

TENTATIVE

TOSHIBA Bi-CMOS INTEGRATED CIRCUIT SILICON MONOLITHIC

# T B 6 5 2 6 F

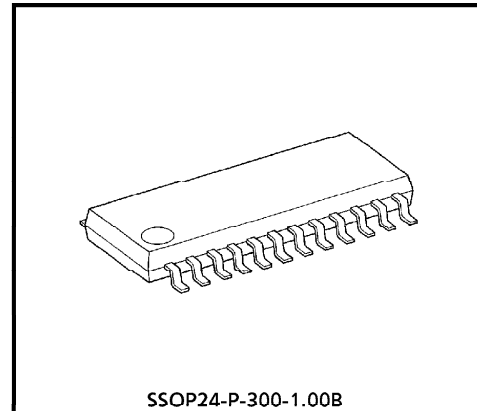
## CHOPPER-TYPE BIPOLAR STEPPING MOTOR CONTROL DRIVER IC

The TB6526F is a PWM chopper-type sinusoidal micro-step bipolar stepping motor driver IC.

It is capable of 1-2 and 2W1-2 phase excitation modes and forward and reverse rotation modes, low-vibration, low-torque ripple, and high-efficiency driving.

### FEATURES

- Forward and reverse rotations are available.
- 1-2, 2W1-2 phase driving is available.
- Structured by high breakdown voltage Bi-CMOS process.
- Package: SSOP24-P-300-1.00B
- Externally equipped with PNP output transistor.
- Reset and enable pins are attached.



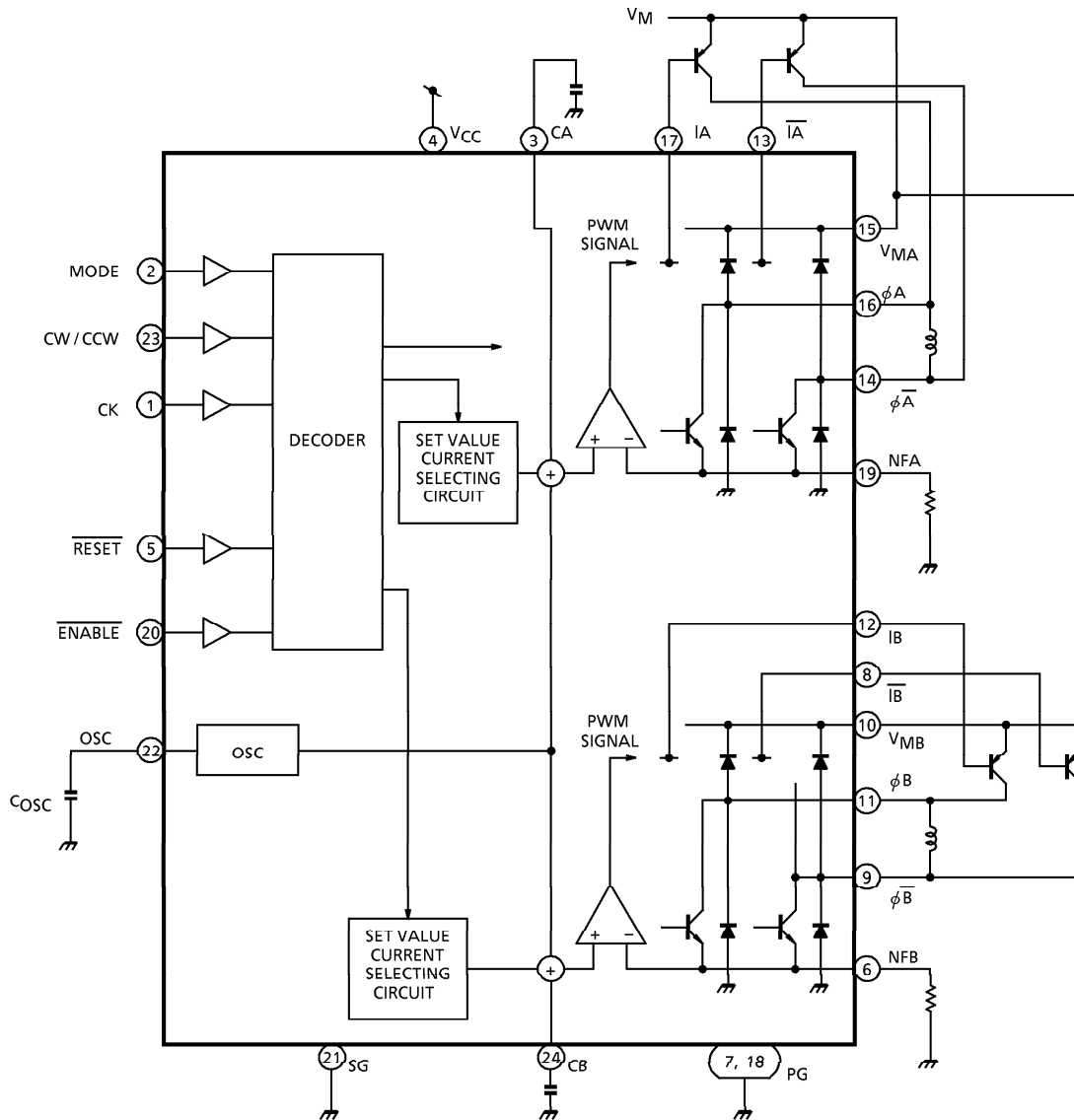
SSOP24-P-300-1.00B

Weight : 0.27g (Typ.)

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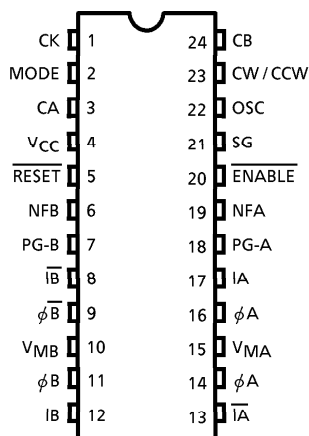
BLOCK DIAGRAM





PIN FUNCTION

| PIN No. | SYMBOL          | FUNCTIONAL DESCRIPTION  |
|---------|-----------------|---|
| 1       | CK              | CLOCK Signal Input <span style="float:right">Truth table A</span>                               |
| 2       | MODE            | Excitation Mode Setting terminal <span style="float:right">Truth table B</span>                 |
| 3       | CA              | Noise reduction condenser outer terminal  |
| 4       | V <sub>CC</sub> | Power voltage supply terminal for Logic   |
| 5       | RESET           | RESET Signal Input terminal <span style="float:right">Truth table A</span>                      |
| 6       | NFB             | B Channel current detective terminal  |
| 7       | PG-B            | Power GND B terminal  |
| 8       | IB              | Upper PNP Transistor Base terminal ( $\bar{B}$ phase)   |
| 9       | $\phi\bar{B}$   | $\bar{B}$ output  |
| 10      | V <sub>MB</sub> | Power voltage supply terminal for Motor B   |
| 11      | $\phi B$        | Output B terminal   |
| 12      | IB              | Upper PNP Transistor Base terminal (B phase)  |
| 13      | $\bar{I}A$      | Upper PNP Transistor Base terminal ( $\bar{A}$ phase)   |
| 14      | $\phi\bar{A}$   | Output $\bar{A}$ terminal   |
| 15      | V <sub>MA</sub> | Power voltage supply terminal for Motor A   |
| 16      | $\phi A$        | Output A terminal   |
| 17      | IA              | Upper side PNP transistor Base terminal (A phase)   |
| 18      | PG-A            | Power GND A terminal  |
| 19      | NFA             | A Channel current detection terminal  |
| 20      | ENABLE          | ENABLE Signal input terminal <span style="float:right">Truth table A</span>                     |
| 21      | SG              | Signal GND terminal   |
| 22      | OSC             | Internal Oscillation frequency detective terminal with external condenser                       |
| 23      | CW / CCW        | Forward rotation / Reverse rotation signal input <span style="float:right">Truth table A</span> |
| 24      | CB              | Noise reduction condenser outside terminal  |

PIN CONNECTION



TRUTH TABLE A

| INPUT   |        |       |        | MODE         |
|---|--------|-------|--------|--------------|
| CK1   | CW/CCW | RESET | ENABLE |              |
|  | L      | H     | L      | CW           |
|  | H      | H     | L      | CCW          |
| X   | X      | L     | L      | INITIAL MODE |
| X   | X      | X     | H      | Z            |

Z : High Impedance

X : Don't Care

(Note) Do not use INHIBIT MODE.

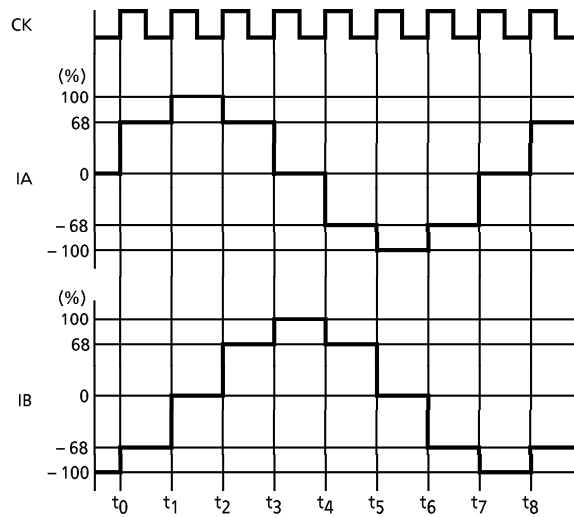
TRUTH TABLE B

| INPUT MODE | MODE (EXCITATION) |
|------------|-------------------|
| L          | 1-2 phase         |
| H          | 2W1-2 phase       |

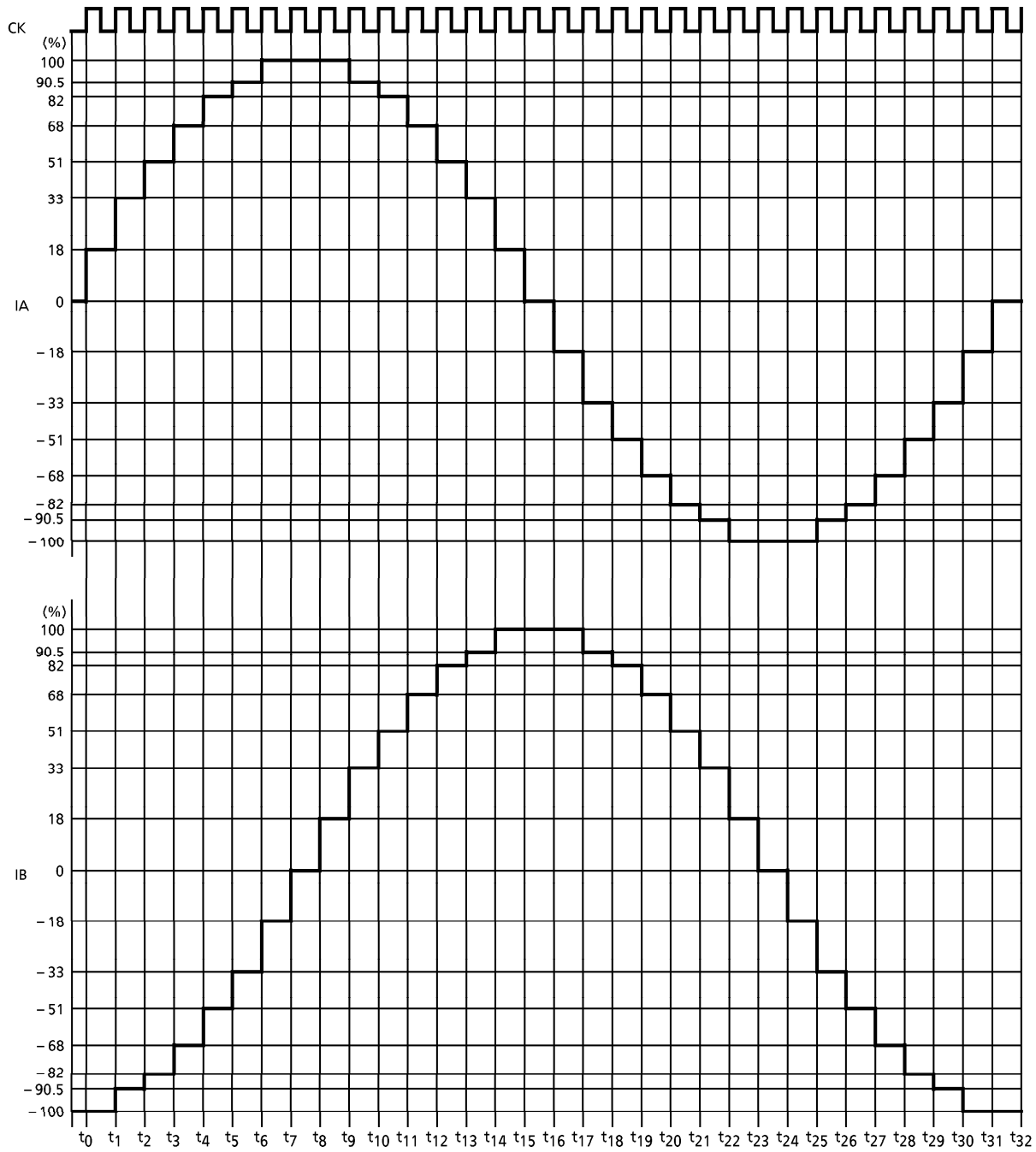
INITIAL MODE

| MODE EXCITATION | A-PHASE CURRENT | B-PHASE CURRENT |
|-----------------|-----------------|-----------------|
| 1-2 phase       | 100%            | 0%              |
| 2W1-2 phase     | 100%            | 0%              |

1-2 PHASE EXCITATION (MODE : L, CW mode)



2W1-2 EXCITATION (MODE : H, CW mode)



**MAXIMUM RATING (Ta = 25°C)**

| CHARACTERISTIC        | SYMBOL                | RATING           | UNIT |
|-----------------------|-----------------------|------------------|------|
| Supply Voltage        | V <sub>CC</sub>       | 5.5              | V    |
| Output Voltage        | V <sub>M (opr.)</sub> | 4.0~8.0          | V    |
|                       | V <sub>M (MAX.)</sub> | 10.0             |      |
| Output Current        | I <sub>O (MAX.)</sub> | 120              | mA   |
| Input Voltage         | V <sub>IN</sub>       | ~V <sub>CC</sub> | V    |
| Power Dissipation     | P <sub>D</sub>        | 0.83 (Note 1)    | W    |
|                       |                       | 1.04 (Note 2)    |      |
| Operating Temperature | T <sub>opr</sub>      | -30~85           | °C   |
| Storage Temperature   | T <sub>stg</sub>      | -55~150          | °C   |
| Feed Back Voltage     | V <sub>I</sub>        | 1.0              | V    |

(Note 1) No heat sink

(Note 2) When mounted on substrate (50×50×1.6mm Cu 10%)

**RECOMMENDED OPERATING CONDITIONS (Ta = -30~85°C)**

| CHARACTERISTIC               | SYMBOL                 | TEST CONDITION | MIN | TYP. | MAX             | UNIT |
|------------------------------|------------------------|----------------|-----|------|-----------------|------|
| Control Power Supply Voltage | V <sub>CC (opr.)</sub> |                | 2.7 | 3.0  | 5.5             | V    |
| Motor Power Supply Voltage   | V <sub>M (opr.)</sub>  |                | 4.0 | —    | 8.0             | V    |
| Output Current               | I <sub>OUT</sub>       |                | —   | —    | 100             | mA   |
| Input Voltage                | V <sub>IN</sub>        |                | —   | —    | V <sub>CC</sub> | V    |
| Clock Frequency              | f <sub>CLOCK</sub>     |                | —   | —    | 5               | kHz  |
| OSC Frequency                | f <sub>OSC</sub>       |                | 15  | —    | 80              | kHz  |

**ELECTRICAL CHARACTERISTICS**

Unless otherwise specified (Ta = 25°C, VCC = 3V, VM = 5V, load inductance : L = 8mH / R = 50Ω, with outer PNP)

| CHARACTERISTIC                        |      | SYMBOL      | TEST CIR-CUIT | TEST CONDITION   | MIN          | TYP. | MAX          | UNIT |
|---------------------------------------|------|-------------|---------------|--|--------------|------|--------------|------|
| Input Voltage                         | High | VIN (H)     | 1             | MODE, CW / CCW, $\overline{\text{ENABLE}}$<br>CK, RESET                                | VCC<br>× 0.7 | —    | VCC<br>+ 0.4 | V    |
|                                       | Low  | VIN (L)     |               |  | GND<br>- 0.4 | —    | VCC<br>× 0.3 |      |
| Input Current                         |      | IIN (H)     | 2             | VIN = 3.0V   | —            | —    | 100          | nA   |
|                                       |      | IIN (L)     |               | VIN = 0V   | —            | —    | 100          |      |
| Current Consumption<br>VCC Pin        |      | ICC1        | 3             | Output open,<br>RESET : H, $\overline{\text{ENABLE}}$ : L,<br>(1-2 phase excitation)   | —            | 7    | 9            | mA   |
|                                       |      | ICC2        |               | Output open,<br>RESET : H, $\overline{\text{ENABLE}}$ : L,<br>(2W1-2 phase excitation) | —            | 7    | 9            |      |
|                                       |      | ICC3        |               | RESET : L, $\overline{\text{ENABLE}}$ : H  | —            | 1.3  | —            |      |
|                                       |      | ICC4        |               | RESET : H, $\overline{\text{ENABLE}}$ : H  | —            | 1.3  | —            |      |
| Comparator Reference<br>Voltage Level |      | VNF1        | 9             | CA, CB   | 0.24         | 0.27 | 0.30         | V    |
|                                       |      | VNF2        | 4             | RNF = 3.3Ω, COSC = 3300pF  | 1.65         | 190  | 215          | mV   |
|                                       |      | VNF3        | 4             | RNF = 2.2Ω, COSC = 3300pF  | 145          | 167  | 185          | mV   |
| Output Inter-channel<br>Differential  |      | ΔVO         | 4             | (VNFA - VNFB) / VNFA,<br>COSC = 3300pF, RNF = 3.3Ω                                     | - 10         | —    | 10           | %    |
| Maximum OSC Frequency                 |      | fOSC (MAX.) | —             |  | 100          | —    | —            | kHz  |
| Minimum OSC Frequency                 |      | fOSC (MIN.) | —             |  | —            | —    | 10           | kHz  |
| OSC Frequency                         |      | fOSC        | 5             | COSC = 3300pF  | 31           | 44   | 70           | kHz  |

**ELECTRICAL CHARACTERISTICS**

Unless otherwise specified (Ta = 25°C, V<sub>CC</sub> = 3V, V<sub>M</sub> = 5V, load inductance : L = 8mH / R = 50Ω, with outer PNP)

**OUTPUT SECTION**

| CHARACTERISTIC                      |                        |                      | SYMBOL              | TEST CIRCUIT             | TEST CONDITION   | MIN  | TYP. | MAX  | UNIT |  |
|-------------------------------------|------------------------|----------------------|---------------------|--------------------------|--|--|------|------|------|--|
| Upper Side Driving Current          |                        |                      | I <sub>U</sub>      | 6                        | V <sub>C</sub> = 3V                                    | —  | 1.5  | 1.6  | mA   |  |
| Lower Side Saturation Voltage       |                        |                      | V <sub>SAT L1</sub> | 7                        | I <sub>OUT</sub> = 0.06A                               | —  | 0.10 | —    | V    |  |
|                                     |                        |                      | V <sub>SAT L2</sub> |                          | I <sub>OUT</sub> = 0.12A                               | —  | 0.16 | 0.43 |      |  |
| Diode Forward Voltage               | Upper Side             | V <sub>F U</sub>     | 8                   | I <sub>OUT</sub> = 0.12A | —  | 1.24   | 1.8  | V    |      |  |
|                                     | Lower Side             | V <sub>F L</sub>     |                     |                          | —  | 0.95   | 1.6  |      |      |  |
| Output Dark Current (A + B channel) |                        |                      | I <sub>M1</sub>     | 3                        | ENABLE : "H" level<br>RESET : "L" level<br>Output open | —  | —    | 50   | μA   |  |
|                                     |                        |                      | I <sub>M2</sub>     |                          | ENABLE : "L" level<br>RESET : "H" level<br>Output open | —  | 17   | 28   | mA   |  |
| NF Dark Current (1 channel)         |                        |                      | I <sub>NF</sub>     |                          | ENABLE : "L" level<br>RESET : "H" level<br>Output open | 1  | 2.5  | 7    |      |  |
| A·B Chopper Current (Note)          | 2W1-2 phase excitation | 1-2 phase excitation | Vector              | 4                        | θ = 0  | R <sub>NF</sub> = 3.3Ω<br>C <sub>OSC</sub> = 3300pF<br>V <sub>NF</sub> | —    | 100  | —    |  |
|                                     | 2W1-2 phase excitation | —                    |                     |                          | θ = 1/8  |  | —    | 100  | —    |  |
|                                     | 2W1-2 phase excitation | —                    |                     |                          | θ = 2/8  |  | 85.5 | 90.5 | 95.5 |  |
|                                     | 2W1-2 phase excitation | —                    |                     |                          | θ = 3/8  |  | 77   | 82   | 87   |  |
|                                     | 2W1-2 phase excitation | 1-2 phase excitation |                     |                          | θ = 4/8  |  | 64   | 69   | 74   |  |
|                                     | 2W1-2 phase excitation | —                    |                     |                          | θ = 5/8  |  | 48   | 53   | 58   |  |
|                                     | 2W1-2 phase excitation | —                    |                     |                          | θ = 6/8  |  | 31   | 36   | 41   |  |
|                                     | 2W1-2 phase excitation | —                    |                     |                          | θ = 7/8  |  | 16   | 21   | 26   |  |

(Note) Maximum current θ = 0 is set at 100.

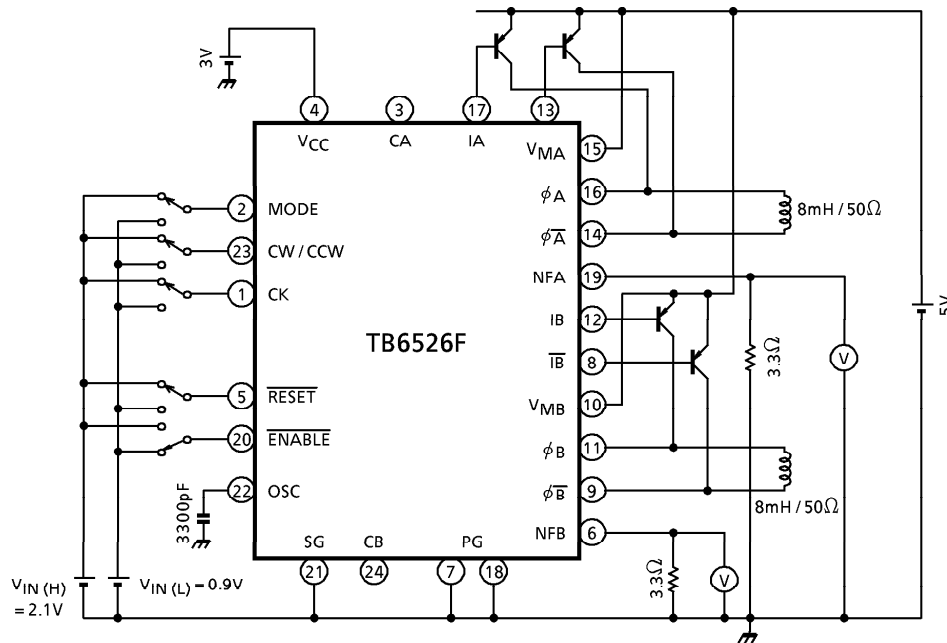


**ELECTRICAL CHARACTERISTICS**

Unless otherwise specified (Ta = 25°C, V<sub>CC</sub> = 3V, V<sub>M</sub> = 5V, load inductance : L = 8mH / R = 50Ω, with outer PNP)

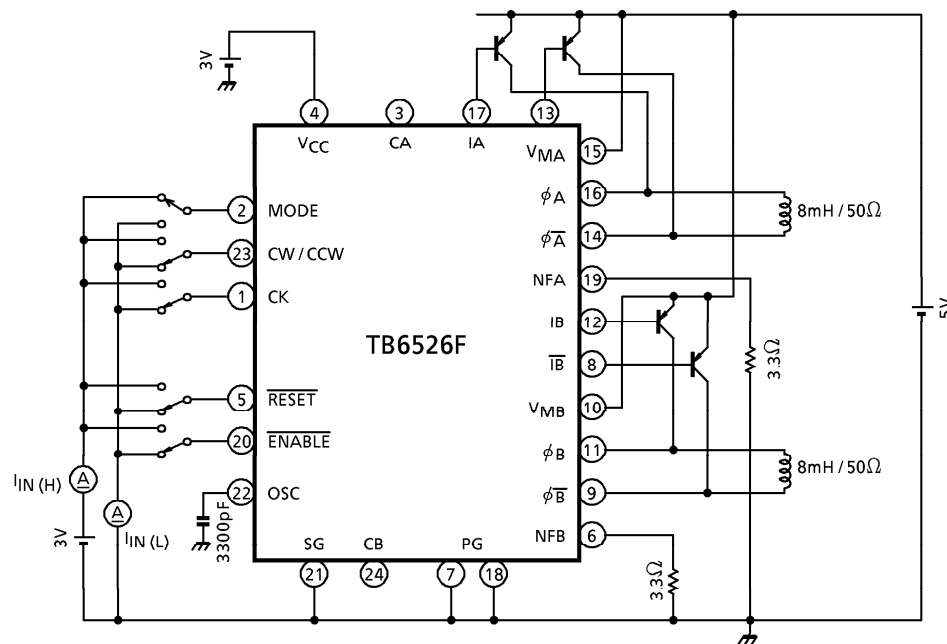
| CHARACTERISTIC                                | SYMBOL          | TEST CIR-CUIT | TEST CONDITION                           | MIN                         | TYP.  | MAX | UNIT    |    |
|---|-----------------|---------------|--|-----------------------------|-------|-----|---------|----|
| Reference Voltage                             | $\Delta V_{NF}$ | 9             | $\Delta\theta = 0/8 - 1/8$               | Measured by CA and CB       | —     | 0   | —       | mV |
|   |                 |               | $\Delta\theta = 1/8 - 2/8$               |                             | 10    | 17  | 35      |    |
|   |                 |               | $\Delta\theta = 2/8 - 3/8$               |                             | 5     | 16  | 30      |    |
|   |                 |               | $\Delta\theta = 3/8 - 4/8$               |                             | 16.25 | 21  | 41.25   |    |
|   |                 |               | $\Delta\theta = 4/8 - 5/8$               |                             | 25    | 32  | 50      |    |
|   |                 |               | $\Delta\theta = 5/8 - 6/8$               |                             | 26.25 | 31  | 51.25   |    |
|   |                 |               | $\Delta\theta = 6/8 - 7/8$               |                             | 15    | 28  | 45      |    |
| Output Tr Switching                           | $t_r$           | 12            | $R_L = 2\Omega, V_{NF} = 0V, C_L = 15pF$ | —                           | 0.3   | —   | $\mu s$ |    |
|   | $t_f$           |               |  | —                           | 2.2   | —   |         |    |
|   | $t_{pLH}$       |               |  | CK~output                   | —     | 1.5 |         | —  |
|   | $t_{pHL}$       |               |  |                             | —     | 2.7 |         | —  |
|   | $t_{pLH}$       |               |  | OSC~output                  | —     | 5.4 |         | —  |
|   | $t_{pHL}$       |               |  |                             | —     | 6.3 |         | —  |
|   | $t_{pLH}$       |               |  | $\overline{RESET}$ ~output  | —     | 2.0 |         | —  |
|   | $t_{pHL}$       |               |  |                             | —     | 2.5 |         | —  |
|   | $t_{pLH}$       |               |  | $\overline{ENABLE}$ ~output | —     | 5.0 |         | —  |
|   | $t_{pHL}$       |               |  |                             | —     | 6.0 |         | —  |
| Output Leakage Current                        | $I_{OL}$        | 10            | $V_M = 10V$                              | —                           | —     | 50  | $\mu A$ |    |
| V <sub>MA</sub> / V <sub>MB</sub> Off Current | $I_{off}$       | 11            | $V_{CC} = 0, V_M = 5V$                   | —                           | —     | 1   | $\mu A$ |    |

TEST CIRCUIT 1 :  $V_{IN(H)}$ ,  $V_{IN(L)}$

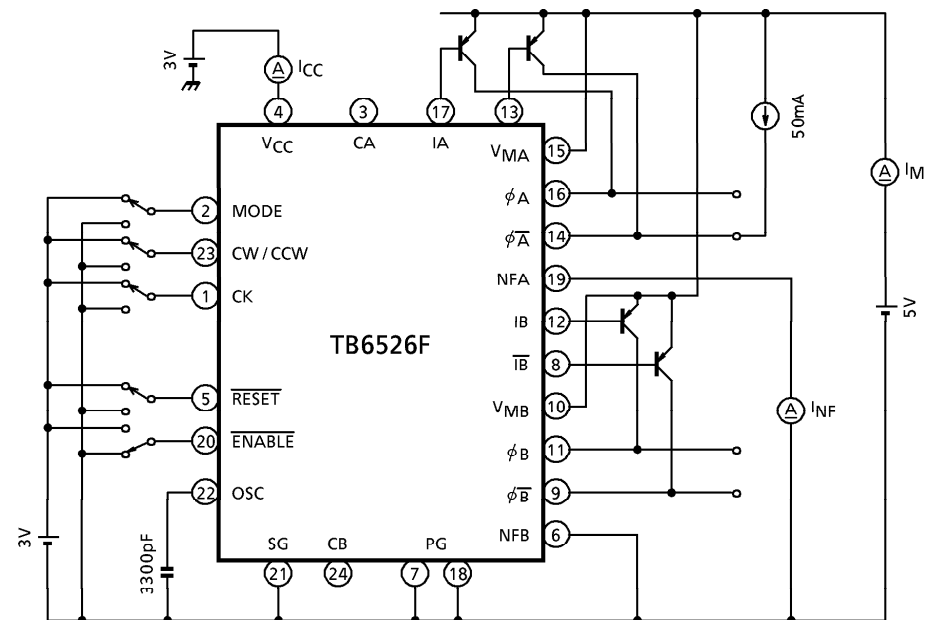


(Note) When input voltage  $V_{IN(H)}$ ,  $V_{IN(L)}$  is applied, verify the output function (NF voltage measurement).

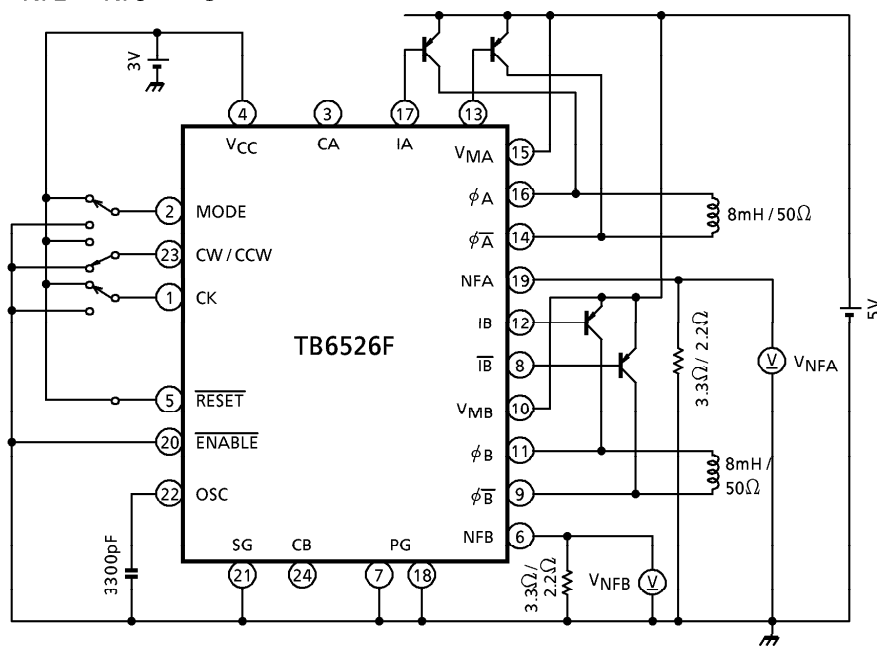
TEST CIRCUIT 2 :  $I_{IN(H)}$ ,  $I_{IN(L)}$



TEST CIRCUIT 3 :  $I_{CC}$ ,  $I_M$ ,  $I_{NF}$

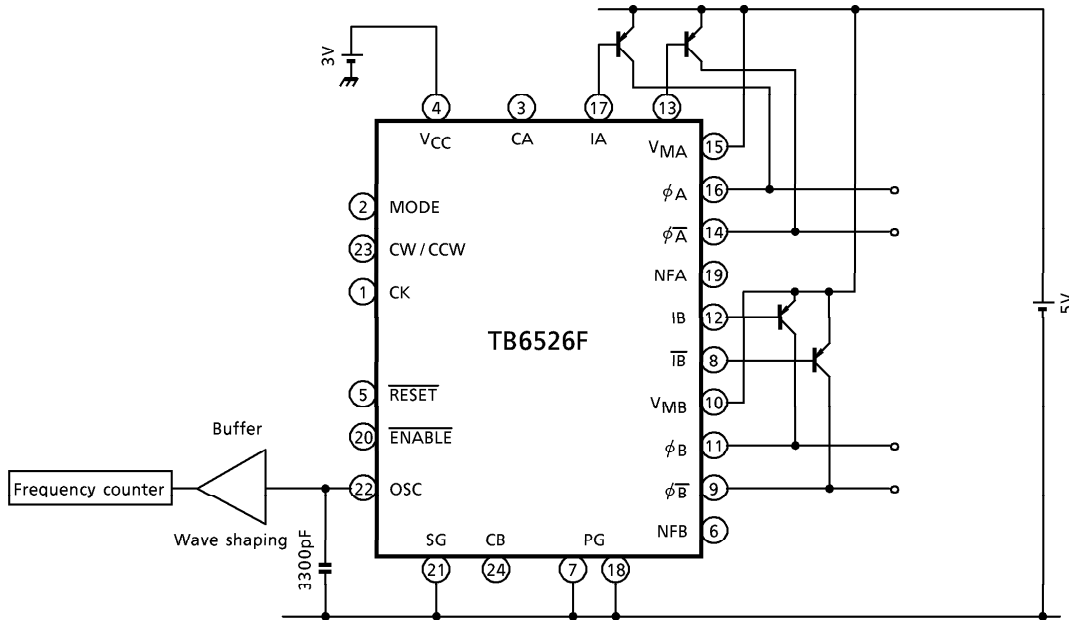


TEST CIRCUIT 4 :  $V_{NF2}$ ,  $V_{NF3}$ ,  $\Delta V_O$

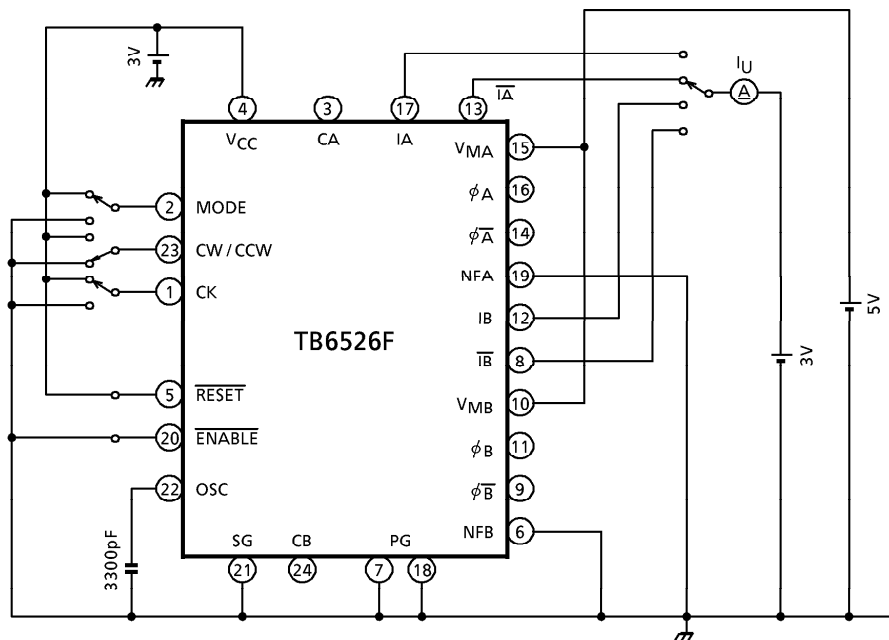


(Note)  $V_{NF2}$  :  $V_{NFA}$  (100%),  $V_{NFB}$  (100%) when  $R_{NF} = 3.3\Omega$   
 $V_{NF3}$  :  $V_{NFA}$  (100%),  $V_{NFB}$  (100%) when  $R_{NF} = 2.2\Omega$

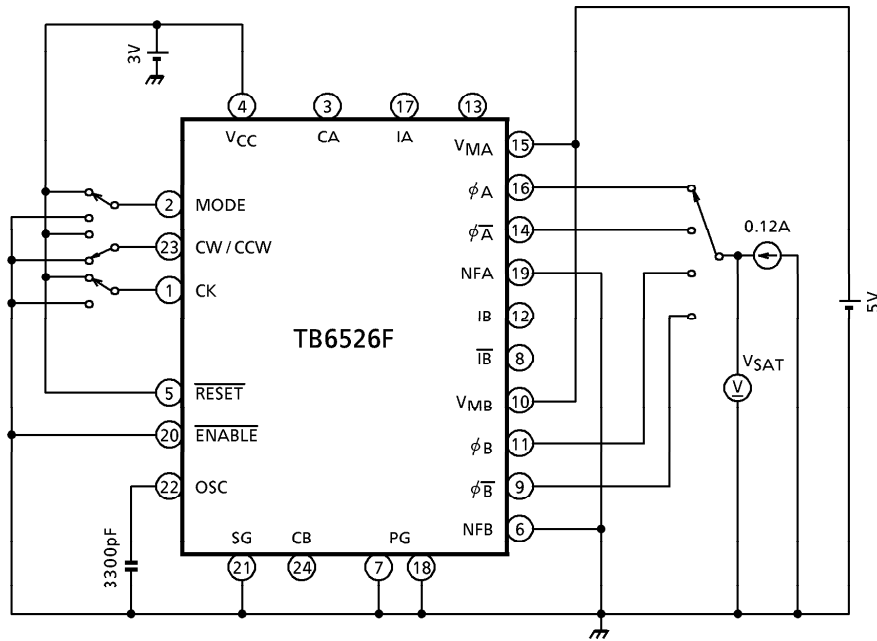
TEST CIRCUIT 5 :  $f_{OSC}$



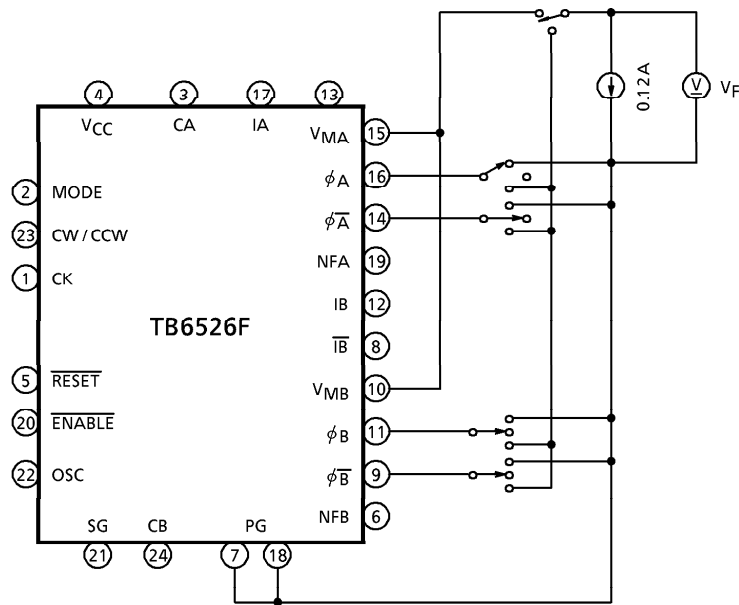
TEST CIRCUIT 6 :  $I_U$



TEST CIRCUIT 7 :  $V_{SAT}$

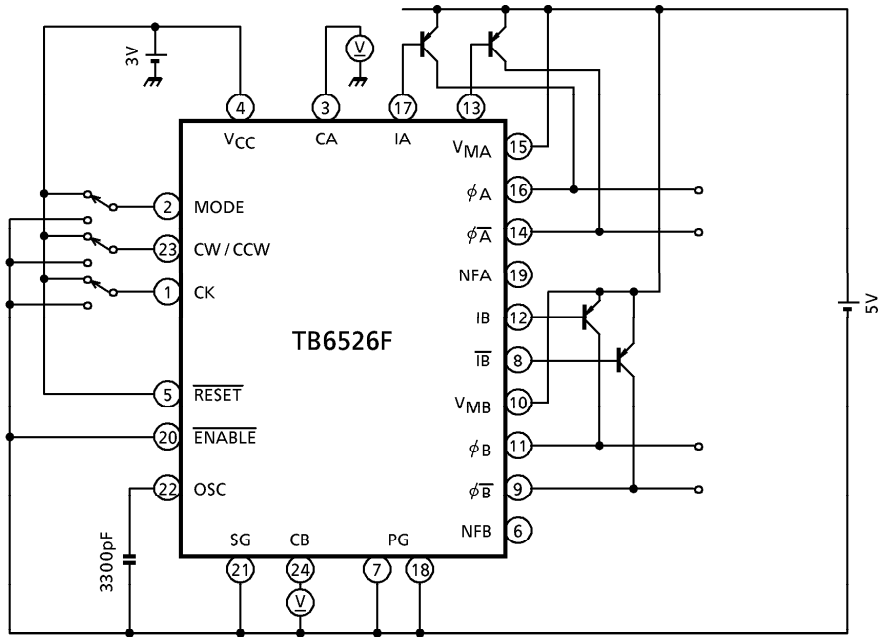


TEST CIRCUIT 8 :  $V_{F-U}$ ,  $V_{F-L}$

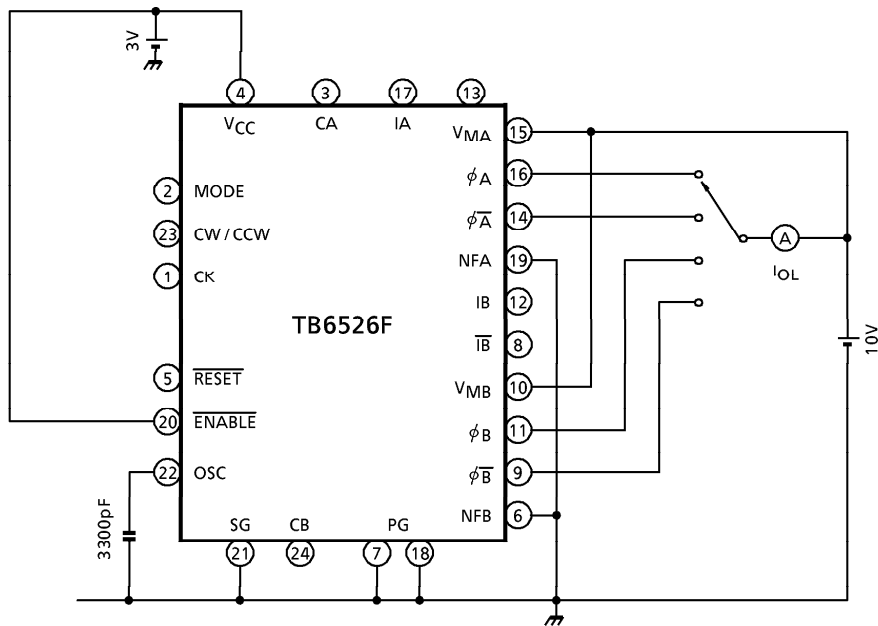


(Note) Not to take GND with any non-connecting pins.

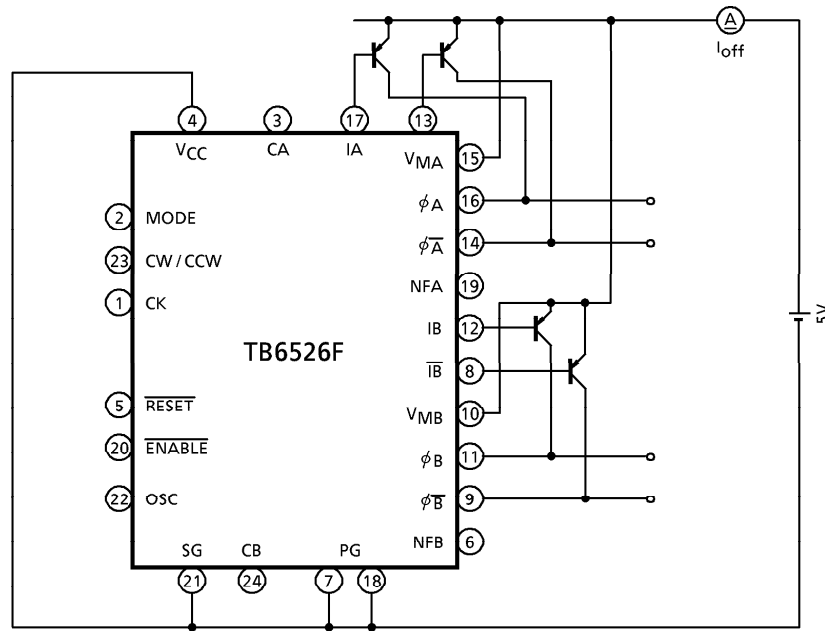
TEST CIRCUIT 9 :  $V_{NF1}$ ,  $\Delta V_{NF}$



TEST CIRCUIT 10 :  $I_{OL}$

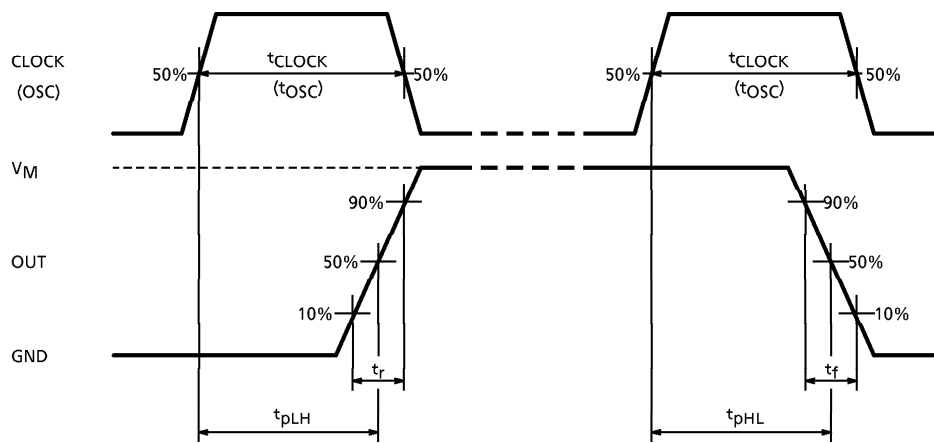


**TEST CIRCUIT 11**



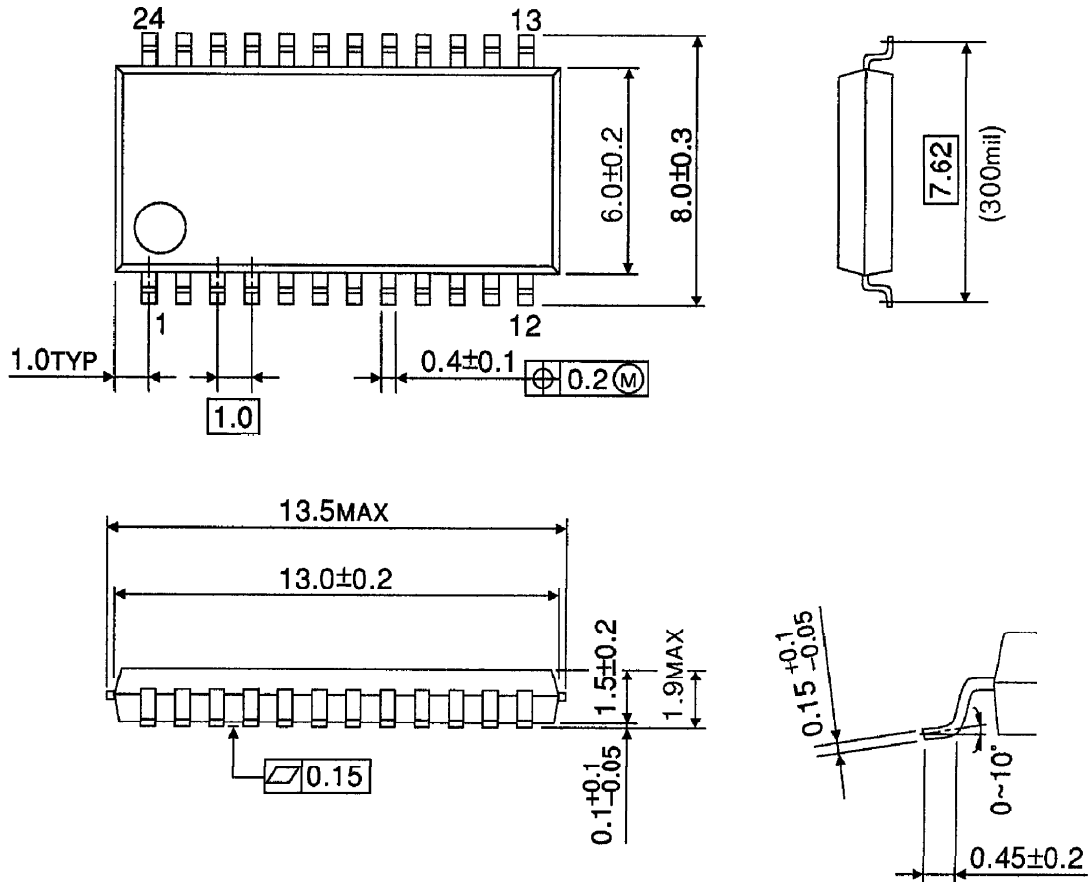
**AC ELECTRICAL CHARACTERISTICS, TEST CIRCUIT 12**

**CK (OSC) - OUT**



OUTLINE DRAWING  
SSOP24-P-300-1.00B

Unit : mm



Weight : 0.27g (Typ.)