

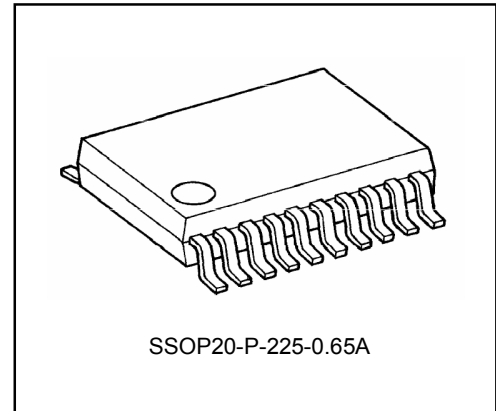
TOSHIBA BiCMOS INTEGRATED CIRCUIT SILICON MONOLITHIC FOR AUTOMOTIVE USE

T B 9 0 0 1 F N G

5 V Voltage Regulator with Watchdog Timer

The TB9001FNG is specially designed for microcomputer systems. The IC features low standby current, oscillator function for CPU sub-clock and various system reset functions.

With external power transistor, TB9001FNG can supply high output current. As a protective feature, current limiter function is incorporated. For system reset includes low voltage reset, power-on reset, and watchdog timer functions.



Weight : 0.1g(typ.)

FEATURES

- Accurate output : 5.0V \pm 0.15V
- Low current consumption : 95 μ A (VIN=12V, Ta=25°C) at 5V output + reset timer + 32kHz sub-clock
- Reset functions : Low voltage reset / power on reset / watchdog timer
- Current limiter : Adjustable with external resistor
- Operating temperature : -40~125°C
- Small SMD package : SSOP-20pin

About solderability, the following conditions were confirmed.

Solderability

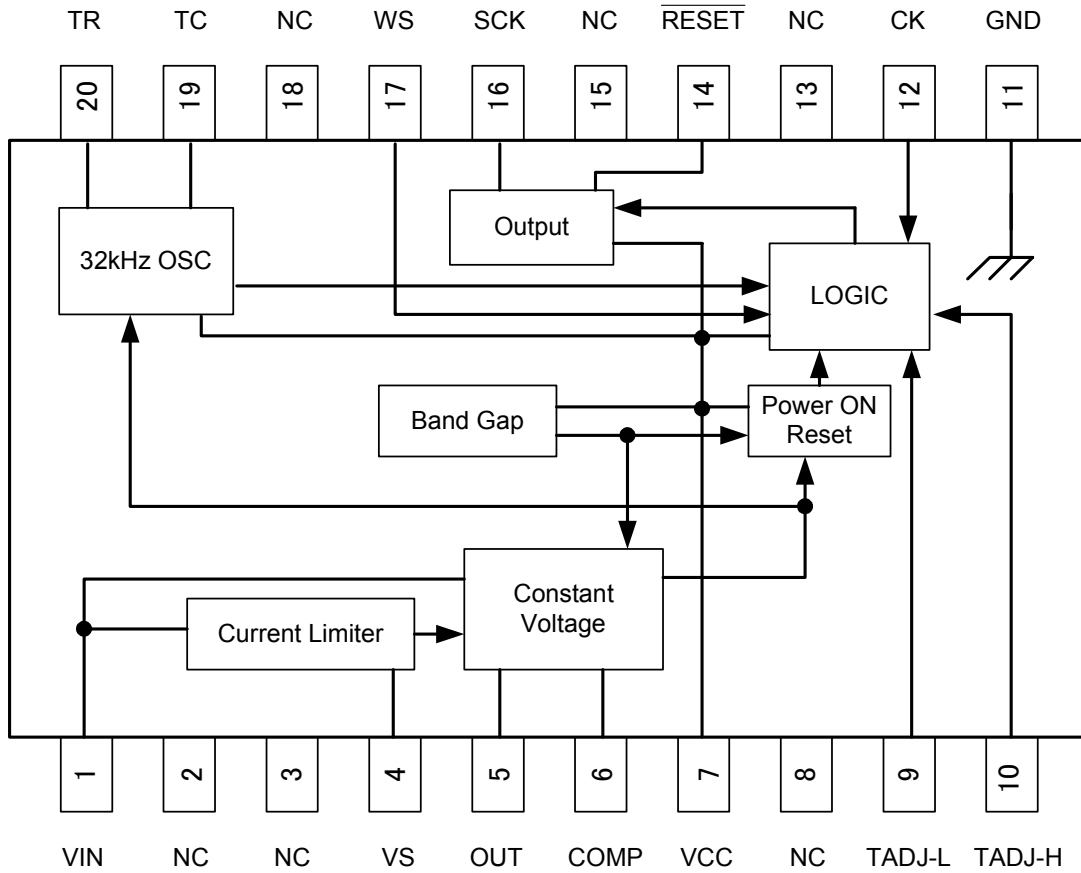
(1) Use of Sn-37Pb solder Bath

- solder bath temperature = 230°C
- dipping time = 5 seconds
- the number of times = once
- use of R-type flux

(2) Use of Sn-3.0Ag-0.5Cu solder Bath

- solder bath temperature = 245°C
- dipping time = 5 seconds
- the number of times = once
- use of R-type flux

BLOCK DIAGRAM AND PIN LAYOUT



Note: Some of the functional blocks, circuits, or constants in the block diagram are omitted or simplified to clarify the descriptions of the relevant features.

PIN DESCRIPTION

| PIN No. | SYMBOL | DESCRIPTION |
|---------------------|--------|--|
| 1 | VIN | Power supply input pin. It contains current limiter and startup circuit. |
| 4 | Vs | Detection pin for the Vcc current limiter. This pin monitors any voltage drop occurring in the external resistor Rs between pins VIN and Vs, and the current limiter is actuated when the voltage drop exceeds 0.7 V. Ex.) When the current limiter need to be actuated at a load current of 250mA, $R_s = 0.7 \text{ V} / 250 \text{ mA} = 2.8 \Omega$ |
| 5 | OUT | This pin is used to connect the base of an external PNP transistor. The output voltage is controlled by an internal op-amp to keep it stable at 5 V. Since the recommended current of Iout is 5 mA, an output current of 300mA can be run if the HFE of the external transistor is 60 or more. |
| 6 | COMP | Phase compensating pin for Vcc. Connect a phase compensating capacitor between pin Vcc and this pin. |
| 7 | Vcc | Voltage detection pin for the 5 V constant-voltage power supply, Vcc. This pin also supplies power to the reset timer circuit. |
| 9 | TADJ-L | Time setup pins for the reset and watchdog timers. For a 32 kHz sub-clock, the time is set by combinations of TADJ-L and TADJ-H. (These pins must be connected to Vcc or 0V because of logic input.) |
| 10 | TADJ-H | <ul style="list-style-type: none"> ● TADJ-H = Vcc , TADJ-L = Vcc : TPOR = 50ms , TWD = 50ms , TRST = 5ms ● TADJ-H = Vcc , TADJ-L = 0V : TPOR = 200ms , TWD = 100ms , TRST = 10ms ● TADJ-H = 0V , TADJ-L = Vcc : TPOR = 50ms , TWD = 25ms , TRST = 2.5ms ● TADJ-H = 0V , TADJ-L = 0V : TPOR = 100ms , TWD = 50ms , TRST = 5ms |
| 11 | GND | Grounded |
| 12 | CK | Clock input pin for the watchdog timer. This pin detects rising edge of the input signal and does not require external coupling capacitor. |
| 14 | RESET | Reset output pin for power on reset and watchdog timer. <ul style="list-style-type: none"> ● Generates a reset signal that is determined by sub-clock and TADJ pins. ● If no clock is fed to the CK input, this pin generates a reset pulse intermittently. This is an N-MOS drain output with 100 kΩ pull-up resistor. |
| 16 | SCK | Sub-clock output pin for CPU. |
| 17 | WS | Watchdog timer function ON / OFF control pin. Set to "Low" for active mode and "High" for Inactive mode. |
| 19 | TC | Time setup pin for sub-clock. Connect capacitor CT to GND. The time is set using the internal constant current from TR pin. |
| 20 | TR | Time setup pin for sub-clock. Connect resistor RT between TC pin and TR pin. |
| 2, 3, 8, 13, 15, 18 | NC | Not connected. (Electrically, these pins are completely open.) |

Functional Description

· Sub-Clock Oscillation Circuit

This IC has a built-in sub-clock function the basic circuit configuration of which comprises a CR charge-discharge circuit and a detection circuit for oscillator abnormalities. The sub-clock is also used as the source oscillation frequency for the timer functions: power on reset, watchdog, and reset.

Basic Operation

The resistor R_T which sets the charge-and-discharge current, is connected between TC and TR pins, and the capacitor C_T is connected between TC and GND pins. The TC pin is repeatedly charged and discharged between VCC04 and VCC06. If TC pin or TR pin is shorted to Vcc or GND, the $\overline{\text{RESET}}$ signal goes to LOW.

External Resistor and Capacitor

VCC06 : $V_{cc} \times 0.6$

VCC04 : $V_{cc} \times 0.4$

$$f_{osc} (\text{Hz}) = 1 / ((t_1 + t_2) \times 2)$$

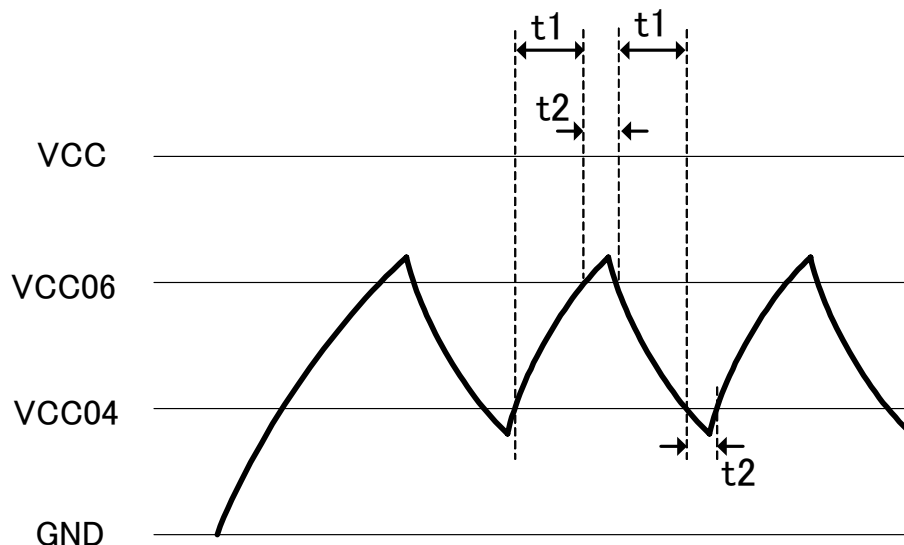
$$t_1 = R_T \times C_T \times \ln(V_{CC06} / V_{CC04})$$

$$t_2 = \text{Delay time of internal circuit} \approx 1\mu\text{s}$$

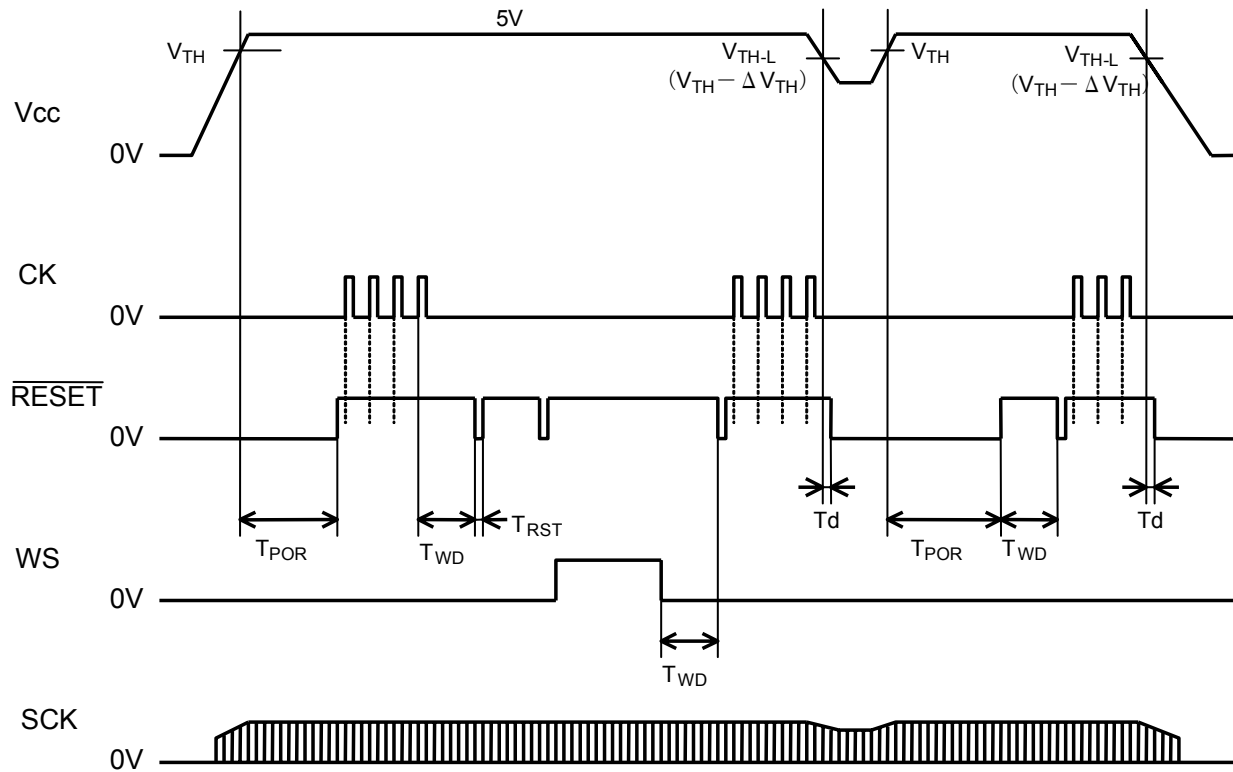
[Example] $C_T = 75\text{pF}$, $R_T = 480\text{k}\Omega$

$$t_1 = 480 \text{ k}\Omega \times 75 \text{ pF} \times \ln(3 \text{ V} / 2 \text{ V}) = 14.6 \mu\text{s}$$

$$f_{osc} = 1 / ((14.6 \mu\text{s} + 1 \mu\text{s}) \times 2) \approx 32.05 \text{ kHz}$$



TIMING CHART



Note1: See ELECTRICAL CHARACTERISTICS about symbols in timing charts.

Note2: Timing charts may be simplified to clarify the descriptions of features and operations.

ABSOLUTE MAXIMUM RATING ($T_a=25^\circ\text{C}$)

| CHARACTERISTIC | SYMBOL | PIN | RATING | UNIT |
|-----------------------|------------|-------------------------------|----------|------------------|
| Input Voltage | V_{IN1} | V_{IN}, V_S | 45 (1s) | V |
| | V_{IN2} | V_{CC} | 6.0 | |
| | V_{IN3} | CK, WS, TC, TADJ-H, TADJ-L | V_{CC} | |
| Output Current | I_{OUT1} | OUT | 5 | mA |
| | I_{OUT2} | RESET | 5 | |
| | I_{OUT3} | SCK | ± 1 | |
| Output Voltage | V_{OUT1} | OUT | 45 (1s) | V |
| | V_{OUT2} | RESET, SCK | V_{CC} | |
| Operating Temperature | T_{opr} | - | -40~125 | $^\circ\text{C}$ |
| Storage Temperature | T_{stg} | - | -55~150 | $^\circ\text{C}$ |

Note: The absolute maximum ratings of a semiconductor device are a set of specified parameter values that must not be exceeded during operation, even for an instant.

If any of these levels is exceeded during operation, the electrical characteristics may be irreparably altered and the reliability and lifetime of the device can no longer be guaranteed, possibly causing damage to any other equipment with which it is used. Applications using the device should be designed so that the absolute maximum ratings will never be exceeded in any operating conditions.

Ensuring that the parameter values remain within these specified ranges during device operation will help to ensure that the integrity of the device is not compromised.

ELECTRICAL CHARACTERISTICS (VIN=6~16V , ILOAD=10mA , Ta=-40~125°C)

| CHARACTERISTIC | SYMBOL | PIN | TEST CONDITION | MIN. | TYP. | MAX. | UNIT |
|---------------------------|---------|----------|-------------------------------|---------|----------|--------|------|
| Output Voltage | VREG | Vcc | Ta=-40~105°C | 4.85 | 5.0 | 5.15 | V |
| | | | Ta=-40~125°C | 4.82 | 5.0 | 5.15 | |
| Line Regulation | VLINE | Vcc | VIN=6~40V | - | 0.1 | 0.5 | % |
| Load Regulation | VLOAD | Vcc | ILOAD=1~200mA | - | 0.2 | 1.0 | % |
| Temperature Coefficient | - | Vcc | | - | 0.01 | - | %/°C |
| Output Voltage | VOL | RESET | IOL=2mA | - | - | 0.3 | V |
| Output Leakage Current | ILEAK | RESET | VIN(RESET)=Vcc | - | - | 5 | μA |
| Threshold Voltage | VIH | TC | | - | Vcc X60% | - | V |
| | VIL | | | - | Vcc X40% | - | |
| Input Current | IIN | TADJ-H/L | VIN(TADJ-H/L)=0~Vcc | -5 | - | 5 | μA |
| Input Voltage | VIH | TADJ-H/L | | 0.8Vcc | - | - | V |
| | VIL | | | - | - | 0.2Vcc | |
| Input Current | IIN | CK | VIN(CK)=0~Vcc | -5 | - | 5 | μA |
| Input Voltage | VIH | CK | | 0.8Vcc | - | - | V |
| | VIL | | | - | - | 0.2Vcc | |
| Input Current | IIN | WS | VIN(WS)=0~Vcc | -5 | - | 5 | μA |
| Input Voltage | VIH | WS | | 0.8Vcc | - | - | V |
| | VIL | | | - | - | 0.2Vcc | |
| Output Voltage | VOH | SCK | IOH=-1mA | Vcc-0.5 | - | - | V |
| | VOL | | IOL=+1mA | - | - | 0.5 | |
| Current Limiter Detection | VLIMIT | Vcc | | 0.385 | 0.7 | 0.945- | V |
| Current Consumption | Icc | - | Ta=25°C (VIN = 12V) *1 | - | 95 | 140 | μA |
| | | | Ta=-40~125°C (VIN = 12V) *1 | - | 95 | 150 | |
| Reset Detection Voltage | VTH-L | Vcc | Hys | 4.22 | 4.40 | 4.55 | V |
| | ΔVTH | | | 0.05 | 0.15 | 0.25 | |
| Power On Reset | TPOR-HH | RESET | TADJ-H=Vcc, -L=Vcc | 42.5 | 50.0 | 57.5 | ms |
| | TPOR-HL | | TADJ-H=Vcc, -L=0V | 170 | 200 | 230 | |
| | TPOR-LH | | TADJ-H=0V, -L=Vcc | 42.5 | 50.0 | 57.5 | |
| | TPOR-LL | | TADJ-H=0V, -L=0V | 85 | 100 | 115 | |
| Watchdog Timer | TWD-HH | RESET | TADJ-H=Vcc, -L=Vcc | 42.5 | 50.0 | 57.5 | ms |
| | TWD-HL | | TADJ-H=Vcc, -L=0V | 85 | 100 | 115 | |
| | TWD-LH | | TADJ-H=0V, -L=Vcc | 21.25 | 25.00 | 28.75 | |
| | TWD-LL | | TADJ-H=0V, -L=0V | 42.5 | 50.0 | 57.5 | |
| Reset Timer | TRST-HH | RESET | TADJ-H=Vcc, -L=Vcc | 4 | 5 | 6 | ms |
| | TRST-HL | | TADJ-H=Vcc, -L=0V | 8 | 10 | 12 | |
| | TRST-LH | | TADJ-H=0V, -L=Vcc | 2 | 2.5 | 3 | |
| | TRST-LL | | TADJ-H=0V, -L=0V | 4 | 5 | 6 | |
| Reset Delay Time | td | RESET | | - | 10 | - | μs |
| Oscillator | fosc | SCK | *1 | 27.2 | 32.0 | 36.8 | kHz |
| Clock Pulse Width | Tw | CK | | 3 | - | - | μs |

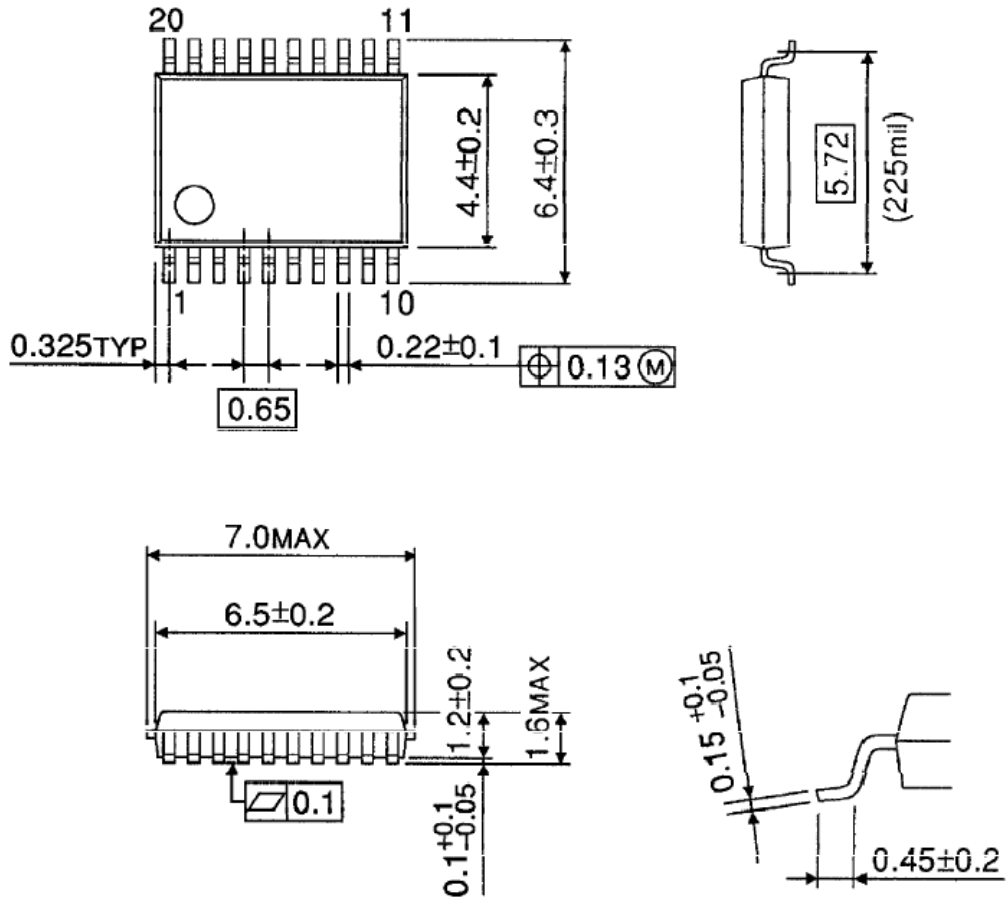
*1 : RT=480kΩ , CT=75pF

The rated value for current consumption is the value that applies when the load current ILOAD=0mA.

*2 : The rated oscillator frequency, power-on reset, watchdog timer and reset timer values are guaranteed only for the IC itself and do not include any variation caused by external CT and RT components. Such variation should be taken into account in the practical application of the IC.

PACKAGE DIMENSION

Unit : mm



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