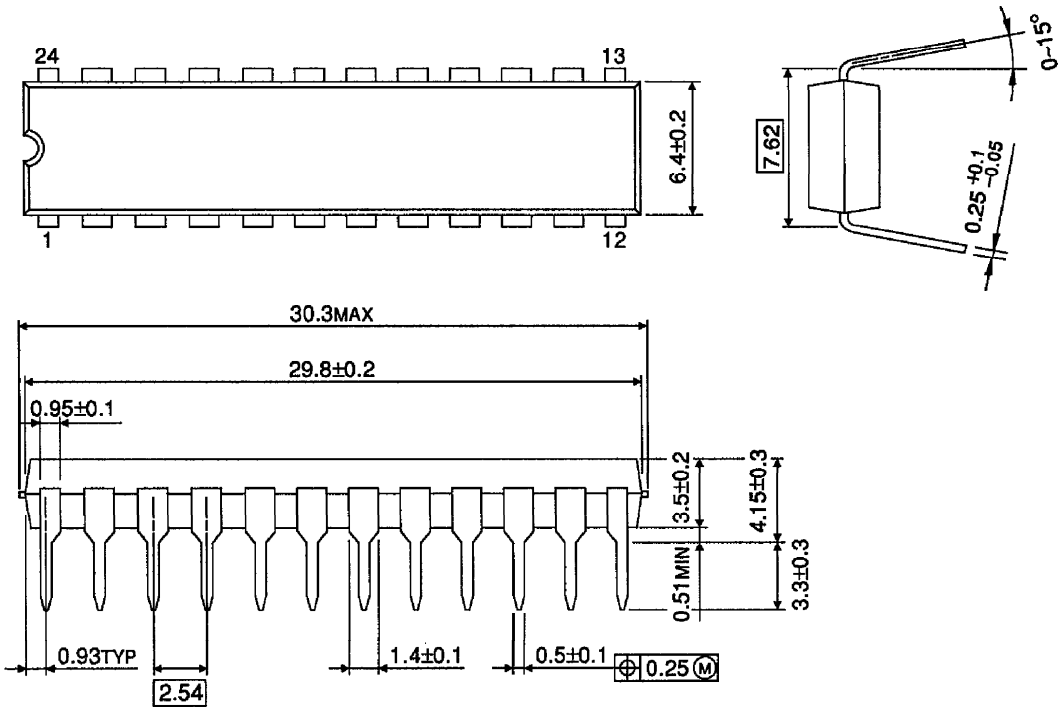



Ta – $f_{MAX}$



**OUTLINE DRAWING**

DIP24-P-300-2.54 Unit : mm

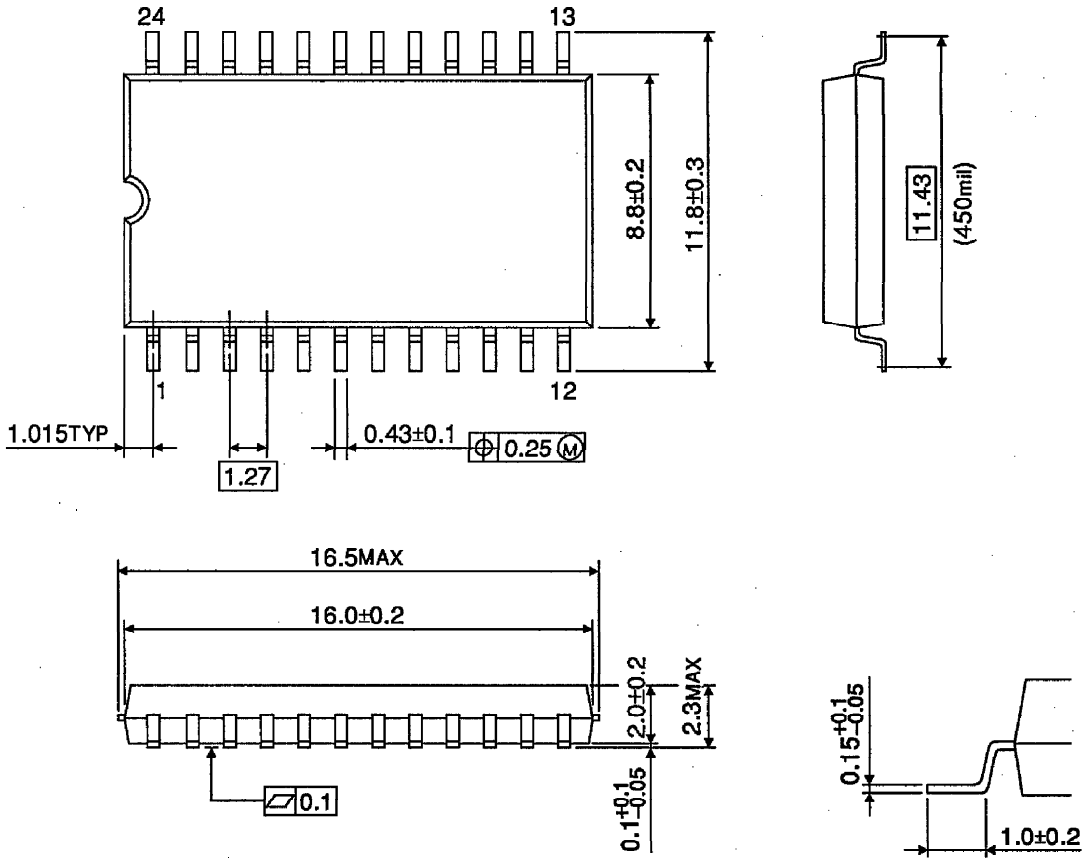



Weight : 1.2g (Typ.)

**OUTLINE DRAWING**

SOP24-P-450-1.27A

Unit : mm




Weight : 0.48g (Typ.)