

THREE-PHASE SPINDLE MOTOR DRIVER  
FOR MONOLITHIC CD-ROM

## DESCRIPTION

The  $\mu$ PD16836 is a three-phase spindle motor driver for CD-ROM drives which consists of a CMOS control circuit and MOS bridge output. It employs a three-phase full-wave PWM driving method and a MOS FET in the output stage to lower the power consumption compared with drivers using conventional bipolar transistors.

## FEATURES

- Low ON resistance (Sum of ON resistance of top and bottom transistors)  $R_{on} = 1.2 \Omega$  (TYP.)
- Low power consumption using three-phase full-wave PWM driving system
- START/STOP pins enable braking operation in STOP mode
- Standby pin turns off internal circuitry in standby mode
- Low current consumption:  $I_{DD} = 3\text{mA}$  (MAX.),  $I_{DD(ST)} = 100 \mu\text{A}$  (MAX.)
- Internal thermal shutdown circuit
- Internal overcurrent protection circuit (can be externally set)
- Internal FG output function
- Reverse prevention circuit
- 24-pin plastic SOP (375 mil)

## ORDERING INFORMATION

Part Number	Package
$\mu$ PD16836GT	24-pin plastic SOP (375 mil)

ABSOLUTE MAXIMUM RATINGS ( $T_A = 25 \text{ }^\circ\text{C}$ )

Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage	$V_{DD}$		-0.5 to +7.0	V
	$V_M$		-0.5 to +15.0	V
Input voltage	$V_{IN}$		-0.5 to $V_{DD} + 0.5$	V
Instantaneous output current <sup>Note 1</sup>	$I_{OP}$	PW $\leq 5$ ms, Duty $\leq 40$ %	$\pm 1.3$	A
Power dissipation <sup>Note 2</sup>	$P_T$		1.25	W
Peak junction temperature	$T_{CH(MAX)}$		150	$^\circ\text{C}$
Storage temperature range	$T_{stg}$		-55 to +150	$^\circ\text{C}$

- Notes**
1. Permissible current value per one phase, when mounted on the printed circuit board
  2. When mounted on the printed circuit board (100 mm  $\times$  100 mm  $\times$  1 mm, glass epoxy)

The information in this document is subject to change without notice.

## RECOMMENDED OPERATING RANGE

Parameter	Symbol	MIN.	TYP.	MAX.	Unit
Supply voltage	V <sub>DD</sub>	4.5		5.5	V
	V <sub>M</sub>	10.8		13.2	V
Instantaneous output current	I <sub>OP</sub>			1.0	A/phase
CL pin input voltage	V <sub>CL</sub>	0.3		1.0	V
Operating temperature range	T <sub>A</sub>	-20		75	°C

ELECTRICAL SPECIFICATIONS (Unless otherwise specified, T<sub>A</sub> = 25 °C, V<sub>DD</sub> = 5 V, V<sub>M</sub> = 12 V)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
<Overall>						
Current consumption 1 (V <sub>DD</sub> )	I <sub>DD</sub>	STB = L		1.5	3.0	mA
Current consumption 2 (standby)	I <sub>DD (ST)</sub>	STB = H			0.1	mA
<ST/SP, REV, STB>						
High-level input voltage	V <sub>IH</sub>	ST/SP = H	0.6×V <sub>DD</sub>		V <sub>DD</sub>	V
Low-level input voltage	V <sub>IL</sub>	ST/SP = L			0.8	V
Input pull-down resistor	R <sub>IND</sub>		60	100	140	kΩ
<Control circuit>						
Triangular wave oscillation frequency	f <sub>PWM</sub>	C <sub>T</sub> = 100 pF	40	100	250	kHz
<Hole amplifier>						
In-phase input voltage range	V <sub>Hch</sub>		1.0		2.8	V
Hysteresis voltage	V <sub>Hhis</sub>			20		mV
Input bias current	I <sub>Hbias</sub>				1.0	μA
<FG output>						
IND pin high-level voltage	V <sub>FG_H</sub>	I <sub>O</sub> = -4 mA	3.5			V
IND pin low-level voltage	V <sub>FG_L</sub>	I <sub>O</sub> = +4 mA			0.5	V
<Output block>						
Output ON resistance	R <sub>ON</sub> <sup>Note</sup>	I <sub>O</sub> = 200 mA, T <sub>A</sub> = -20 to 70 °C		1.2	1.8	Ω
Output turn-ON time	t <sub>ON</sub>	R <sub>M</sub> = 5 Ω (Star connection)		1.0	2.0	μs
Output turn-OFF time	t <sub>OFF</sub>			1.0	2.0	μs
<Torque command>						
Control reference input voltage range	ECR		1.5		3.0	V
Control input voltage range	EC		1.0		3.5	V
Input current	I				100	μA
Input differential voltage	ECR-EC	Duty = 100 %		0.32		V
DEADZONE (+)	EC d+		5	75	150	mV
DEADZONE (-)	EC d-		-150	-75	-150	mV

**Note** Sum of ON resistance of top and bottom transistors

The thermal shutdown circuit operates at T<sub>CH</sub> ≥ 150 °C

The low-voltage malfunction prevention circuit (UVLO) operates at V<sub>DD</sub> = 4 V (TYP.)

**PIN CONFIGURATION**

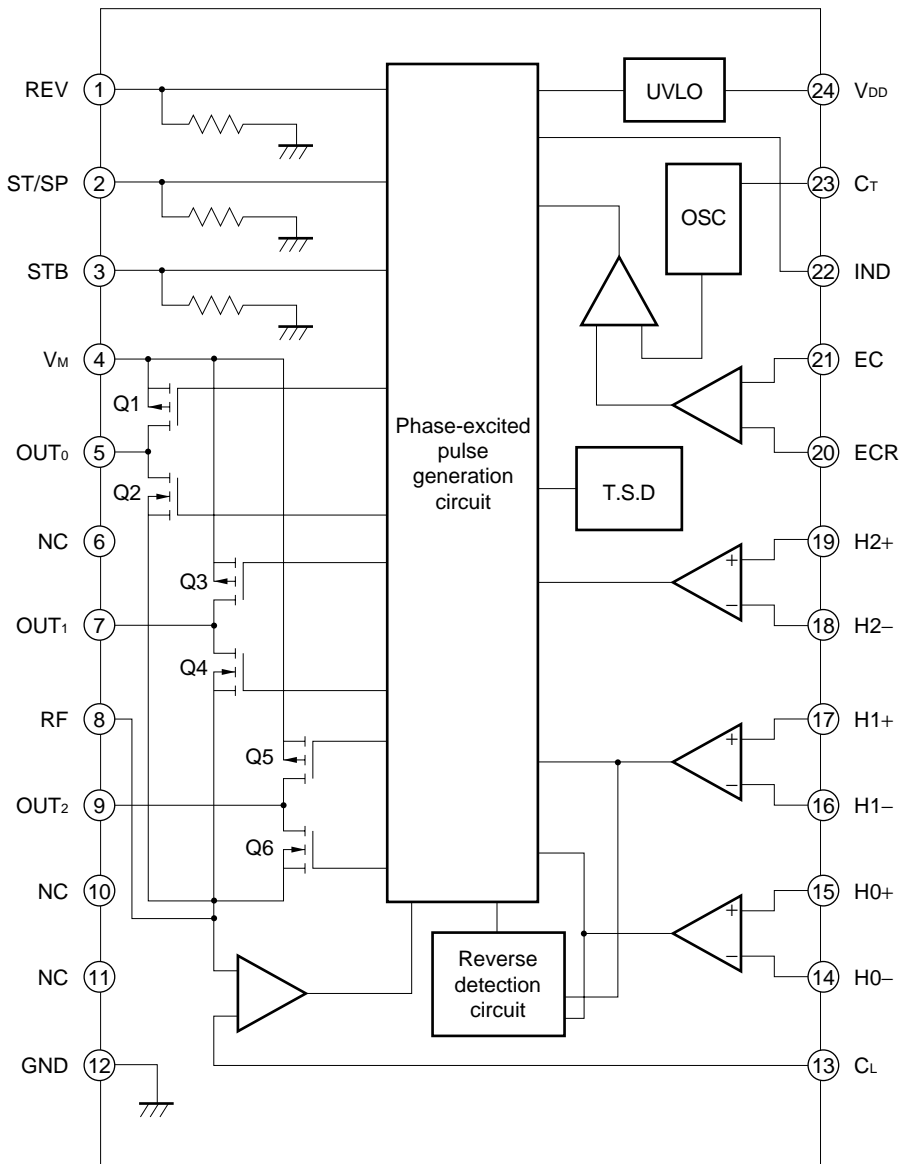
REV	1	24	V <sub>DD</sub>
ST/SP	2	23	C <sub>T</sub>
STB	3	22	IND
V <sub>M</sub>	4	21	EC
OUT0	5	20	ECR
NC	6	19	H2+
OUT1	7	18	H2-
RF	8	17	H1+
OUT2	9	16	H1-
NC	10	15	H0+
NC	11	14	H0-
GND	12	13	C <sub>L</sub>

**PIN FUNCTIONS**

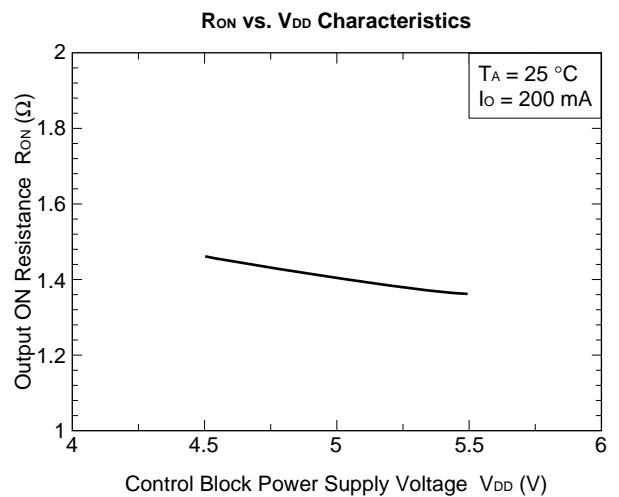
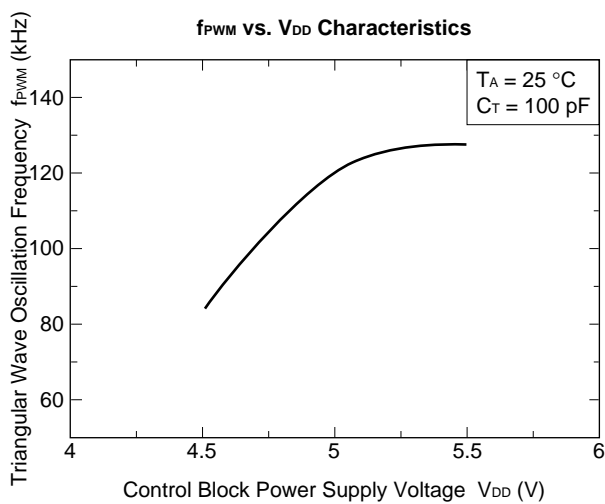
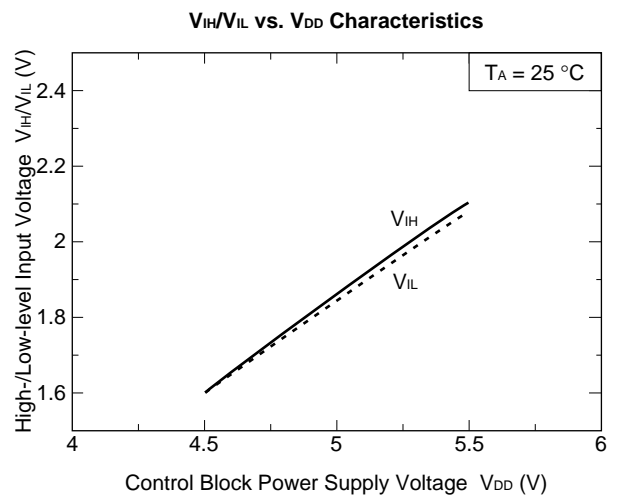
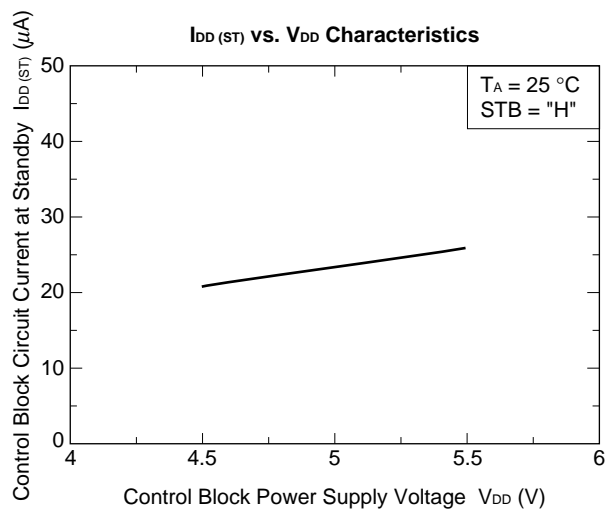
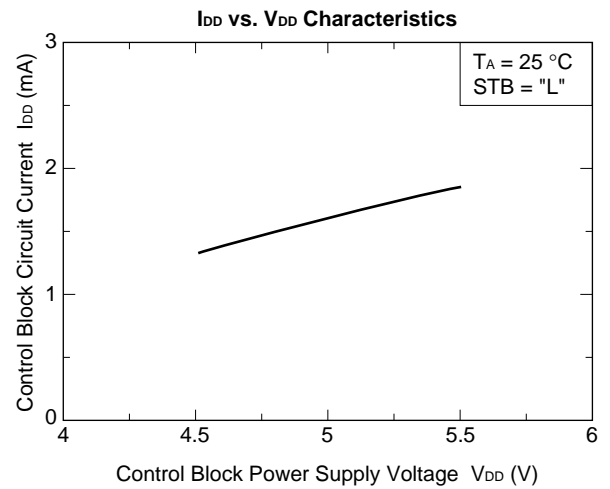
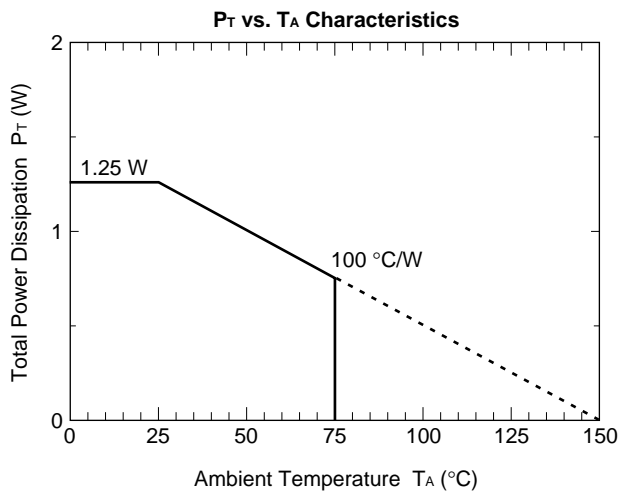
**Package: 24-pin plastic SOP (375 mil)**

Pin Number	Pin Name	I/O	Pin Functions
1	REV	I	Reverse operation input pin (reverse brake)
2	ST/SP	I	Start/stop input pin
3	STB	I	Standby operation input pin
4	V <sub>M</sub>	-	Motor block power supply voltage (12 V)
5	OUT0	O	Motor connection pin (output pin)
6	NC	-	Open pin
7	OUT1	O	Motor connection pin
8	RF	I	Sense resistor connection pin
9	OUT2	O	Motor connection pin
10	NC	-	Open pin
11	NC	-	Open pin
12	GND	-	GND pin
13	C <sub>L</sub>	I	Reference voltage input pin for overcurrent detection
14	H0-	I	Hole signal input pin
15	H0+	I	Hole signal input pin
16	H1-	I	Hole signal input pin
17	H1+	I	Hole signal input pin
18	H2-	I	Hole signal input pin
19	H2+	I	Hole signal input pin
20	ECR	I	Control reference voltage input pin
21	EC	I	Control voltage input pin
22	IND	O	Index signal output pin
23	C <sub>T</sub>	I	Capacitor connection pin for oscillator frequency setting
24	V <sub>DD</sub>	-	Control block power supply voltage input pin (5 V)

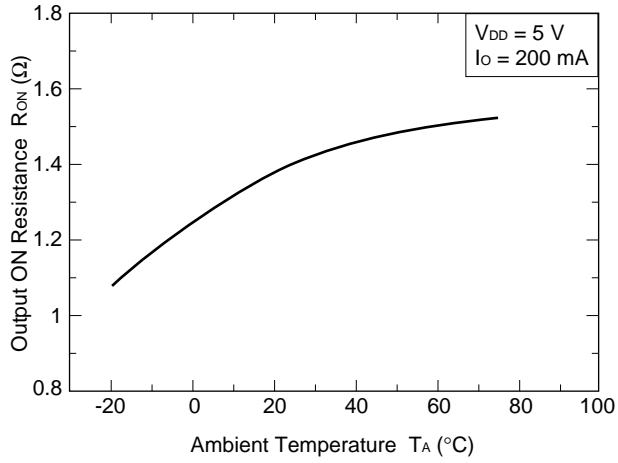
BLOCK DIAGRAM



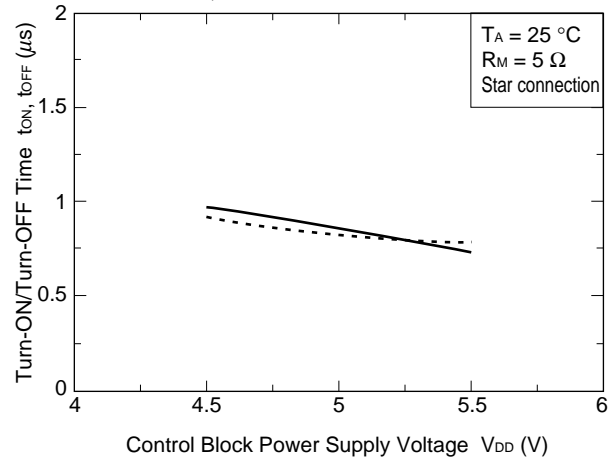
TYPICAL CHARACTERISTIC CURVES (T<sub>A</sub> = 25 °C)



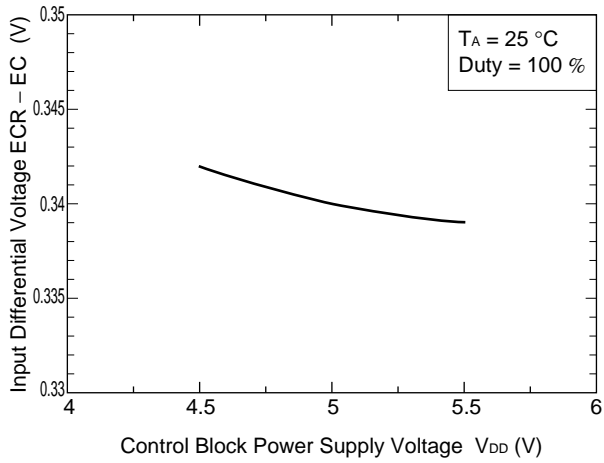
**R<sub>ON</sub> vs. T<sub>A</sub> Characteristics**



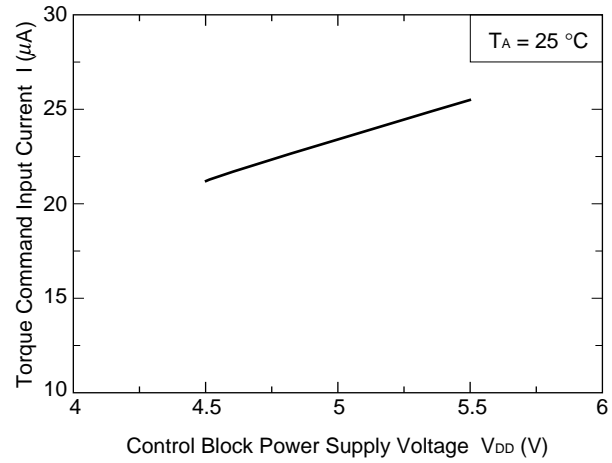
**t<sub>ON</sub>, t<sub>OFF</sub> vs. V<sub>DD</sub> Characteristics**



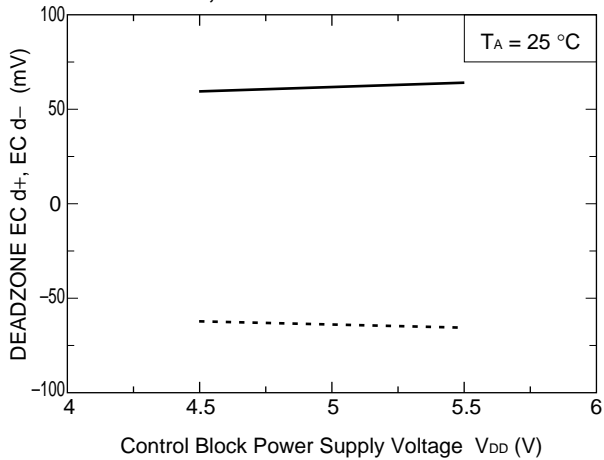
**ECR – EC vs. V<sub>DD</sub> Characteristics**



**I vs. V<sub>DD</sub> Characteristics**



**EC d<sub>+</sub>, EC d<sub>-</sub> vs. V<sub>DD</sub> Characteristics**



**FUNCTION OPERATION TABLE**

**(1) ST/SP = "H"**

Input Signal				Circuit Operation Mode	Source → Sink
CMP0	CMP1	CMP2	PWM		
H	H	L	H	Operation	W → V
H	H	L	L	Brake	
H	L	L	H	Operation	W → U
H	L	L	L	Brake	
H	L	H	H	Operation	V → U
H	L	H	L	Brake	
L	L	H	H	Operation	V → W
L	L	H	L	Brake	
L	H	H	H	Operation	U → W
L	H	H	L	Brake	
L	H	L	H	Operation	U → V
L	H	L	L	Brake	

Brake: For circuit operation, each high-side switch of the source and sink turns ON.

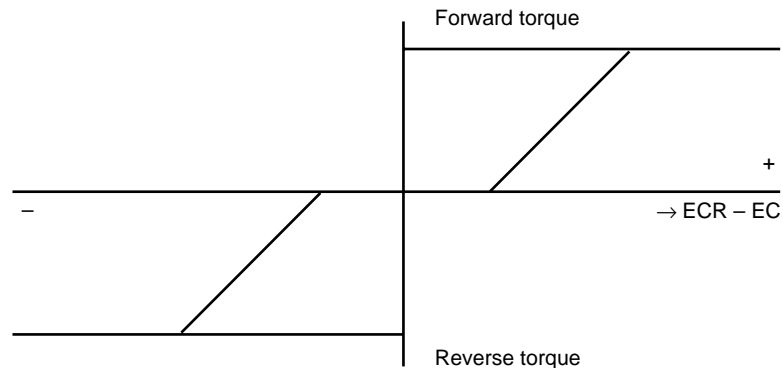
**(2) ST/SP = "L"**

Input Signal				Circuit Operation Mode
CMP0	CMP1	CMP2	PWM	
-	-	-	-	Stop

**Remark** Q1, Q3, and Q5 are ON. Q2, Q4, and Q6 are OFF.

**(3) Torque command**

The relationship between the control reference voltage (ECR) and control voltage (ECR – EC), and torque is as follows. Dead band width is 150 mV (TYP).



	Reverse Pin Voltage (REV)	
	L	H
$ECR > EC$	Forward	Reverse <sup>Note</sup>
$ECR < EC$	Reverse <sup>Note</sup>	Stop

**Note** Stops after detecting reverse.

**(4) Standby mode**

The internal power supply for the μPD16836 is turned off by setting the standby mode.

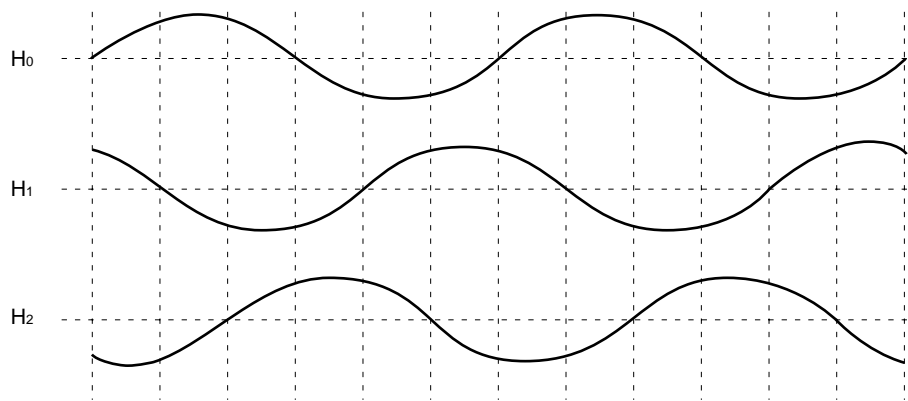
Each pin output is high-impedance in the standby mode. The internal oscillation block also stops, and the circuit current can be reduced.

After the normal operation mode has been set, a few of 10's of μs are necessary for the motor to restart.

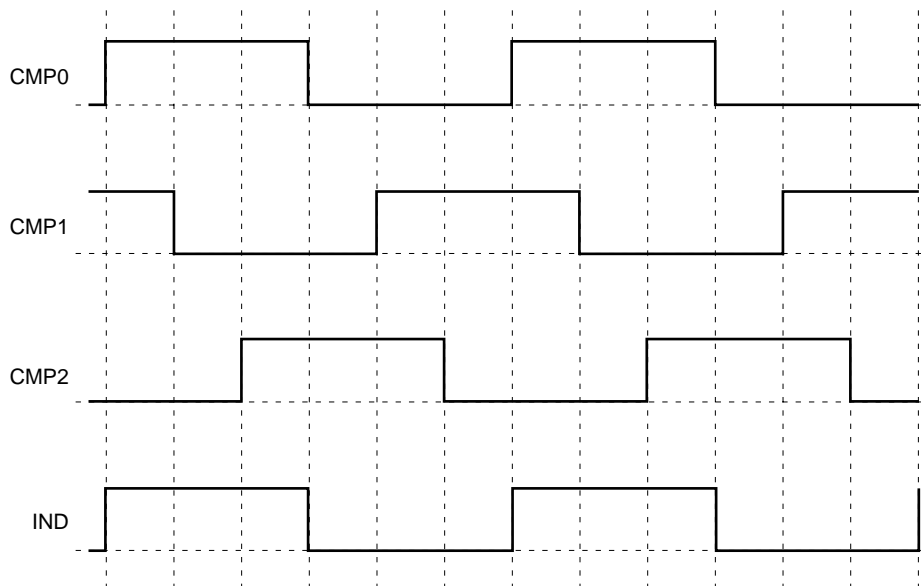
STB Pin	Operation Mode
L	Normal mode
H	Standby mode

**TIMING CHART**

**(1) Hole signal input**



**(2) CMP signal**

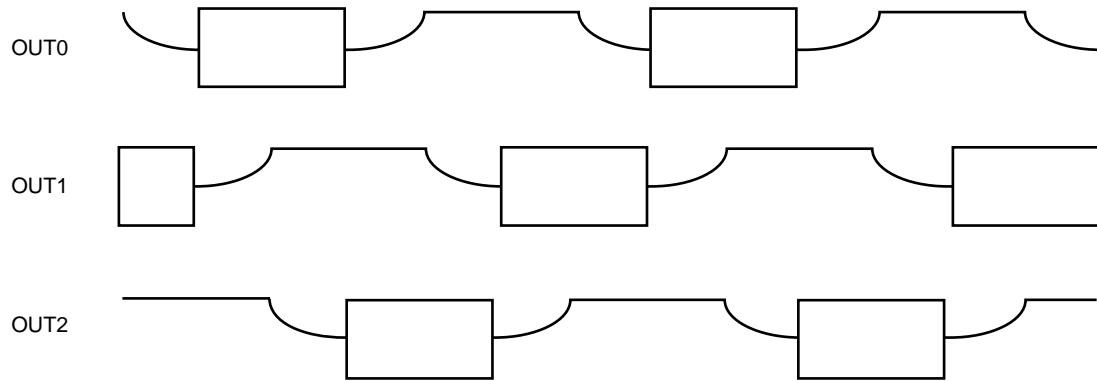




**(3) Output MOSFET driving and comparator selection**

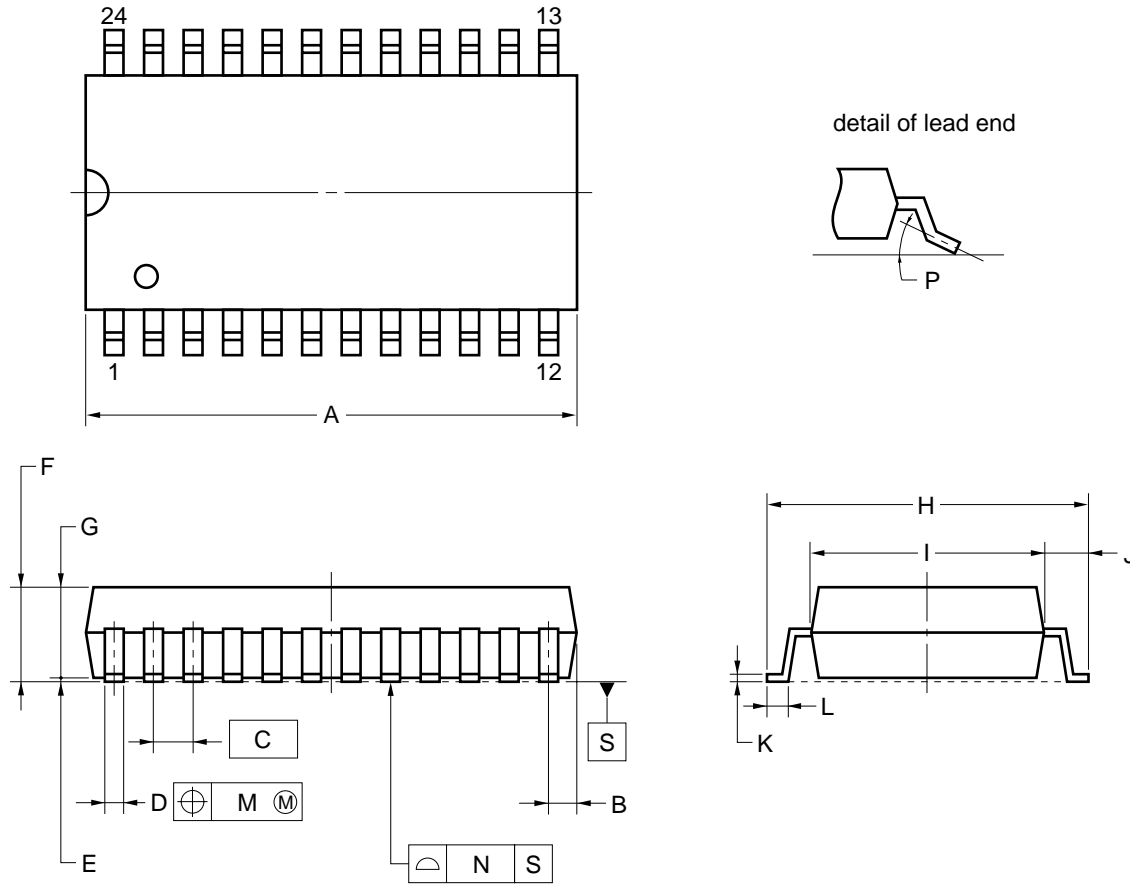
Q1		SW	SW		ON	ON		SW	SW		ON	ON	
Q2		SW	SW					SW	SW				
Q3	SW		ON	ON		SW	SW		ON	ON		SW	SW
Q4	SW					SW	SW					SW	SW
Q5	ON	ON		SW	SW		ON	ON		SW	SW		ON
Q6				SW	SW					SW	SW		

**(4) Motor driving waveform**



PACKAGE DRAWING

24 PIN PLASTIC SOP (375 mil)



**NOTE**

1. Controlling dimension — millimeter.
2. Each lead centerline is located within 0.12 mm (0.005 inch) of its true position (T.P.) at maximum material condition.

ITEM	MILLIMETERS	INCHES
A	15.3 <sup>+0.41</sup> <sub>-0.2</sub>	0.602 <sup>+0.017</sup> <sub>-0.008</sub>
B	0.87 MAX.	0.035 MAX.
C	1.27 (T.P.)	0.050 (T.P.)
D	0.42 <sup>+0.08</sup> <sub>-0.07</sub>	0.017 <sup>+0.003</sup> <sub>-0.004</sub>
E	0.125±0.075	0.005±0.003
F	2.9 MAX.	0.115 MAX.
G	2.50±0.2	0.098 <sup>+0.009</sup> <sub>-0.008</sub>
H	10.3±0.2	0.406 <sup>+0.008</sup> <sub>-0.009</sub>
I	7.2±0.2	0.283 <sup>+0.009</sup> <sub>-0.008</sub>
J	1.6±0.2	0.063±0.008
K	0.17 <sup>+0.08</sup> <sub>-0.07</sub>	0.007 <sup>+0.003</sup> <sub>-0.004</sub>
L	0.8±0.2	0.031 <sup>+0.009</sup> <sub>-0.008</sub>
M	0.12	0.005
N	0.10	0.004
P	3° <sup>+7°</sup> <sub>-3°</sub>	3° <sup>+7°</sup> <sub>-3°</sub>

P24GT-50-375B-2

**ELECTRICAL SPECIFICATIONS**

Solder this product under the following recommended conditions.

For details of the recommended soldering conditions, refer to information document **Semiconductor Device Mounting Technology Manual (C10535E)**.

For soldering methods and conditions other than those recommended, consult NEC.

Soldering Methods	Soldering Conditions	Recommended Conditions Symbol
Infrared reflow	Package peak temperature: 235 °C, Time: 30 secs. max. (210 °C min.), Number of times: three times max., Number of days: none <sup>Note</sup> , Flux: Rosin-based flux with little chlorine content (chlorine: 0.2 Wt% max.) is recommended.	IR35-00-3
VPS	Package peak temperature: 215 °C, Time: 40 secs. max. (200 °C min.), Number of times: three times max., Number of days: none <sup>Note</sup> , Flux: Rosin-based flux with little chlorine content (chlorine: 0.2 Wt% max.) is recommended.	VP15-00-1
Wave soldering	Package peak temperature: 260 °C, Time: 10 secs. max., Preheating temperature: 120 °C max., Number of times: once, Flux: Rosin-based flux with little chlorine content (chlorine: 0.2 Wt% max.) is recommended.	WS60-00-1

**Note** Number of days in storage after the dry pack has been opened. The storage conditions are at 25 °C, 65% RH MAX.

**Caution** Do not use two or more soldering methods in combination.

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Special: Transportation equipment (automobiles, trains, ships, etc.), traffic control systems, anti-disaster systems, anti-crime systems, safety equipment and medical equipment (not specifically designed for life support)

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