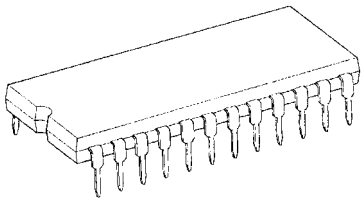
TOSHIBA Bi−CMOS INTEGRATED CIRCUIT SILICON MONOLITHIC

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.



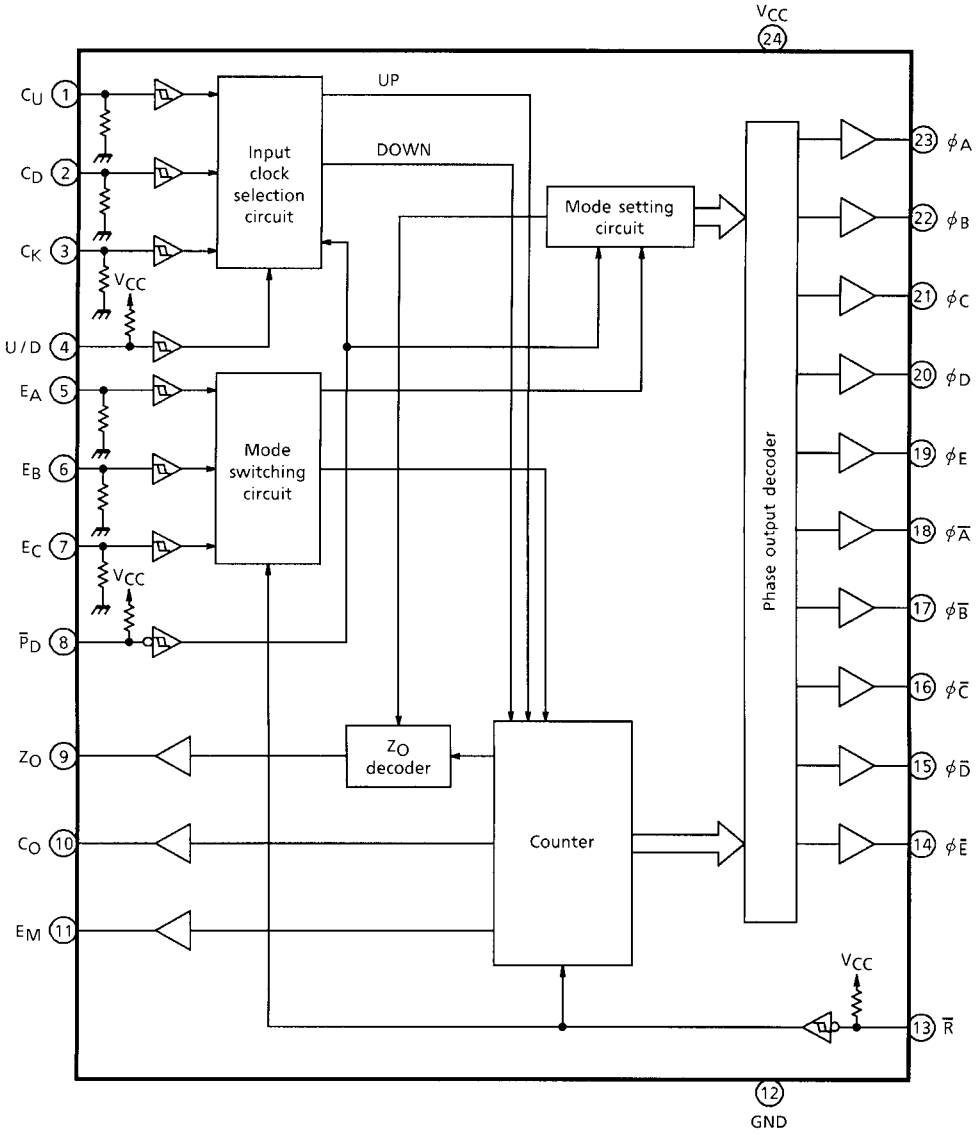
DIP24-P-600-2.54

Weight: 3.38 g (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} = 4~16 V
- High−output current : 20 mA 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).
- Power down function : All output is at the “L” level
- 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

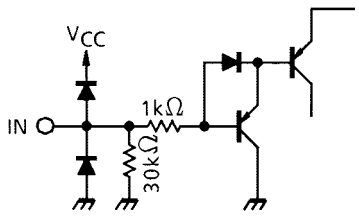


PIN FUNCTION

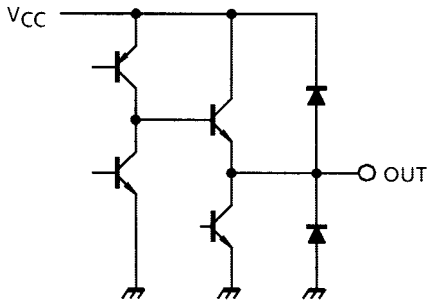
PIN No.	PIN SYMBOL	PIN FUNCTION	
1	C_U	Input pulse UP clock	Truth table A
2	C_D	Input pulse DOWN clock	
3	C_K	Input pulse clock	
4	U / D	Converts rotation directions “0” is DOWN, “1” is UP	
5	E_A	Excitation mode switching input	Truth table B
6	E_B		
7	E_C		
8	P_D	All output becomes “L” when power down 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	φ_B Output	
23	φ_A	φ_A Output	
24	V_{CC}	V_{CC}	

EQUIVALENT I / O CIRCUIT

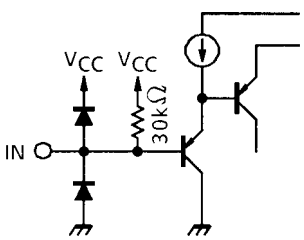
C_U, C_D, C_K



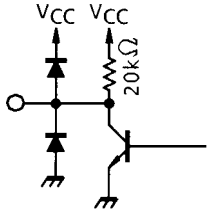
φ_A~φ_E and $\varphi\overline{A}$~$\varphi\overline{E}$



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



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 (φA~φE and $\varphi\overline{A}$ ~$\varphi\overline{E}$) 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
$\varphi\overline{A}$	L	L	L	L	L	L
$\varphi\overline{B}$	L	L	L	L	L	L
$\varphi\overline{C}$	L	L	L	L	L	L
$\varphi\overline{D}$	L	L	L	L	L	L
$\varphi\overline{E}$	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
$\varphi\overline{A}$	L	L	L	L	L	L	L	L	L	L	L
$\varphi\overline{B}$	L	L	L	L	L	L	L	L	L	L	L
$\varphi\overline{C}$	L	L	L	L	L	L	L	L	L	L	L
$\varphi\overline{D}$	L	L	L	L	L	L	L	L	L	L	L
$\varphi\overline{E}$	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	L
φ_C	L	H	H	H	L	L
φ_D	L	L	H	H	H	H
φ_E	H	L	L	H	H	L
$\varphi\overline{A}$	L	L	L	L	L	L
$\varphi\overline{B}$	L	L	L	L	L	L
$\varphi\overline{C}$	L	L	L	L	L	L
$\varphi\overline{D}$	L	L	L	L	L	L
$\varphi\overline{E}$	L	L	L	L	L	L
$\overline{Z}_O$	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
$\varphi_{A'}$	L	L	L	L	L	L	L	L	L	L	L	H	H	H	H	H	L	L	L	L	L
$\varphi_{B'}$	H	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H	H	H
$\varphi_{C'}$	L	L	L	H	H	H	H	H	L	L	L	L	L	L	L	L	L	L	L	L	L
$\varphi_{D'}$	L	L	L	L	L	L	L	L	L	H	H	H	H	H	L	L	L	L	L	L	L
$\varphi_{E'}$	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H	H	H	H	L
$\varphi\overline{A}$ '	L	H	H	H	H	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
$\varphi\overline{B}$ '	L	L	L	L	L	L	L	H	H	H	H	H	L	L	L	L	L	L	L	L	L
$\varphi\overline{C}$ '	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H	H	H	H	L	L	L
$\varphi\overline{D}$ '	H	H	H	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H
$\varphi\overline{E}$ '	L	L	L	L	L	H	H	H	H	H	L	L	L	L	L	L	L	L	L	L	L
$\overline{Z}_O$	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
$\varphi_{A'}$	L	L	L	L	L	L	H	H	H	L	L
$\varphi_{B'}$	H	H	L	L	L	L	L	L	L	H	H
$\varphi_{C'}$	L	L	H	H	H	L	L	L	L	L	L
$\varphi_{D'}$	L	L	L	L	L	H	H	H	L	L	L
$\varphi_{E'}$	H	L	L	L	L	L	L	L	H	H	H
$\varphi\overline{A}'$	L	H	H	H	L	L	L	L	L	L	L
$\varphi\overline{B}'$	L	L	L	L	H	H	H	L	L	L	L
$\varphi\overline{C}'$	L	L	L	L	L	L	L	H	H	H	L
$\varphi\overline{D}'$	H	H	H	L	L	L	L	L	L	L	H
$\varphi\overline{E}'$	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
φ_A	H	L	L	L	L	L	L	H	H	H	H
φ_B	H	H	L	L	L	L	L	L	H	H	H
φ_C	H	H	H	L	L	L	L	L	L	H	H
φ_D	H	H	H	H	L	L	L	L	L	L	H
φ_E	L	H	H	H	H	L	L	L	L	L	L
$\varphi\overline{A}$	L	L	H	H	H	H	L	L	L	L	L
$\varphi\overline{B}$	L	L	L	H	H	H	H	L	L	L	L
$\varphi\overline{C}$	L	L	L	L	H	H	H	H	L	L	L
$\varphi\overline{D}$	L	L	L	L	L	H	H	H	H	L	L
$\varphi\overline{E}$	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	H	L	L	L	L	L	L	L	L	L	L
$\varphi\overline{A}$	L	L	L	H	H	H	H	H	H	H	H	H	H	L	L	L	L	L	L	L	L
$\varphi\overline{B}$	L	L	L	L	L	H	H	H	H	H	H	H	H	H	H	L	L	L	L	L	L
$\varphi\overline{C}$	L	L	L	L	L	L	L	H	H	H	H	H	H	H	H	H	H	L	L	L	L
$\varphi\overline{D}$	L	L	L	L	L	L	L	L	L	H	H	H	H	H	H	H	H	H	H	L	L
$\varphi\overline{E}$	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
$\varphi\overline{A}$	L	L	H	H	H	H	H	L	L	L	L
$\varphi\overline{B}$	L	L	L	H	H	H	H	H	L	L	L
$\varphi\overline{C}$	L	L	L	L	H	H	H	H	H	L	L
$\varphi\overline{D}$	L	L	L	L	L	H	H	H	H	H	L
$\varphi\overline{E}$	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

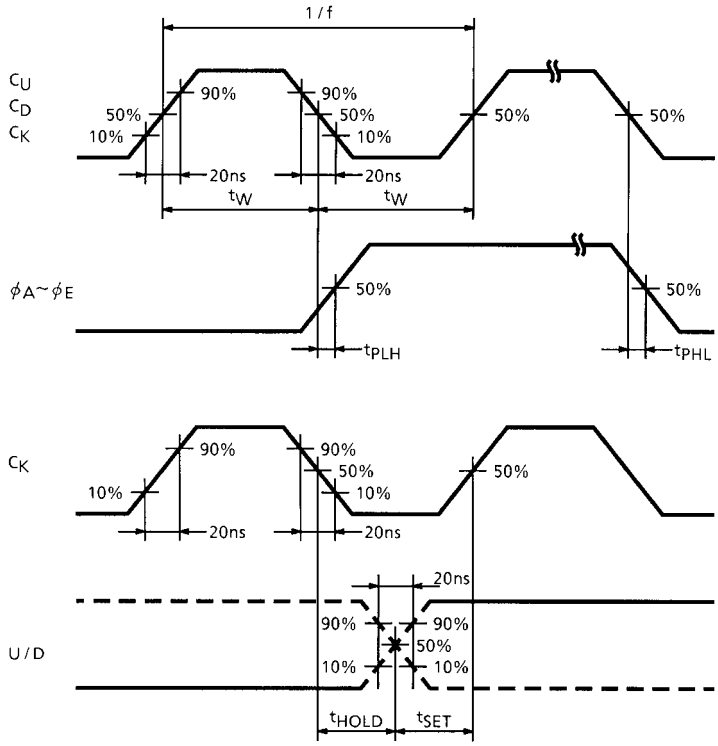
ELECTRICAL CHARACTERISTICS (Ta = 25°C)

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

SWITCHING CHARACTERISTICS (Ta = 25°C)

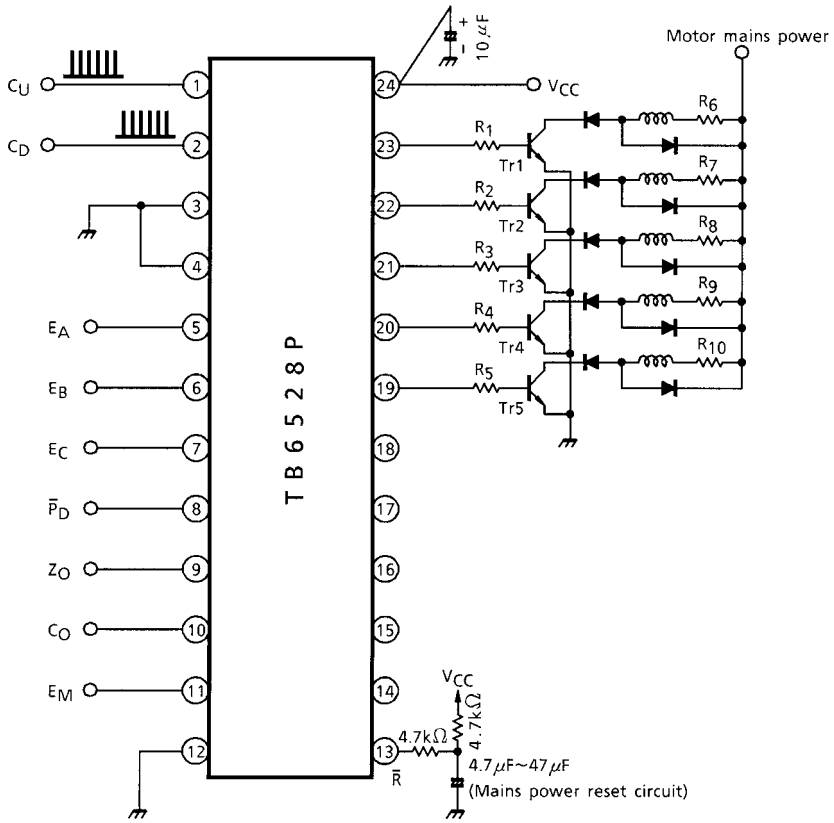
CHARACTERISTIC	SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN	TYP.	MAX	UNIT
Maximum Clock Frequency	f_{MAX}	—	V_{CC} = 5 V	250	300	—	kHz
		—	V_{CC} = 10 V	270	350	—	
Minimum Clock Pulse Width	t_W	—	V_{CC} = 5 V	—	300	500	ns
		—	V_{CC} = 10 V	—	300	500	
Minimum Reset Pulse Width	t_{WR}	—	V_{CC} = 5 V	—	200	500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

MEASURED WAVE−FORM FOR SWITCHING TIME



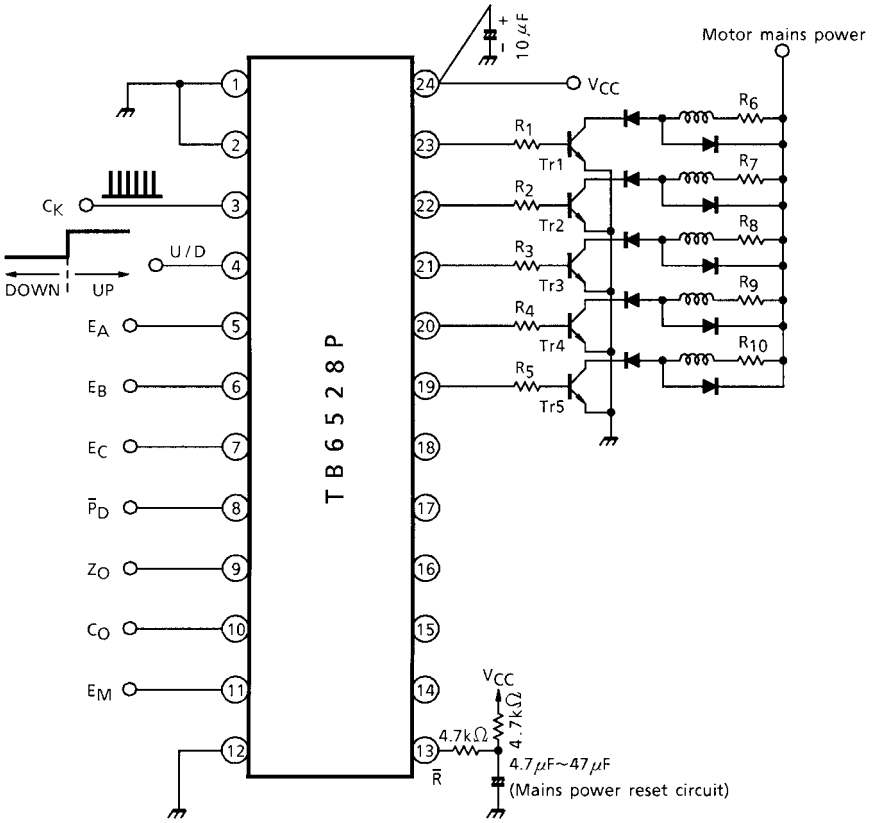
APPLICATION CIRCUIT 1

2 input pin method



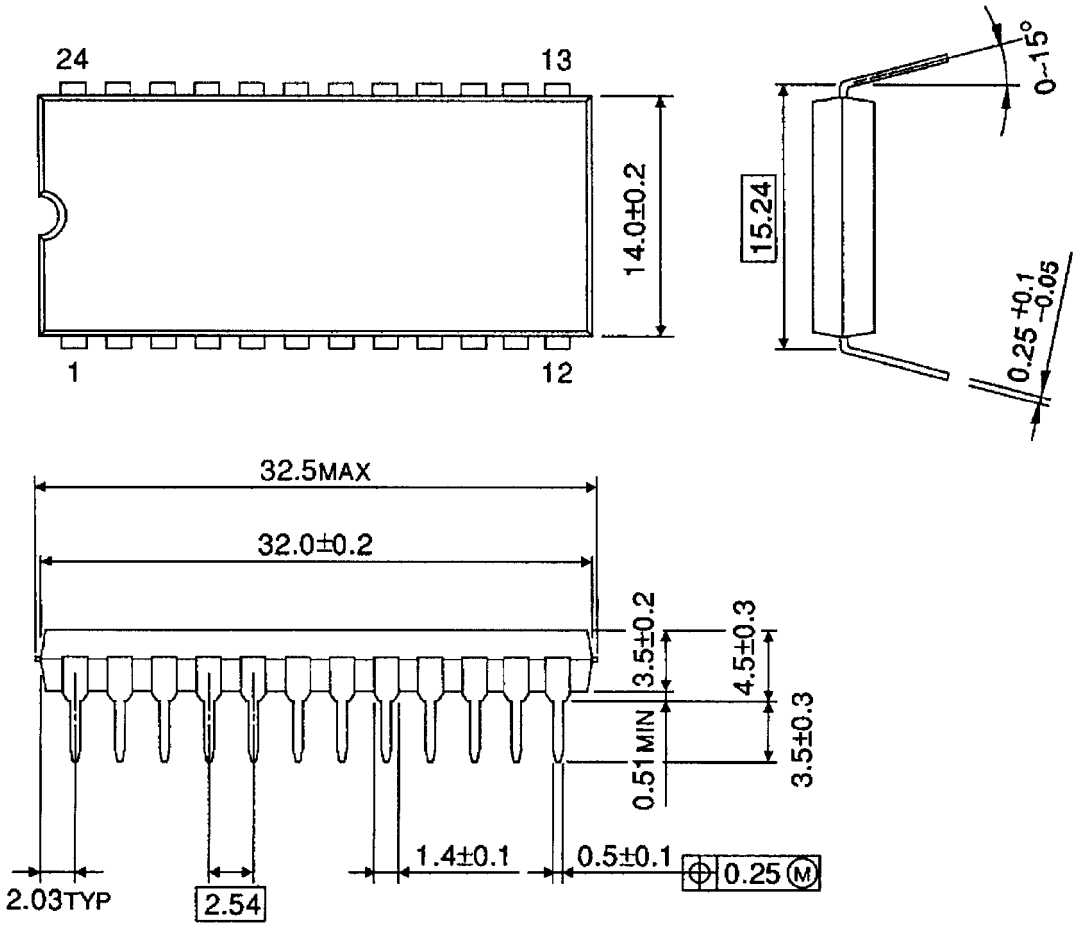
APPLICATION CIRCUIT 2

1 input / switting pin method



PACKAGE DIMENSIONS

DIP24−P−600−2.54 Unit: mm



Weight: 3.38 g (Typ.)

RESTRICTIONS ON PRODUCT USE

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