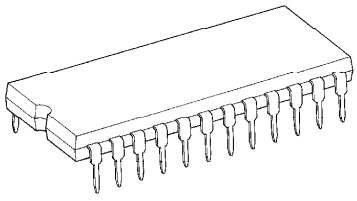
TOSHIBA Bi-CMOS INTEGRATED CIRCUIT SILICON MONOLITHIC

TB6528P

FIVE-PHASE STEPPING MOTOR DRIVE CONTROLLER

The TB6528P universal controller for stepping motor drives is a Bi-CMOS monolithic-type IC for controlling five-phase stepping motors.
This IC enables five-phase stepping motor drive units to be configured simply by preparing a pulse oscillator, a switching element and a direct current power source. This IC was developed in order to simplify the use of stepping motors.



DIP24-P-600-2.54

Weight : 3.38g (Typ.)

FEATURES

- Universal controller : The excitation mode switching terminal enables the selection of the following eight modes.
  Uni-polar type : 2 excitation, 2-3 excitation, 3 excitation
  Bi-polar type : 2-3 excitation, 3 excitation, 4 excitation, 4-5 excitation, 5 excitation
- Operating suplly voltage range : V_{CC} = 4~16V
- High-output current : 20mA min (source)
- High noise margin : All input pin are equipped with a Schmidt circuit.
- Two types of pulse input : 2 input pin method (CW and CCW input modes).
  1 input / 1 switching pin method (CK and U / D input modes).
  } Either of these can be selected.
- Power down function : All output is at the "L" level

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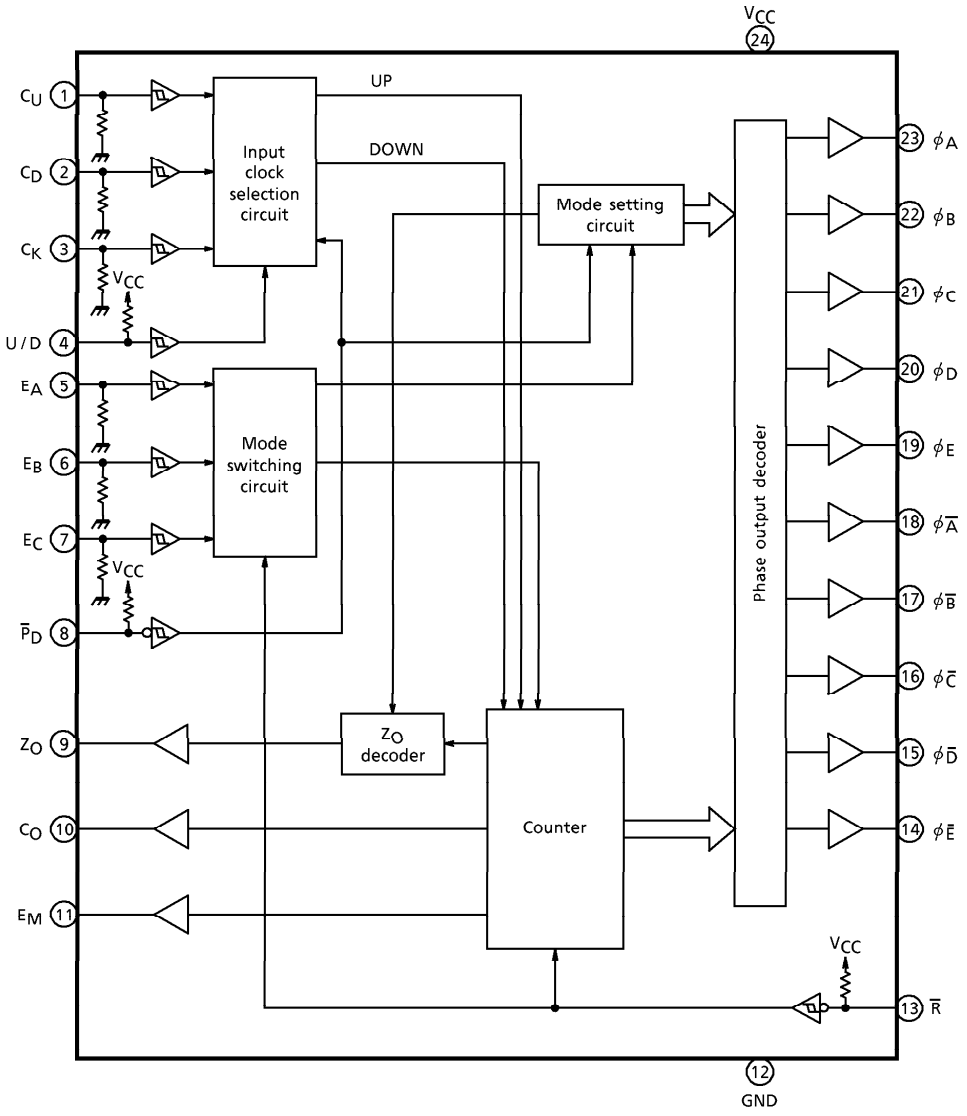
- Excitation mode protection function : No fluctuations in output even when switching excitation modes such as 2Ex↔2-3Ex↔3Ex, 4Ex↔4-5Ex↔5Ex.
- Reset function : Moves the phase home position across to the excitation status.
- Phase home position monitor : "H" level is output when at the phase home position (output in the reset mode).
- Excitation status identification monitor : The controller's operating status is output as a monitor signal.
- Input pulse monitor : The input is output as a monitor signal.

BLOCK DIAGRAM

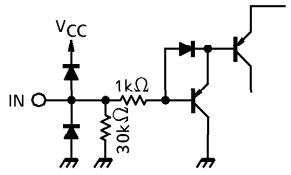


PIN FUNCTION

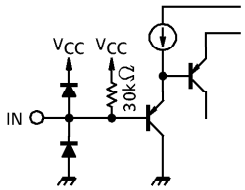
PIN No.	PIN SYMBOL	PIN FUNCTION	
1	C_U	Input pulse UP clock	Truth table A
2	C_D	Input pulse DOWN clock	
3	C_K	Input pulse clock	
4	U / D	Converts rotation directions "0" is DOWN, "1" is UP	
5	E_A	Excitation mode switching input	Truth table B
6	E_B		
7	E_C		
8	P_D	All output becomes "L" when power down is "L"	
9	Z_O	Phase home position monitor	
10	C_O	Input pulse monitor	
11	E_M	Excitation monitor	
12	GND	GND	
13	$\overline{R}$	Reset when the reset input is "L"	
14	ϕ_E	ϕ_E Output	
15	ϕ_D	ϕ_D Output	
16	ϕ_C	ϕ_C Output	
17	ϕ_B	ϕ_B Output	
18	ϕ_A	ϕ_A Output	
19	ϕ_E	ϕ_E Output	
20	ϕ_D	ϕ_D Output	
21	ϕ_C	ϕ_C Output	
22	ϕ_B	ϕB Output	
23	ϕ_A	ϕA Output	
24	V_{CC}	V_{CC}	

EQUIVALENT I / O CIRCUIT

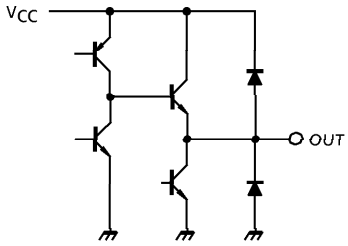
C_U, C_D, C_K



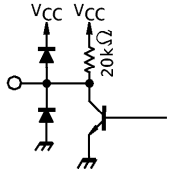
U / D, $\overline{P}_D$, $\overline{R}$



ϕ_A~ϕ_E and $\phi\overline{A}$~$\phi\overline{E}$



Z_O, C_O, E_M



TRUTH TABLE A

C_U	C_D	C_K	U / D	FUNCTION
↓	L	L	*	CW
L	↓	L	*	CCW
L	L	↓	H	CW
L	L	↓	L	CCW

(Note 1) * means Don't Care

(Note 2) The C_U pin is an input pin when counting up, and the C_D pin is an input pin when counting down.

(Note 3) The C_K pin is the count pulse input pin, and count-up and count-down is determined by the U / D pin.

TRUTH TABLE B

E_A	E_B	E_C	$\overline{R}$	$\overline{P}_D$	FUNCTION	EXCITATION TYPE
L	H	H	H	H	2 Excitation	Uni-polar type
L	L	H	H	H	2-3 Excitation	
H	L	H	H	H	3 Excitation	
H	H	L	H	H	2-3 Excitation	Bi-polar type
H	H	H	H	H	3 Excitation	
L	H	L	H	H	4 Excitation	
L	L	L	H	H	4-5 Excitation	
H	L	L	H	H	5 Excitation	

(Note 4) The output enters the initial status when $\overline{R}$ is set at the LOW level, and the Z_O output indicates the High level.

(Note 5) The input clock signal is prohibited and the phase output terminals ($\phi A \sim \phi E$ and $\phi\overline{A} \sim \phi\overline{E}$) enter the LOW level when $\overline{P}_D$ is set at the LOW level.
Z_O, C_O and E_M output is not prohibited.

FUNCTION 1 (Uni-polar type)

2 EXCITATION

PHASE \ PULSE	0 (RESET)	1	2	3	4	5
ϕ_A	H	L	L	L	H	H
ϕ_B	H	H	L	L	L	H
ϕ_C	L	H	H	L	L	L
ϕ_D	L	L	H	H	L	L
ϕ_E	L	L	L	H	H	L
$\phi_{\overline{A}}$	L	L	L	L	L	L
$\phi_{\overline{B}}$	L	L	L	L	L	L
$\phi_{\overline{C}}$	L	L	L	L	L	L
$\phi_{\overline{D}}$	L	L	L	L	L	L
$\phi_{\overline{E}}$	L	L	L	L	L	L
Z_O	H	L	L	L	L	H
E_M	L	L	L	L	L	L
UP	→					
DOWN	←					

2-3 EXCITATION

PHASE \ PULSE	0 (RESET)	1	2	3	4	5	6	7	8	9	10
ϕ_A	H	H	L	L	L	L	L	H	H	H	H
ϕ_B	H	H	H	H	L	L	L	L	L	H	H
ϕ_C	L	H	H	H	H	H	L	L	L	L	L
ϕ_D	L	L	L	H	H	H	H	H	L	L	L
ϕ_E	L	L	L	L	L	H	H	H	H	H	L
$\phi_{\overline{A}}$	L	L	L	L	L	L	L	L	L	L	L
$\phi_{\overline{B}}$	L	L	L	L	L	L	L	L	L	L	L
$\phi_{\overline{C}}$	L	L	L	L	L	L	L	L	L	L	L
$\phi_{\overline{D}}$	L	L	L	L	L	L	L	L	L	L	L
$\phi_{\overline{E}}$	L	L	L	L	L	L	L	L	L	L	L
Z_O	H	L	L	L	L	L	L	L	L	L	H
E_M	L	H	L	H	L	H	L	H	L	H	L
UP	→										
DOWN	←										

3 EXCITATION

PHASE \ PULSE	0 (RESET)	1	2	3	4	5
ϕ_A	H	H	L	L	H	H
ϕ_B	H	H	H	L	L	H
ϕ_C	L	H	H	H	L	L
ϕ_D	L	L	H	H	H	L
ϕ_E	H	L	L	H	H	H
$\phi_{\overline{A}}$	L	L	L	L	L	L
$\phi_{\overline{B}}$	L	L	L	L	L	L
$\phi_{\overline{C}}$	L	L	L	L	L	L
$\phi_{\overline{D}}$	L	L	L	L	L	L
$\phi_{\overline{E}}$	L	L	L	L	L	L
Z_O	H	L	L	L	L	H
E_M	H	H	H	H	H	H
UP	→					
DOWN	←					

FUNCTION 2 (Bi-polar type)
2-3 EXCITATION

PHASE \ PULSE	0 (RESET)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
$\phi_{A'}$	L	L	L	L	L	L	L	L	L	L	L	H	H	H	H	H	L	L	L	L	L
$\phi_{B'}$	H	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H	H	H
$\phi_{C'}$	L	L	L	H	H	H	H	H	L	L	L	L	L	L	L	L	L	L	L	L	L
$\phi_{D'}$	L	L	L	L	L	L	L	L	L	H	H	H	H	H	L	L	L	L	L	L	L
$\phi_{E'}$	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H	H	H	H	L
$\phi_{\overline{A}'}$	L	H	H	H	H	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
$\phi_{\overline{B}'}$	L	L	L	L	L	L	L	H	H	H	H	H	L	L	L	L	L	L	L	L	L
$\phi_{\overline{C}'}$	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H	H	H	H	L	L	L
$\phi_{\overline{D}'}$	H	H	H	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H
$\phi_{\overline{E}'}$	L	L	L	L	L	H	H	H	H	H	L	L	L	L	L	L	L	L	L	L	L
Z_O	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H
E_M	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L
UP	→																				
DOWN	←																				

3 EXCITATION

PHASE \ PULSE	0 (RESET)	1	2	3	4	5	6	7	8	9	10
$\phi A'$	L	L	L	L	L	L	H	H	H	L	L
$\phi B'$	H	H	L	L	L	L	L	L	L	H	H
$\phi C'$	L	L	H	H	H	L	L	L	L	L	L
$\phi D'$	L	L	L	L	L	H	H	H	L	L	L
$\phi E'$	H	L	L	L	L	L	L	L	H	H	H
$\phi \overline{A}'$	L	H	H	H	L	L	L	L	L	L	L
$\phi \overline{B}'$	L	L	L	L	H	H	H	L	L	L	L
$\phi \overline{C}'$	L	L	L	L	L	L	L	H	H	H	L
$\phi \overline{D}'$	H	H	H	L	L	L	L	L	L	L	H
$\phi \overline{E}'$	L	L	L	H	H	H	L	L	L	L	L
Z_O	H	L	L	L	L	L	L	L	L	L	H
E_M	H	H	H	H	H	H	H	H	H	H	H
UP	→										
DOWN	←										

4 EXCITATION

PHASE \ PULSE	0 (RESET)	1	2	3	4	5	6	7	8	9	10
ϕA	H	L	L	L	L	L	L	H	H	H	H
ϕB	H	H	L	L	L	L	L	L	H	H	H
ϕC	H	H	H	L	L	L	L	L	L	H	H
ϕD	H	H	H	H	L	L	L	L	L	L	H
ϕE	L	H	H	H	H	L	L	L	L	L	L
$\phi \overline{A}$	L	L	H	H	H	H	L	L	L	L	L
$\phi \overline{B}$	L	L	L	H	H	H	H	L	L	L	L
$\phi \overline{C}$	L	L	L	L	H	H	H	H	L	L	L
$\phi \overline{D}$	L	L	L	L	L	H	H	H	H	L	L
$\phi \overline{E}$	L	L	L	L	L	L	H	H	H	H	L
Z_O	H	L	L	L	L	L	L	L	L	L	H
E_M	L	L	L	L	L	L	L	L	L	L	L
UP	→										
DOWN	←										

4-5 EXCITATION

PHASE \ PULSE	0 (RESET)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
ϕ_A	H	H	L	L	L	L	L	L	L	L	L	L	L	H	H	H	H	H	H	H	H
ϕ_B	H	H	H	H	L	L	L	L	L	L	L	L	L	L	L	H	H	H	H	H	H
ϕ_C	H	H	H	H	H	H	L	L	L	L	L	L	L	L	L	L	L	H	H	H	H
ϕ_D	H	H	H	H	H	H	H	H	L	L	L	L	L	L	L	L	L	L	L	H	H
ϕ_E	L	H	H	H	H	H	H	H	H	H	L	L	L	L	L	L	L	L	L	L	L
$\phi_{\overline{A}}$	L	L	L	H	H	H	H	H	H	H	H	H	L	L	L	L	L	L	L	L	L
$\phi_{\overline{B}}$	L	L	L	L	L	H	H	H	H	H	H	H	H	H	L	L	L	L	L	L	L
$\phi_{\overline{C}}$	L	L	L	L	L	L	L	H	H	H	H	H	H	H	H	H	L	L	L	L	L
$\phi_{\overline{D}}$	L	L	L	L	L	L	L	L	L	H	H	H	H	H	H	H	H	H	L	L	L
$\phi_{\overline{E}}$	L	L	L	L	L	L	L	L	L	L	L	H	H	H	H	H	H	H	H	H	L
Z_O	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H
E_M	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L
UP	→																				
DOWN	←																				

5 EXCITATION

PHASE \ PULSE	0 (RESET)	1	2	3	4	5	6	7	8	9	10
ϕ_A	H	H	L	L	L	L	L	H	H	H	H
ϕ_B	H	H	H	L	L	L	L	L	H	H	H
ϕ_C	H	H	H	H	L	L	L	L	L	H	H
ϕ_D	H	H	H	H	H	L	L	L	L	L	H
ϕ_E	L	H	H	H	H	H	L	L	L	L	L
$\phi_{\overline{A}}$	L	L	H	H	H	H	H	L	L	L	L
$\phi_{\overline{B}}$	L	L	L	H	H	H	H	H	L	L	L
$\phi_{\overline{C}}$	L	L	L	L	H	H	H	H	H	L	L
$\phi_{\overline{D}}$	L	L	L	L	L	H	H	H	H	H	L
$\phi_{\overline{E}}$	H	L	L	L	L	L	H	H	H	H	H
Z_O	H	L	L	L	L	L	L	L	L	L	H
E_M	H	H	H	H	H	H	H	H	H	H	H
UP	→										
DOWN	←										

MAXIMUM RATINGS (Ta = 25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Power Suplly Voltage		V_{CC}	−0.5~20	V
Output Current ϕn	"H" level	I_{OH} ϕ	−30	mA
	"L" level	I_{OL} ϕ	2	
Output Current (C_O, E_M, Z_O)	"H" level	I_{OH}	−50	μA
	"L" level	I_{OL}	2	mA
Input Voltage		V_{IN}	−0.5~V_{CC}	V
Input Current		I_{IN}	±1	mA
Power Dissipation		P_D	1000	mW
Operating Temperature		T_{opr}	−20~85	°C
Storage Temperature		T_{stg}	−55~150	°C

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

CHARACTERISTIC		SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Power Suplly Voltage		V_{CC}	—	4	—	13	V
Output Current ϕn	"H" level	I_{OH} ϕ	—	—	—	−10	mA
	"L" level	I_{OL} ϕ	—	—	—	1.6	
Output Current (C_O, E_M, Z_O)	"H" level	I_{OH}	—	—	—	−40	μA
	"L" level	I_{OL}	—	—	—	1.6	mA
Input Voltage		V_{IN}	—	0	—	V_{CC}	V
Clock Frequency		—	—	0	—	250	kHz

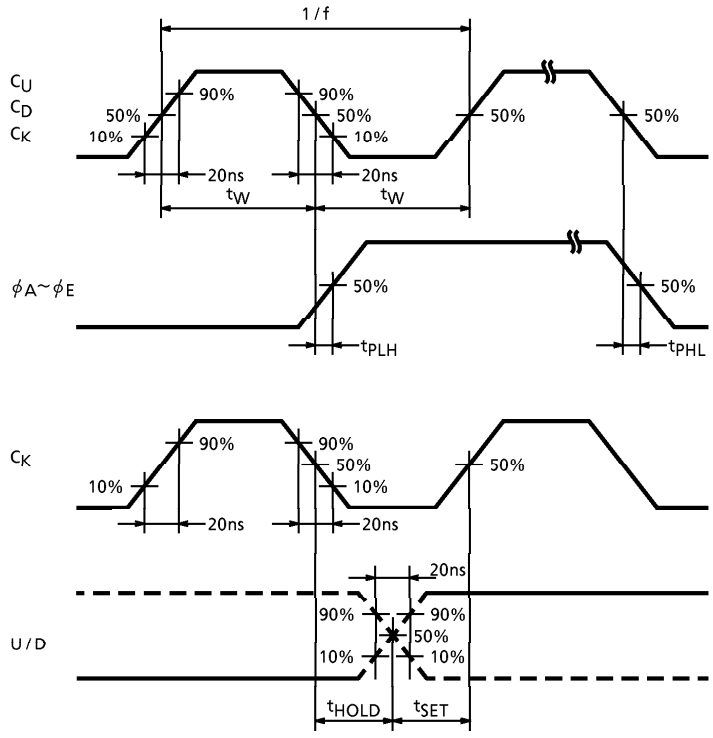
ELECTRICAL CHARACTERISTICS (Ta = 25°C)

CHARACTERISTIC		SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Output Current $\phi A \sim \phi \bar{E}$	"H" level	I_{OH}	—	V_{CC} = 5V, $V_O = V_{CC} - 2.0$	−20	—	—	mA
			—	V_{CC} = 10V, $V_O = V_{CC} - 2.0$	−20	—	—	
	"L" level	I_{OL}	—	V_{CC} = 5V, V_O = 0.3V	1.6	—	—	mA
			—	V_{CC} = 10V, V_O = 0.3V	1.6	—	—	
Output Current C_O, E_M, Z_O	"H" level	V_{OH}	—	V_{CC} = 5V, $I_O = -40\mu A$	3.6	—	—	V
			—	V_{CC} = 10V, $I_O = -40\mu A$	8.6	—	—	
	"L" level	V_{OL}	—	V_{CC} = 5V, I_O = 1.6mA	—	—	0.4	V
			—	V_{CC} = 10V, I_O = 1.6mA	—	—	0.6	
Input Voltage	"H" level	V_{IH}	—	V_{CC} = 5V	3.0	2.5	—	V
			—	V_{CC} = 10V	6.0	5.0	—	
	"L" level	V_{IL}	—	V_{CC} = 5V	—	2.0	1.5	V
			—	V_{CC} = 10V	—	4.0	3.0	
Input Current C_U, C_D, C_K E_A, E_B, E_C	"H" level	I_{IH}	—	$V_{CC} = 5V$, $V_{IN} = V_{CC} - 0.5V$	—	—	0.4	mA
			—	$V_{CC} = 10V$, $V_{IN} = V_{CC} - 0.5V$	—	—	0.7	
	"L" level	I_{IL}	—	V_{CC} = 5V, V_{IN} = 0V	—	—	±10	μA
			—	V_{CC} = 10V, V_{IN} = 0V	—	—	±10	
Input Current U / D, $\bar{P}_D$, $\bar{R}$	"H" level	I_{IH}	—	$V_{CC} = 5V$, $V_{IN} = V_{CC} - 0.5V$	—	—	−100	μA
			—	$V_{CC} = 10V$, $V_{IN} = V_{CC} - 0.5V$	—	—	−100	
	"L" level	I_{IL}	—	V_{CC} = 5V, V_{IN} = 0V	—	—	−0.4	mA
			—	V_{CC} = 10V, V_{IN} = 0V	—	—	−0.7	
Static Current Consumption		I_{CC}	—	V_{CC} = 5V, all pins open	—	—	25	mA
			—	V_{CC} = 10V, all pins open	—	—	35	

SWITCHING CHARACTERISTICS (Ta = 25°C)

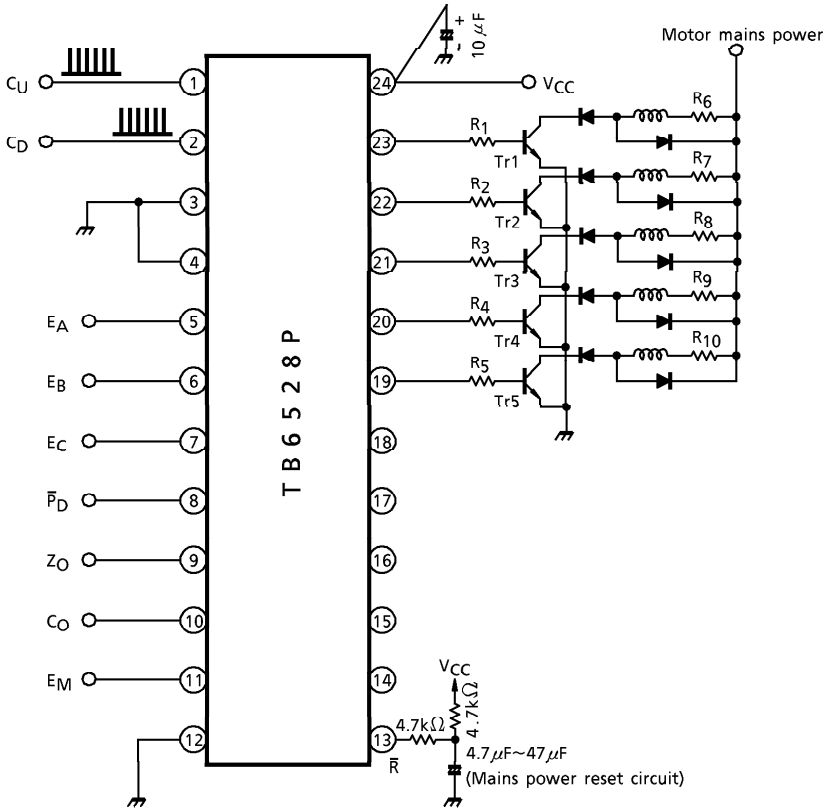
CHARACTERISTIC	SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Maximum Clock Frequency	f_{MAX}	—	V_{CC} = 5V	250	300	—	kHz
		—	V_{CC} = 10V	270	350	—	
Minimum Clock Pulse Width	t_W	—	V_{CC} = 5V	—	300	500	ns
		—	V_{CC} = 10V	—	300	500	
Minimum Reset Pulse Width	t_{WR}	—	V_{CC} = 5V	—	200	500	ns
		—	V_{CC} = 10V	—	200	500	
Delay Time (ϕ output from clock input)	t_{PLH} t_{PHL}	—	V_{CC} = 5V	—	2500	3500	ns
		—	V_{CC} = 10V	—	2500	3500	
Delay Time (each monitor from clock input)	t_{PLH} t_{PHL}	—	V_{CC} = 5V	—	3000	4000	ns
		—	V_{CC} = 10V	—	3000	4000	
Setting Time	t_{SET}	—	V_{CC} = 5V	4000	3000	—	ns
		—	V_{CC} = 10V	4000	3000	—	
Storage Time	t_{HOLD}	—	V_{CC} = 5V	500	0	—	ns
		—	V_{CC} = 10V	500	0	—	

MEASURED WAVE-FORM FOR SWITCHING TIME



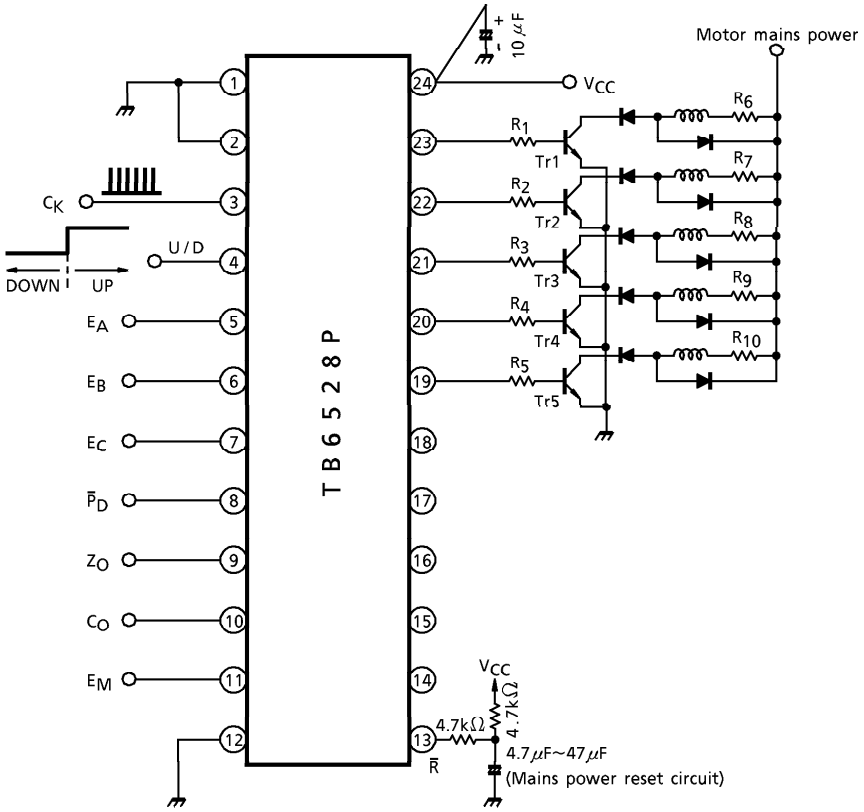
APPLICATION CIRCUIT 1

2 input pin method



APPLICATION CIRCUIT 2

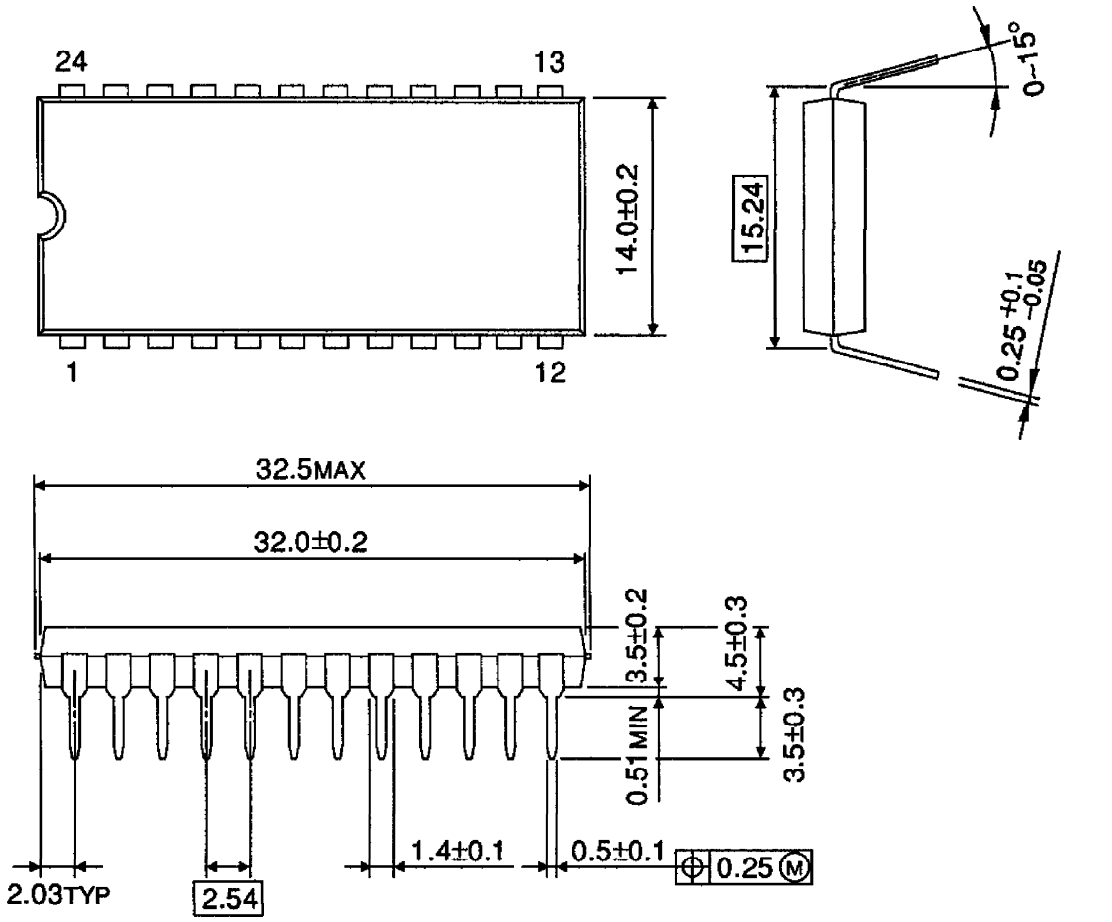
1 input / swtting pin method



OUTLINE DRAWING

DIP24-P-600-2.54

Unit : mm



Weight : 3.38g (Typ.)