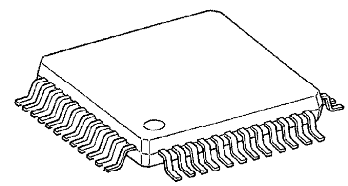
TOSHIBA Bi-CMOS INTEGRATED CIRCUIT SILICON MONOLITHIC

# TB6508F

## CYLINDER MOTOR CONTROL DRIVER IC FOR VTR MOVIE

The TB6508F is a 3 Phase, Low Noise, Low Voltage, Sensorless Motor Control IC for VTR Movie.
The Outputs (10mA Max.) drive external PNP / NPN Power transistors.
Small outline (QFP-48) surface mount package enables to design a compact cylinder drive system.



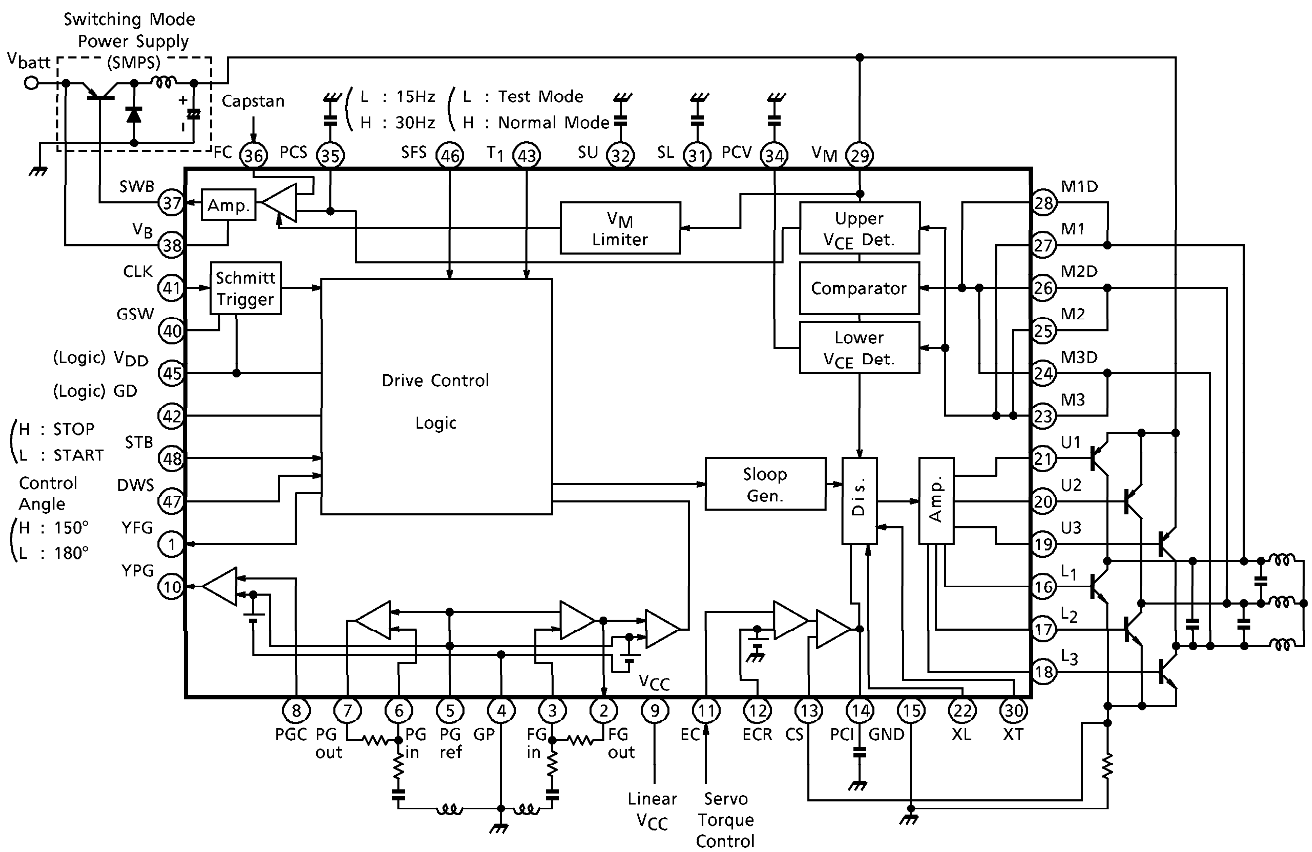
LQFP48-P-0707-0.50

Weight : 0.17g (Typ.)

### FEATURES

- Operating Supply Voltage : $V_{CC}$ = 3.2~5.5V
- Motor Supply Voltage : $V_M$ = 3.0~12V
- Low Noise Type. : Soft Switching Drive
  : Quasi-Linear Driving Wave form generator
- Internal Functions
- Switching Mode Power Supply Control Circuit
- Torque Signal Input
- FG Amp.
- PG Amp.

## BLOCK DIAGRAM




## PIN FUNCTION

| PIN No. | SYMBOL | FUNCTIONAL DESCRIPTION | PIN No. | SYMBOL | FUNCTIONAL DESCRIPTION |
|---|---|---|---|---|---|
| 1 | YFG | FG Processed Output | 15 | GND | GND Terminal |
| 2 | $FG_{out}$ | FG Amp. Output | 16 | $L_1$ | Lower Side Pre Drive Output 1 |
| 3 | $FG_{in}$ | FG Input | 17 | $L_2$ | Lower Side Pre Drive Output 2 |
| 4 | GP | PG GND | 18 | $L_3$ | Lower Side Pre Drive Output 3 |
| 5 | $PG_{ref}$ | FG·PG Reference Voltage | 19 | U3 | Upper Side Pre Drive Output 3 |
| 6 | $PG_{in}$ | PG Input | 20 | U2 | Upper Side Pre Drive Output 2 |
| 7 | $PG_{out}$ | PG Amp. Output | 21 | U1 | Upper Side Pre Drive Output 1 |
| 8 | PGC | PG Comparator Input | 22 | XL | Conduction Angle Fine Adj. (1) |
| 9 | $V_{CC}$ | Linear Power Supply | 23 | M3 | Motor Coil Terminal 3 |
| 10 | YPG | PG Waveform Output | 24 | M3D | Motor Back Electromotive Force In |
| 11 | EC | Torque Control Input | 25 | M2 | Motor Coil Terminal 2 |
| 12 | ECR | Torque Control Reference Input | 26 | M2D | Motor Back Electromotive Force In |
| 13 | CS | Current Detection Terminal | 27 | M1 | Motor Coil Terminal 1 |
| 14 | PCI | Current Feed Back Phase Comp. | 28 | M1D | Motor Back Electromotive Force In |

| PIN No. | SYMBOL | FUNCTIONAL DESCRIPTION | PIN No. | SYMBOL | FUNCTIONAL DESCRIPTION |
|---|---|---|---|---|---|
| 29 | $V_M$ | Motor Supply Terminal | 39 | N.C. | Non Connection |
| 30 | XT | Conduction Angle Fine Adj. (2) | 40 | GSW | SMPS Supply GND |
| 31 | SL | Upper Side Slope Voltage | 41 | CLK | Clock Input |
| 32 | SU | Lower Side Slope Voltage | 42 | GD | Logic GND |
| 33 | N.C. | Non Connection | 43 | $T_1$ | Test Mode Switch |
| 34 | PCV | Voltage Feed Back Compensation | 44 | N.C. | Non Connection |
| 35 | PCS | SENSE Compensation | 45 | $V_{DD}$ | Logic Power Supply |
| 36 | FC | Reference Slope Input | 46 | SFS | Start Frequency Selector |
| 37 | SWB | SMPS Drive Output | 47 | DWS | Conduction Angle Selection |
| 38 | $V_B$ | Unregulated Supply Voltage | 48 | STB | Stand-by Switch Input |

**MAXIMUM RATINGS** (Ta = 25°C)

| CHARACTERISTIC | SYMBOL | RATING | UNIT |
|---|---|---|---|
| Supply Voltage | $V_{CC}$ | 6 | V |
| Motor Supply Voltage | $V_M$ | 14 | V |
| Switching Supply Voltage | $V_B$ | 14 | |
| Supply Input / Output Voltage | $V_{SWB}$ | 14 | |
| Output Terminal Voltage | $V_N$ | 14 (Note 1) | V |
| Input Terminal Voltage | $V_I$ | $-0.3 \sim V_{CC}+0.3$ (Note 2) | V |
| Power Dissipation | $P_D$ | 300 (Note 3) | mW |
| Operating Temperature | $T_{opr}$ | −20~75 | °C |
| Storage Temperature | $T_{stg}$ | −55~125 | °C |

Recommended Supply Voltage
$V_{CC} = 5V$

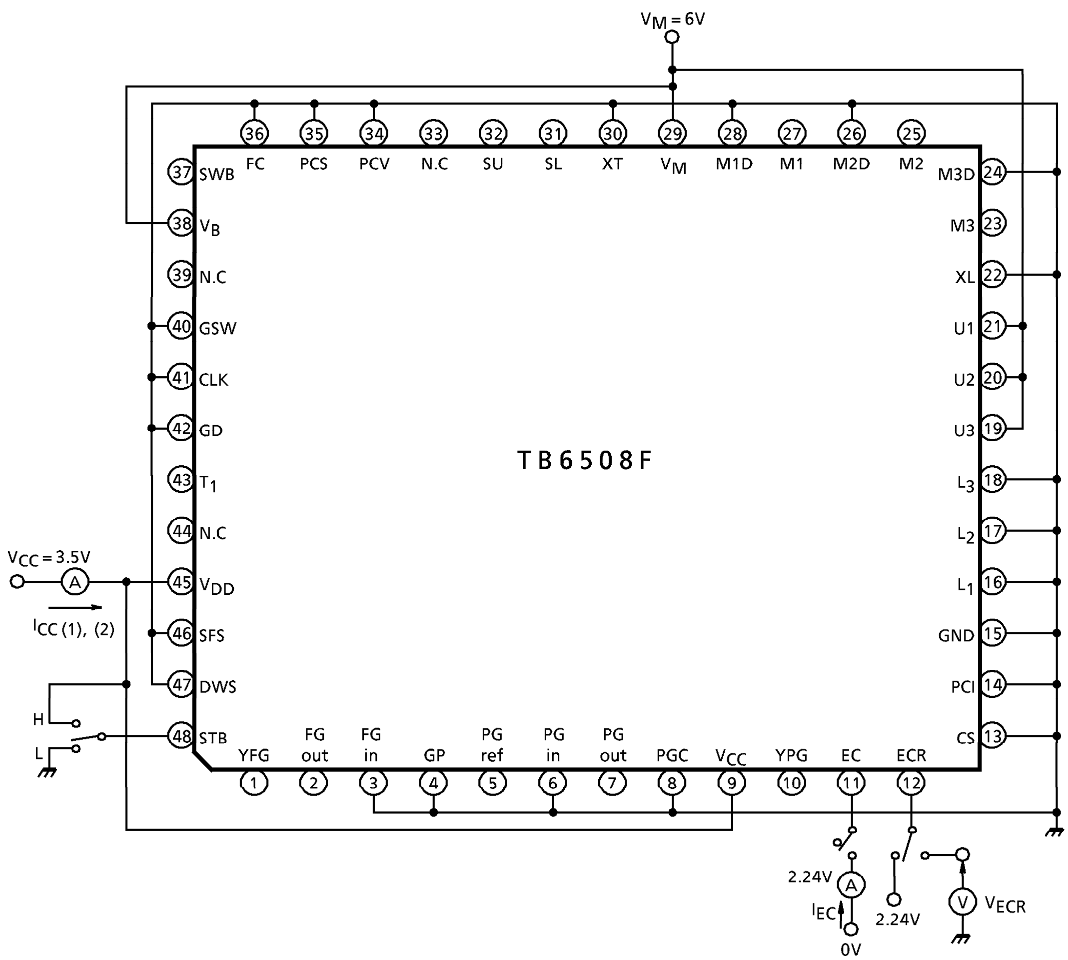
(Note 1) N = 19, 20, 21, 23, 24, 25, 27 and 28.
(Note 2) I = 3, 5, 6, 10, 11, 12, 13, 22, 30, 33, 36, 41, 43, 46, 47 and 48.
(Note 3) Mounted on a 50mm × 50mm × 1.6mm PCB with 50% Copper area coverage.

**ELECTRICAL CHARACTERISTICS** (Unless otherwise specified, Ta = 25°C, $V_{CC}$ = 3.5V)
Recommended nominal supply voltage $V_{CC}$ is 5V. Following electrical characteristics is to assure low voltage operation.

| No. | CHARACTERISTIC | SYMBOL | TEST CIR-CUIT | TEST CONDITION | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|---|---|
| 1 | Supply Current (1) | $I_{CC (1)}$ | 1 | Operational | — | — | 20 | mA |
| 2 | Supply Current (2) | $I_{CC (2)}$ | 1 | STB mode | — | — | 6 | mA |
| 3 | ETR Voltage | $V_{ECR}$ | 1 | — | 2.14 | 2.24 | 2.54 | V |
| 4 | Torque Control Input Current | $I_{EC}$ | 1 | EC = 0V | −5 | — | — | μA |
| 5 | Torque Cont. Input Offset Vol | $\Delta EC$ | 2 | — | −100 | — | 100 | mV |
| 6 | Input / Output Gain | $G_{io}$ | 2 | — | −17.72 | −16.48 | −15.39 | dB |
| 7 | Max. Output Voltage | CSmax | 2 | $R_{CS} = 0.27\Omega$ | 136 | 151 | 174 | mV |
| 8 | Low Side Output Voltage (1) | $V_{L (1)}$ | 3 | $V_{CS}$ = 54mV | 0.2 | — | 0.6 | V |

| No. | CHARACTERISTIC | SYMBOL | TEST CIR-CUIT | TEST CONDITION | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|---|---|
| 9 | Low Side Output Voltage (2) | $V_{L\ (2)}$ | 3 | ECR = 2.24V, EC = 0V | 0.45 | — | 0.85 | V |
| 10 | Upper Side Drive Current | $I_U$ | 4 | — | — | — | − 10 | mA |
| 11 | Low Side Drive Current | $I_L$ | 4 | — | 10 | — | — | mA |
| 12 | PCS Operation Point | $V_{PCS\ (1)}$ | 5 | EC = ECR = 2.24V<br>$V_{PCS}$ = 1.75V | 0.26 | 0.37 | 0.48 | V |
| 13 | PCS Operation Point | $V_{PCS\ (2)}$ | 5 | EC = 0V, ECR = 2.24V<br>$V_{PCS}$ = 1.75V | 0.43 | 0.62 | 0.81 | V |
| 14 | PCS Gain | $G_{PCS}$ | 5 | — | 13.06 | 16.26 | 18.59 | dB |
| 15 | SMPS Drive Current (1) | $I_{SW\ (1)}$ | 5 | VM1 = 6V<br>EC = ECR = 2.24V | 3 | — | — | mA |
| 16 | SMPS Drive Current (2) | $I_{SW\ (2)}$ | 5 | VM1 = 6V<br>EC = 0V, ECR = 2.24V | 11 | — | — | mA |
| 17 | SMPS Comparator ON Time | $t_{ON}$ | 5 | — | — | — | 1.0 | μs |
| 18 | SMPS Comparator OFF Time | $t_{OFF}$ | 5 | — | — | — | 1.0 | μs |
| 19 | SMPS Comparator Offset Voltage | $\Delta V_{FC}$ | 5 | — | − 5 | — | 25 | mV |
| 20 | FG Amp. Gain | $G_{FG}$ | 6 | $V_{p\text{-}p}$ = 1.5mV<br>f = 1kHz | 45 | — | — | dB |
| 21 | YFG High Level | YFG (H) | 7 | $I_{YFG}$ = − 100μA | 2.0 | — | — | V |
| 22 | YFG Low Level | YFG (L) | 7 | $I_{YFG}$ = 100μA | — | — | 1.5 | V |
| 23 | PG Amp. Gain | $G_{PG}$ | 6 | $V_{p\text{-}p}$ = 1.5mV,<br>f = 1kHz | 45 | — | — | dB |
| 24 | PG Amp. Offset Voltage | $\Delta PG_{in}$ | 7 | — | 0.45 | 0.5 | 0.6 | V |
| 25 | YPG High Level | YPG (H) | 7 | $I_{YPG}$ = − 10μA | 2.0 | — | — | V |
| 26 | YPG Low Level | YPG (L) | 7 | $I_{YPG}$ = 100μA | — | — | 1.0 | V |
| 27 | Stand-by Voltage | $STB_{on}$ | 8 | — | 2.15 | — | — | V |
| 28 | Stand-by Release Voltage | $STB_{off}$ | 8 | — | — | — | 1.0 | V |
| 29 | Stand-by Input Current | $I_{STB}$ | 8 | $V_{STB}$ = 0V | − 100 | — | — | μA |
| 30 | Conduction Angle Selector Control Voltage Q = 180° | DWS (L) | 9 | — | — | — | 1.05 | V |
| 31 | Conduction Angle Selector Control Voltage Q = 150° | DWS (H) | 9 | — | 2.45 | — | — | V |
| 32 | Starting Frequency Selector Control Voltage f = 15Hz | SFS (L) | 10 | — | — | — | 1.05 | V |
| 33 | Starting Frequency Selector Control Voltage f = 30Hz | SFS (H) | 10 | — | 2.45 | — | — | V |

**TEST CIRCUIT 1**




No.1

Set STB = 0V, EC = 2.24V, and ECR = 2.24V, then measure the current to the $V_{CC}$ pin.

No.2

Set STB = 3.5V, EC = 2.24V, and ECR = 2.24V, then measure the current to the $V_{CC}$ pin.

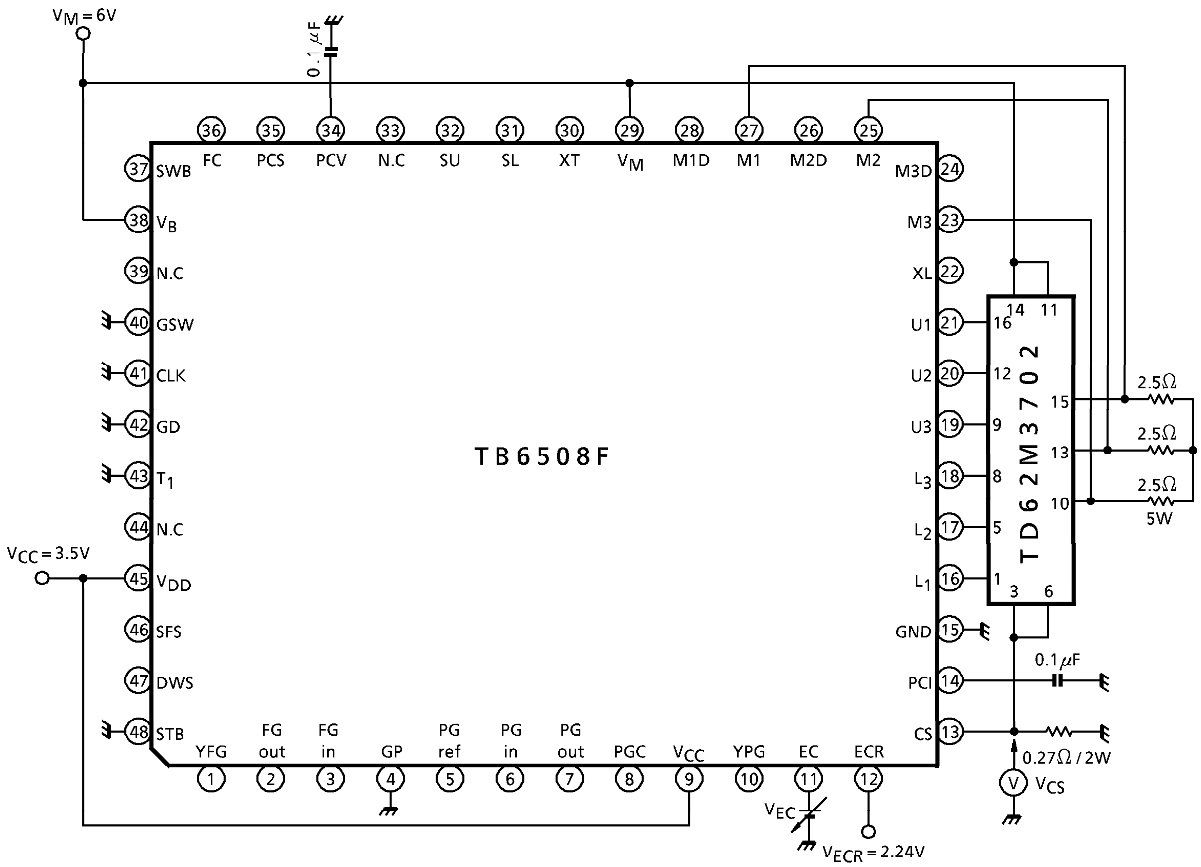
No.3

Measure the voltage potential of pin⑫.

No.4

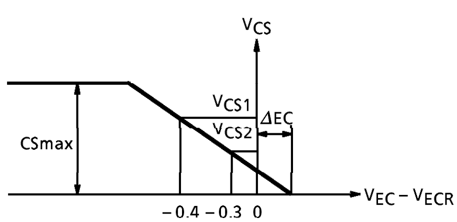
Set EC = 0V, ECR = 2.24V, then measure the current to pin⑪.

**TEST CIRCUIT 2**




No.5, 6, 7

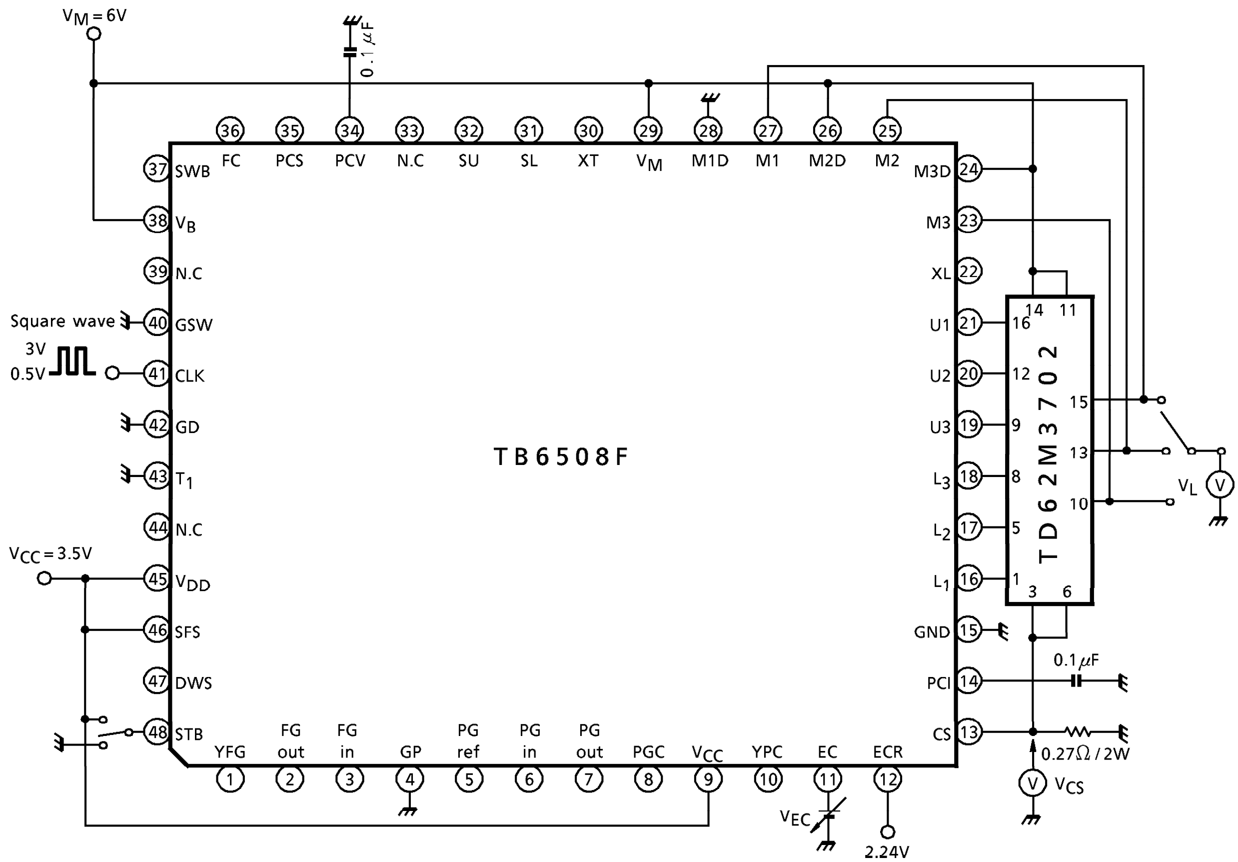
Set $V_{ECR} = 2.24V$, change $V_{EC}$ from 0V to 3V, then measure the voltage potential of $V_{CS}$.




$$\Delta EC = V_{EC} - V_{ECR} \ (V_{CS} = 0V)$$

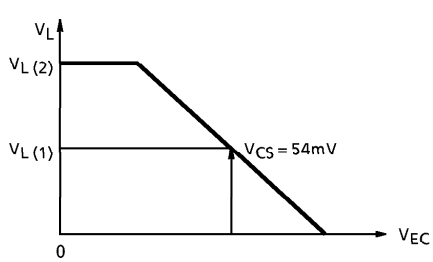
$$G_{io} = \frac{V_{CS1} - V_{CS2}}{0.1V}$$

**TEST CIRCUIT 3**



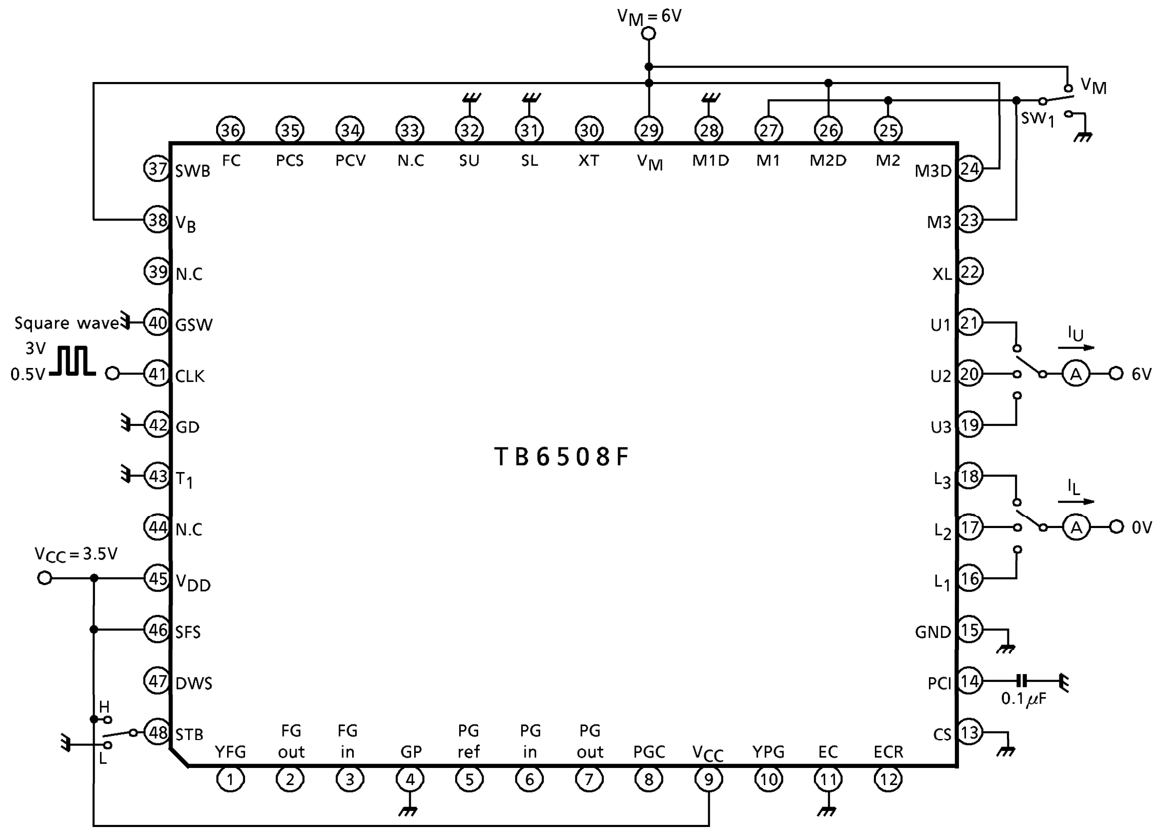

No.8, 9

To set the drive angle, change the STB terminal (pin 48) from high to low.
Then input the number of clocks indicated below to the CLK terminal (pin 41).




| CLOCK | 50 | 200 | 300 |
|---|---|---|---|
| Terminal | M3 | M1 | M2 |

**TEST CIRCUIT 4**

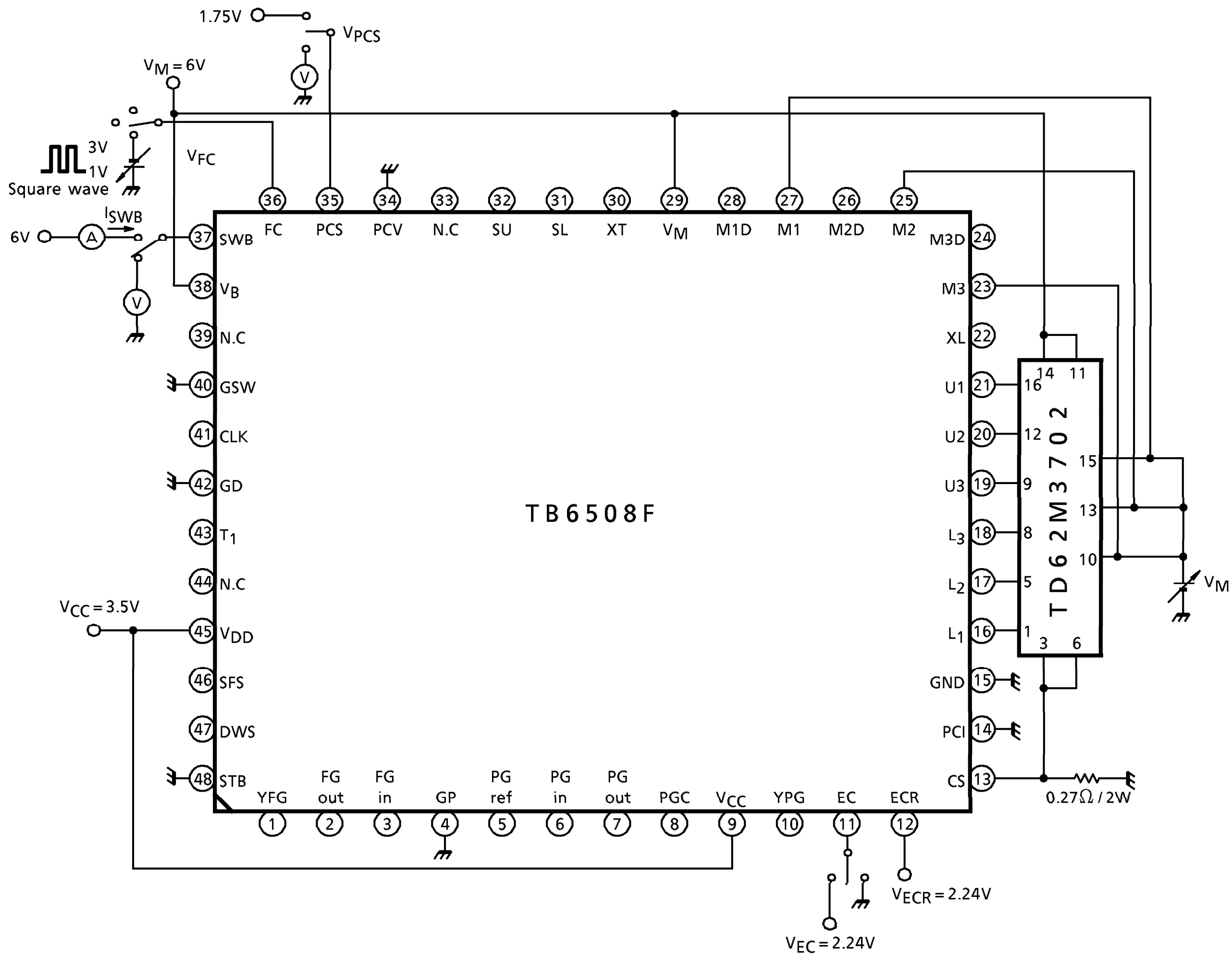



No.10, 11

To set the drive angle, change the STB terminal (pin 48) from high to low.
Then input the number of clocks indicated below to the CLK terminal (pin 41).

| CLOCK | 50 | | 150 | | 280 | |
|---|---|---|---|---|---|---|
| Terminal | $I_{U1}$ | $I_{L3}$ | $I_{U2}$ | $I_{L1}$ | $I_{U3}$ | $I_{L2}$ |
| SW1 | 0V | $V_M$ | 0V | $V_M$ | 0V | $V_M$ |

## TEST CIRCUIT 5




No.12

Set $V_{EC} = 2.24V$, then measure $V_{M1}$ when $V_{PCS} = 1.75V$.

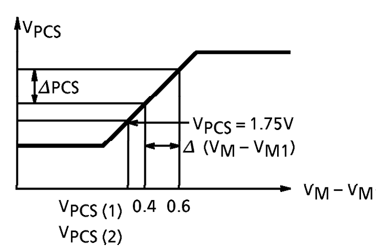
No.13

Set $V_{EC} = 0V$ then measure $V_{M1}$ when $V_{PCS} = 1.75V$.

No.14

Set $V_{EC} = 2.24V$, $V_{ECR} = 2.24V$ and $V_M = 6V$, then determine $G_{PCS}$ from the amount $V_{PCS}$ voltage varies when ($V_M$-$V_{M1}$) changes from 0.4V to 0.6V.

$$G_{PCS} = \frac{\Delta PCS}{\Delta\ (V_M - V_{M1})}$$



No.15

Set FC = 3V, EC = 2.24V, and ECR = 2.24, then measure the current to 37.

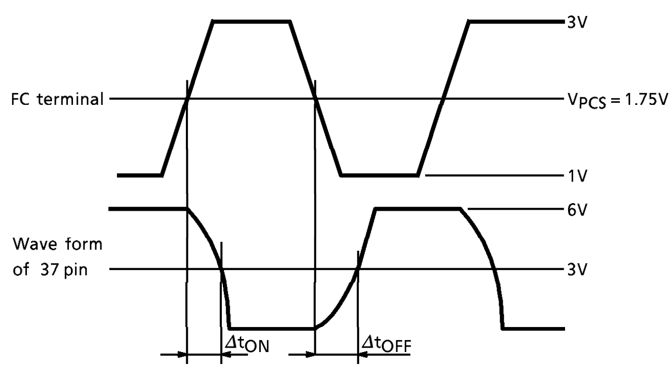
No.16

Set FC = 3V, EC = 0V, and ECR = 2.24V, then measure the current to 37.

No.17, 18

Input a square wave from FC terminal.

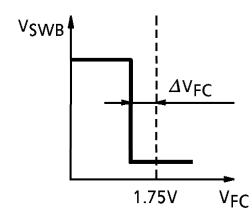
Set $V_{PCS}$ = 1.75V



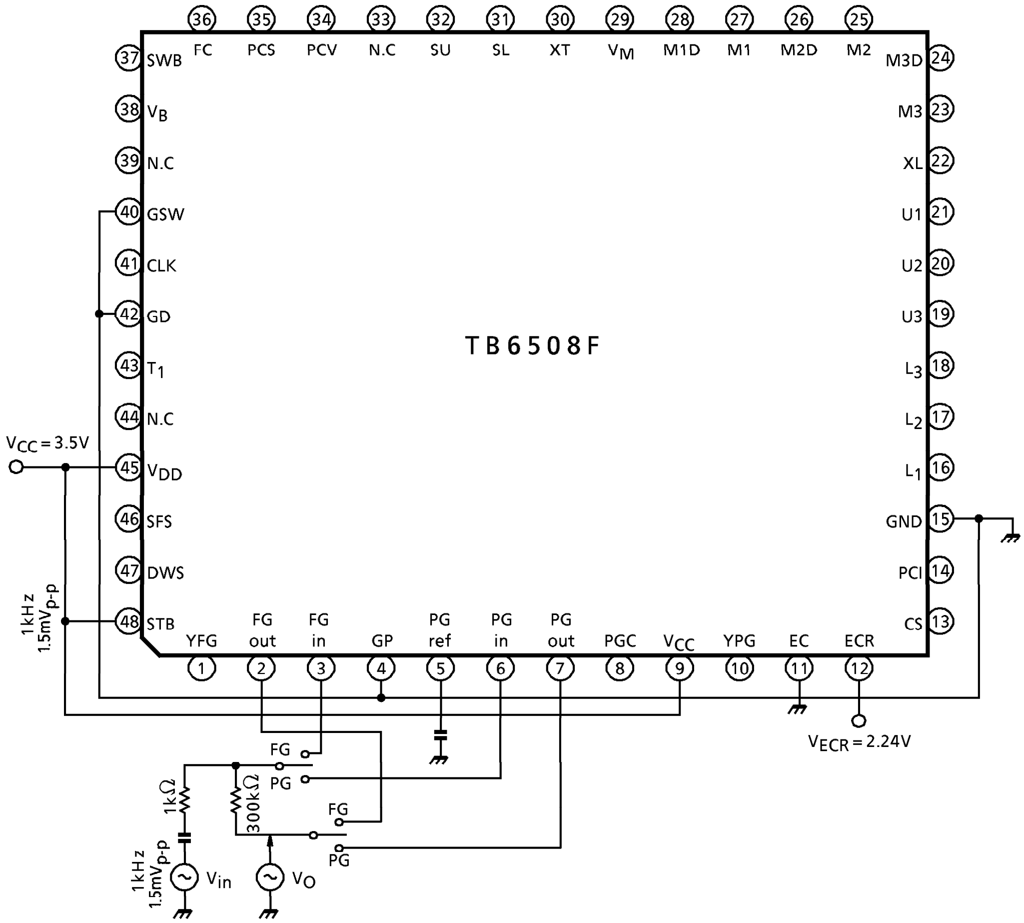

No.19

Set $V_{PCS}$ = 1.75V, change $V_{FC}$

$\Delta V_{FC} = V_{PCS} - V_{FC}$



**TEST CIRCUIT 6**



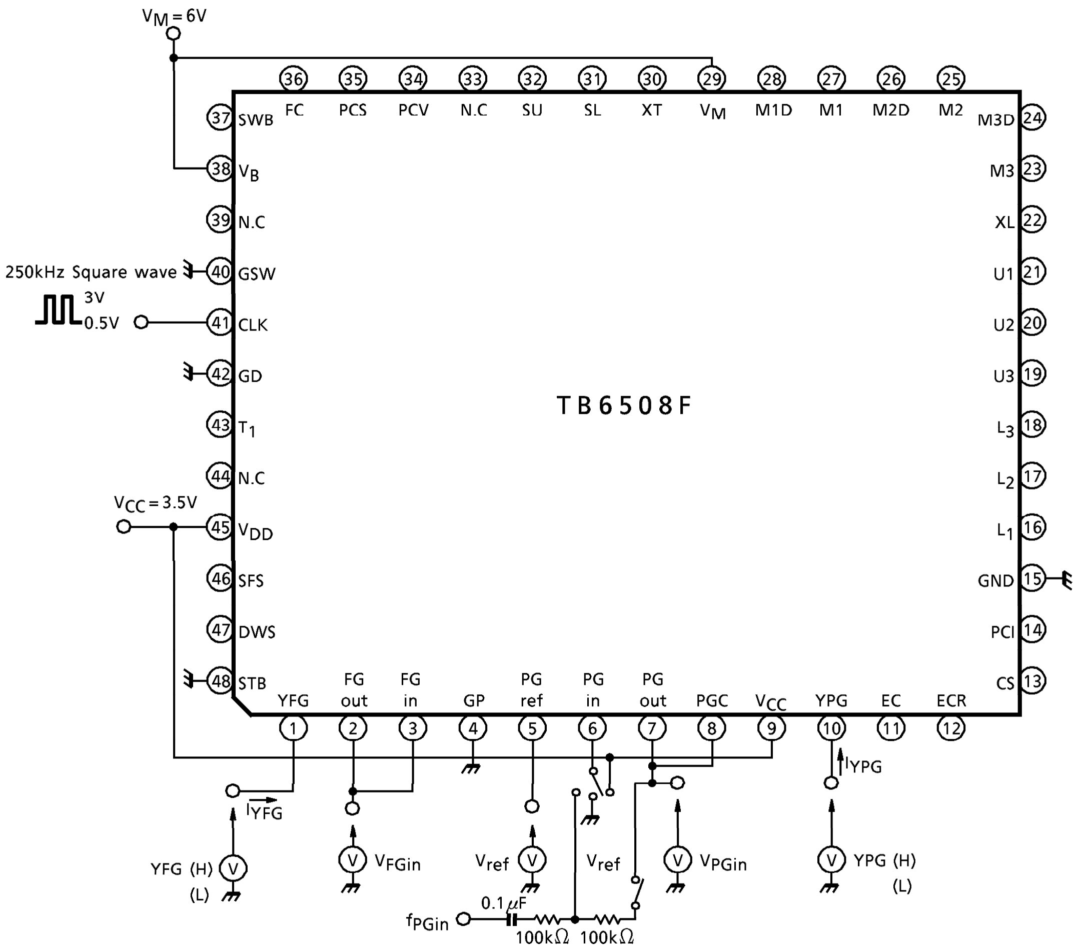

No.20

Set SW to FG, then determine $G_{FG} = 20\ell og\ (V_O / V_{IN})$ by measuring.
$V_O$ when $V_{IN} = 1.5mV_{p\text{-}p}$, 1kHz.

No.23

Set SW to PG, then determine $G_{PG} = 20\ell og\ (V_O / V_{IN})$ by measuring $V_O$ when $V_{IN} = 1.5mV_{p\text{-}p}$, 1kHz.

**TEST CIRCUIT 7**

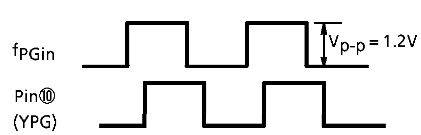



No.24

Input a 10kHz square wave from $f_{PGin}$, Set $f_{PGin}$ to $1.2V_{p\text{-}p}$ ($\Delta PG_{in} = 0.6V$) and check that ⑩ is active.
Also, set $V_{p\text{-}p}$ to 0.9V ($\Delta PG_{in} = 0.45V$) and check that pin is not active.

No.21

Set YFG to high then measure the YFG voltage potention when a current of $I_{YFG} = -100\mu A$ is obtained.




No.22

Set YFG to low then measure the YFG voltage potential when measure a current of $I_{YFG} = -100\mu A$.

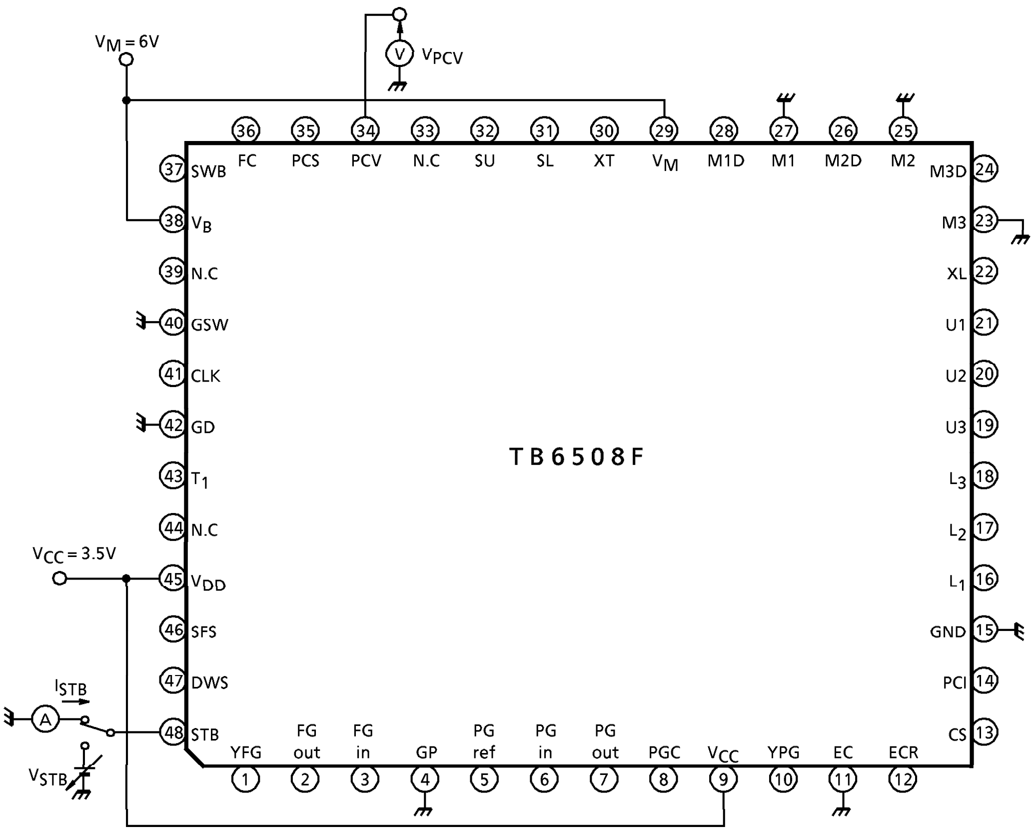
No.25

Set PG into Low and set YPG to High, then measure the YFG voltage potential when a current of $I_{YFG} = 100\mu A$ is obtained.

No.26

Set PG into high and set YPG to low then measure the YPG voltage potential when a current of $I_{YPG} = 100\mu A$ is obtained.

**TEST CIRCUIT 8**

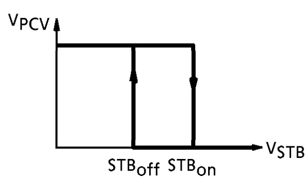



No.27, 28

Change $V_{STB}$ from 0V to 3.5V, and from 3.5V to 0V, then measure the $V_{PCV}$.

$V_{STB}$ is $STB_{on}$, when change $V_{PCV}$ from high to Low.

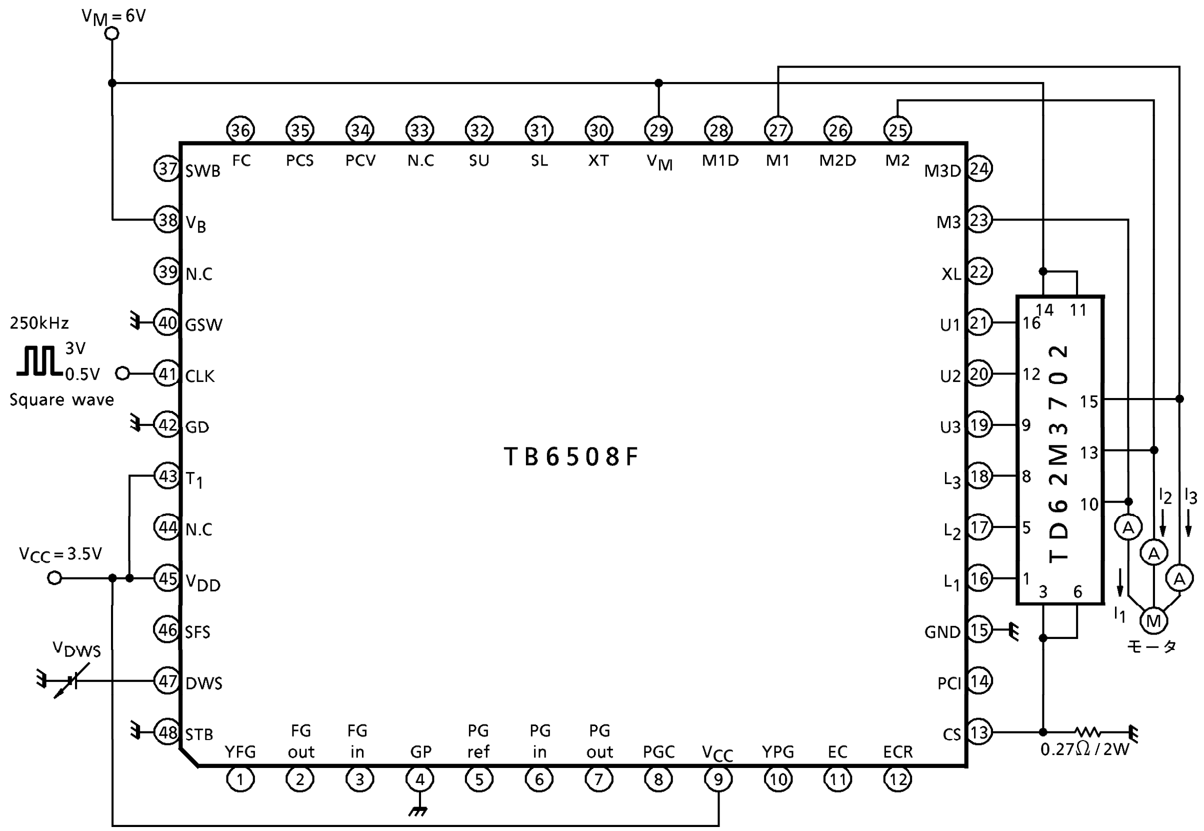
$V_{STB}$ is $STB_{on}$, when change $V_{PCV}$ from high to low.




No.29

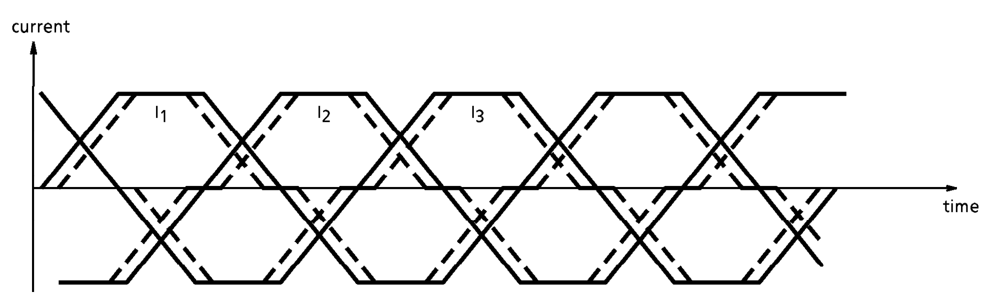
Measure the $I_{STB}$ when $V_{STB} = 0V$

**TEST CIRCUIT 9**

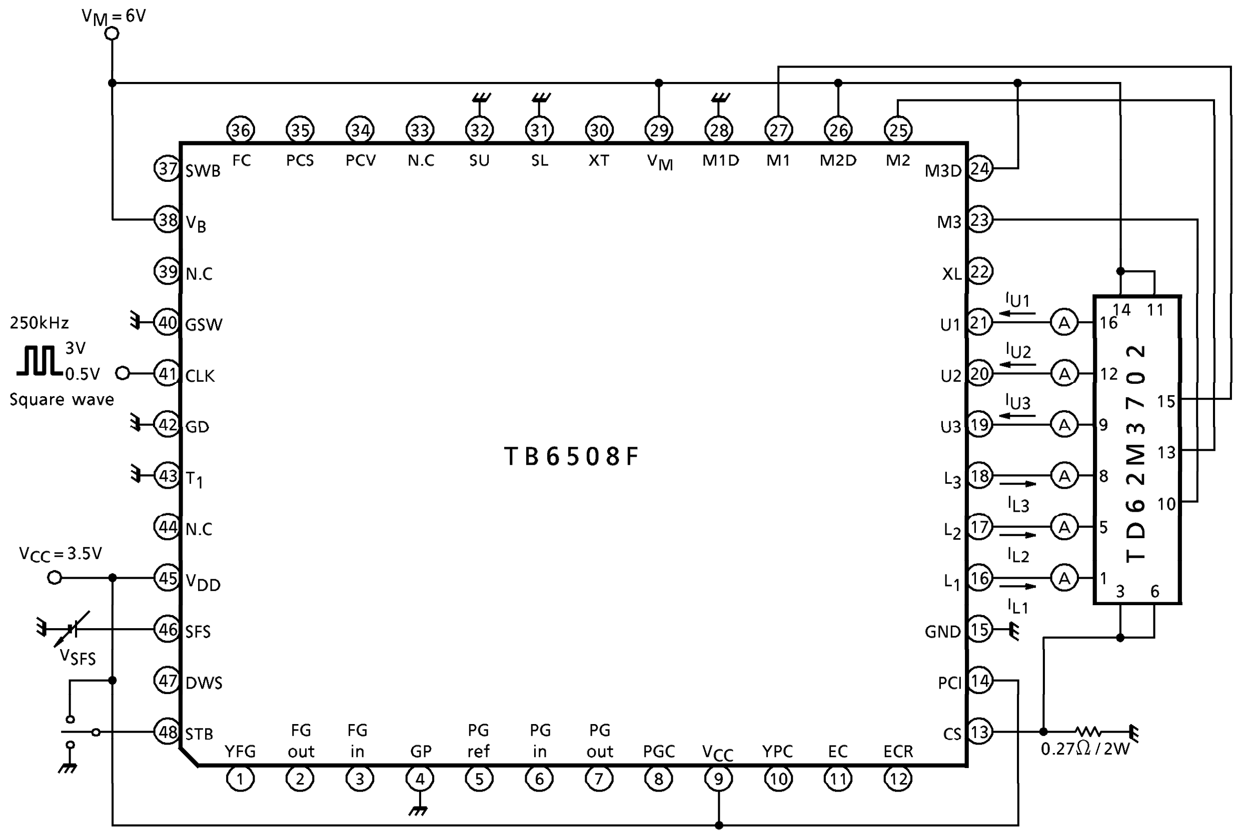



No.30, 31

Changes $V_{DWS}$ from 0V to 3.5V while the motor is running, and measures the changes of $I_1$, $I_2$, and $I_3$.
The continuous lines in the diagram are DWS (L) at 180° or, while the dotted lines are DWS (H) at 150° on.



## TEST CIRCUIT 10




No.32, 33

Change $V_{SFS}$ to 0V and to 3.5V, then measure the current of $I_{U1\sim3}$ and $I_{L1\sim3}$.

Fig.1 Case of SFS (L)-15Hz.

Fig.2 Case of SFS (H)-30Hz.

SFS-L (15Hz)

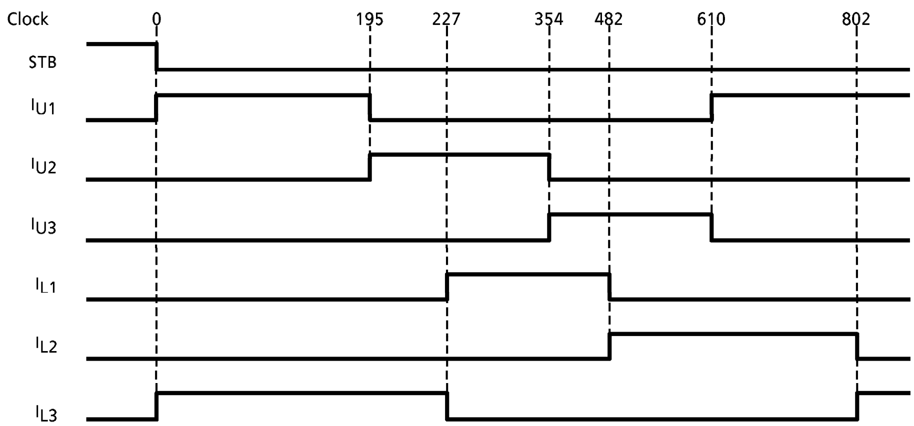



Fig.1 SFS (L)

SFS-H (30Hz)

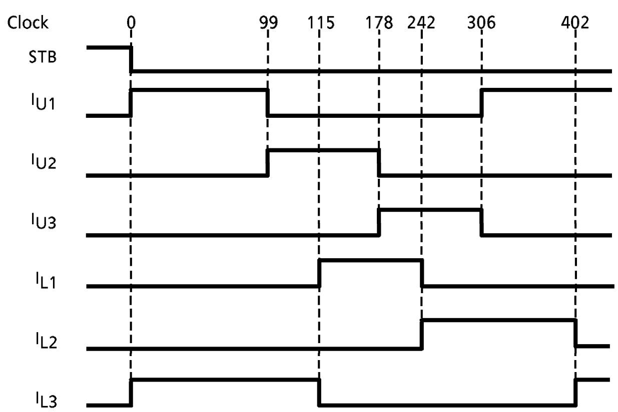
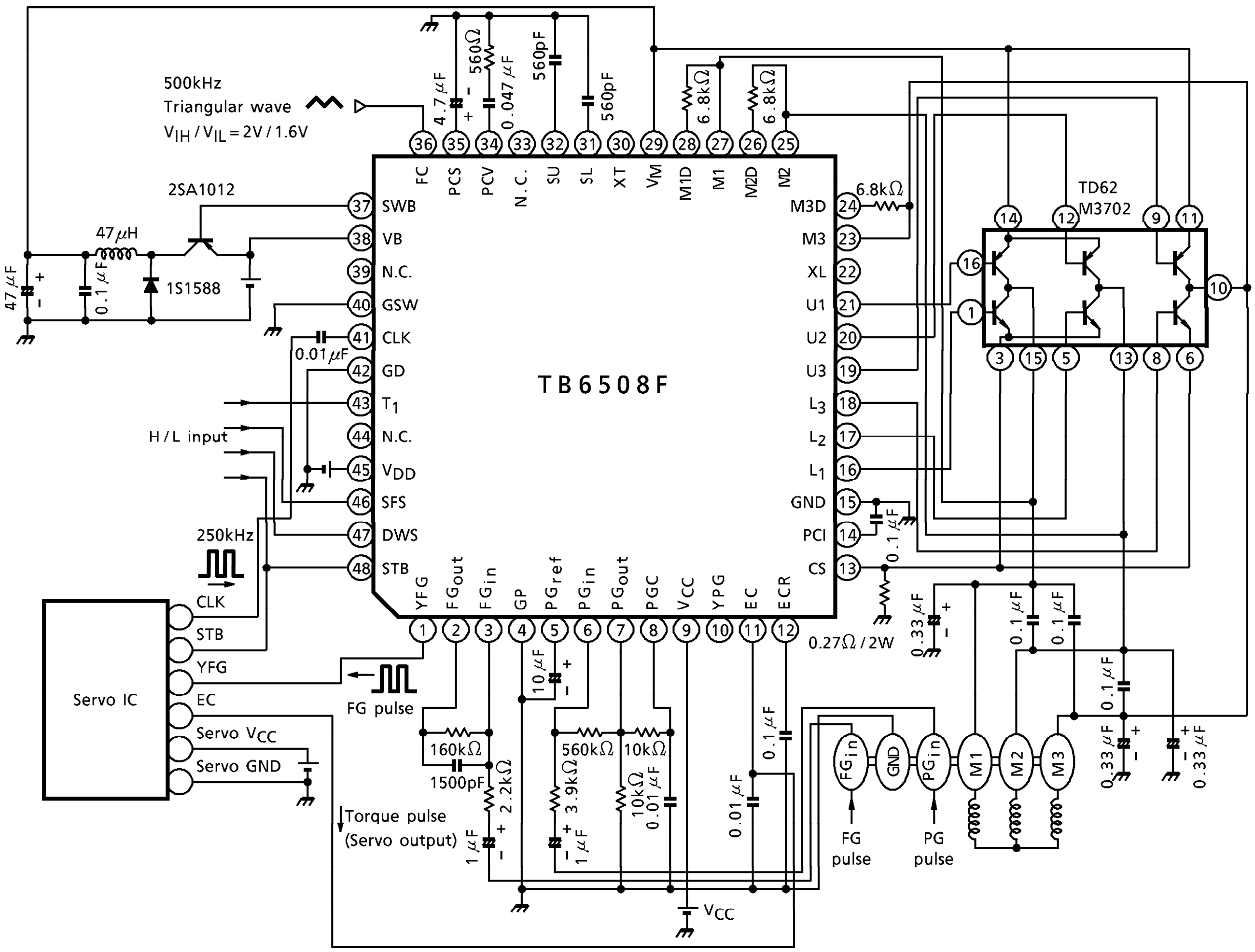



Fig.2 SFS (H)

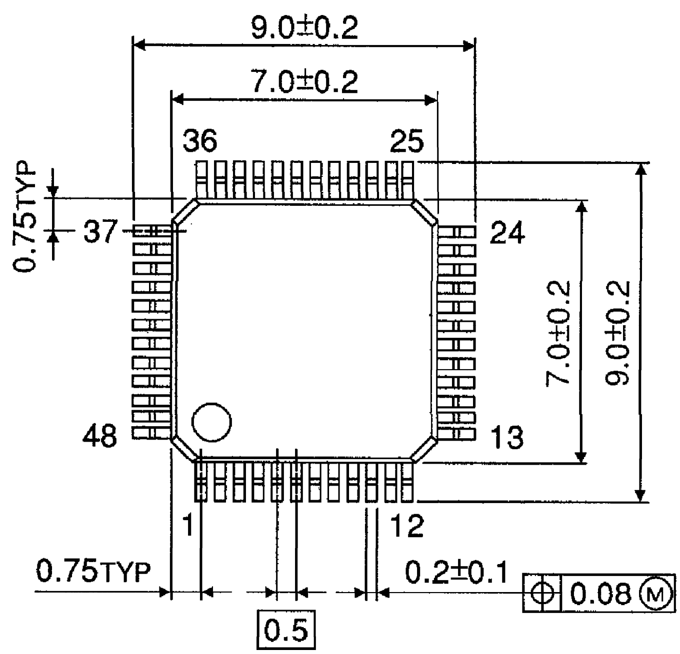
## APPLICATION CIRCUIT

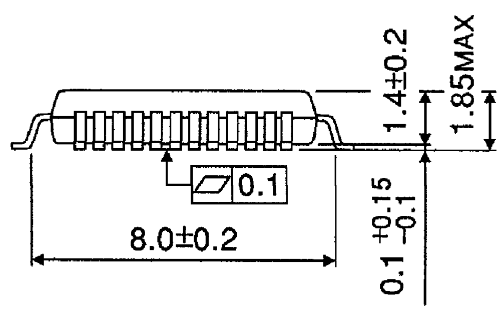


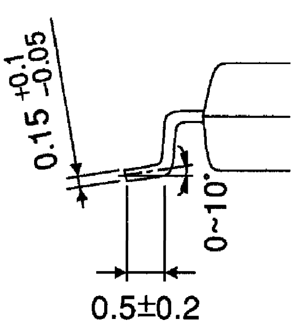
**OUTLINE DRAWING**

LQFP48-P-0707-0.50

Unit : mm




Weight : 0.17g (Typ.)