DATA SHEET

NEC

MOS Integrated Circuit

μPD16873/A/B/C

MONOLITHIC 3-ASPECT SPINDLE MOTOR DRIVER

DESCRIPTION

μPD16873/A/B/C is 3 aspect spindle motor driver that composed by CMOS control circuit and MOS bridge output.

The consumption electric power can be substantially reduced to the screwdriver which used a conventional Bipolar transistor by the adoption of 3 aspect all-wave PWM methods and making an output paragraph MOSFET.

FEATURES

- Low On resistance. (The summation of the on resistance of the upper and lower MOSFET) R_{ON} = 0.6 Ω (TYP.)
- Low consumption power for 3 aspects all-wave PWM drive method.
- Index pulse (FG pulse) output function built in.
- By the PWM-drive form and the IND pulse pattern, 4 kind, line-up

	PWM method	Pattern of IND pulse (at 12 pole motor)
μPD16873	normal	3 phase composition output (18 pulses/turn)
μPD16873A	normal	1 phase output (6 pulses/turn)
μPD16873B	synchronous	1 phase output (6 pulses/turn)
μPD16873C	synchronous	3 phase composition output (18 pulses/turn)

- Built in STANDBY terminal and off the inner circuit at the time of the standby.
- Built in START/STOP terminal. Operating short brake works, when ST/SP terminal is off state.
- Supply voltage: 5 V drive
- Low consumption current: I_{DD} = 3 mA (MAX.)
- Thermal shut down circuit (TSD) built in.
- Over current protection circuit built in. (Setting by outside resistance)
- Low voltage malfunction prevention circuit built in.
- Reverse turn prevention circuit built in.
- Hall bias switch built in. (synchronized STB signal.)
- Loading into 30-pin plastic TSSOP (300 mil).

ORDERING INFORMATION

Part number	Function	Package
μPD16873MC-6A4	normal-PWM/3 phase IND	30-pin plastic TSSOP (7.62 mm (300))
μPD16873AMC-6A4	normal-PWM/1 phase IND	
μPD16873BMC-6A4	synchronous-PWM/1 phase IND	
μPD16873CMC-6A4	synchronous-PWM/3 phase IND	

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Not all devices/types available in every country. Please check with local NEC representative for availability and additional information.

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ABSOLUTE MAXIMUM RATINGS (T_A = 25°C)

When mounted on a glass epoxy board (10 cm × 10cm × 1mm, 15% copper foil)

Parameter	Symbol	Condition	Rating	Unit
Supply voltage	V_{DD}	control block	–0.5 to +5.7	V
	V_M	output block	–0.5 to +5.7	V
Input voltage	V_{IN}		–0.5 to V_{DD} + 0.5	V
Output pin voltage	V_{OUT}		–0.5 to +6.7	V
Output current (DC)[Note 1]	$I_{D(DC)}$	DC	±0.5	A/phase
Output current (pulse)[Note 2]	$I_{D(pulse)}$	PW < 5 ms, Duty < 30 %	±1.3	A/phase
Output current (pulse, reverse brake)[Note 3]	$I_{DR(pulse)}$	PW < 5 ms, Duty < 30 %	±1.9	A/phase
Power consumption	P_T		1.0	W
Peak junction temperature	$T_{CH(MAX)}$		150	°C
Storage temperature range	T_{stg}		–55 to 150	°C

Notes 1. DC
2. PW < 5 ms, Duty < 30 % (start-up, locking)
3. PW < 5 ms, Duty < 30 % (reverse brake)

RECOMMENDED OPERATING CONDITIONS

When mounted on a glass epoxy board (10 cm × 10cm × 1mm, 15% copper foil)

Parameter	Symbol	Condition	MIN.	TYP.	MAX.	Unit
Supply voltage	V_{DD}	control block	4.5	5.0	5.5	V
	V_M	output block	4.5	5.0	5.5	V
Input voltage	V_{IN}		0		V_{DD}	V
Output current (DC)[Note 1]	$I_{D(DC)}$	DC			0.4	A/phase
Output current (pulse)[Note 2]	$I_{D(pulse)}$	PW < 5 ms, Duty < 30 %			1.0	A/phase
Output current (pulse, reverse brake)[Note 3]	$I_{DR(pulse)}$	PW < 5 ms, Duty < 30 %			1.5	A/phase
Hall bias current	I_{HB}			10	20	mA
IND terminal output current	I_{FG}			±2.5	±5.0	mA
Operating temperature	T_A		–20		75	°C

Notes 1. DC
2. PW < 5 ms, Duty < 30 % (start-up, locking)
3. PW < 5ms, Duty < 30 % (reverse brake)

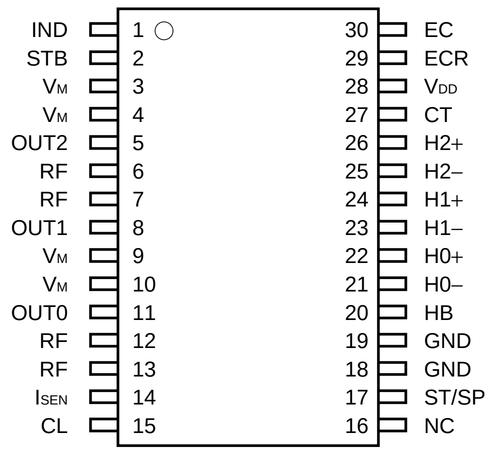
CHARACTERISTICS (Unless otherwise specified, T_A = 25°C, V_{DD} = V_M = 5 V)

Parameter	Symbol	Condition	MIN.	TYP.	MAX	Unit
<all>						
V_{DD} pin current (operating)	I_{DD}	STB = V_{DD}		1.5	3.0	mA
V_{DD} pin current (standby)	$I_{DD(ST)}$	STB = GND			1.0	μA
<ST/SP, STB pin>						
High level input voltage	V_{IH}		1.8		V_{DD}	V
Low level input voltage	V_{IL}				0.8	V
Input pull-down resistance	R_{IND}			110		kΩ
<Oscillation circuit part>						
Triangle wave oscillation frequency	f_{PWM}	C_T = 330pF		75		kHz
<Hall amplifier part>						
Same aspect input range	V_{Hch}		1.5		4.0	V
Hysteresis	V_{Hhys}	V_H = 2.5 V		15	50	mV
Input bias voltage	I_{Hbias}				1.0	μA
<Hall bias part>						
Hall bias voltage	V_{HB}	I_{HB} = 10 mA		0.3	0.5	V
<IND signal output part>						
IND terminal high level votlage	V_{FG_H}	I_{FG} = –2.5 mA	3.5			V
IND terminal low level voltage	V_{FG_L}	I_{FG} = +2.5 mA			0.5	V
<Output part>						
Output on resistance (upper + lower MOSFET)	R_{ON}	I_D = 200 mA –20°C $< T_A <$ 75°C		0.6	0.9	Ω
Off state leakage	$I_{D(OFF)}$	–20°C $< T_A <$ 75°C			10	μA
Output turn-on time	t_{ONH}	R_M = 5Ω star connection			1.0	μs
Output turn-off time	t_{OFFH}				1.0	μs
<Torque order part>						
Control standard input votlage range	ECR		0.3		4.0	V
Control input voltage range	EC		0.3		4.0	V
Input current	I_{IN}	EC, ECR = 0.5 to 3.0 V			70	μA
Input voltage difference	ECR-EC	Duty = 100%, ECR = 2 V exclusing dead zone		0.75		V
Dead zone (+)	EC_d+	ECR = 2 V	0	65	100	mV
Dead zone (–)	EC_d–	ECR = 2 V	0	–65	–100	mV
<Over current detection part>						
Input offset voltage	V_{IO}		–15		15	mV
CL terminal voltage	V_{CL}		90	100	110	mV

Thermal shut down circuit (TSD) works in $T_{CH} >$ 150°C.

Low voltage malfunction prevention circuit (UVLO) works in 4 V (TYP.).

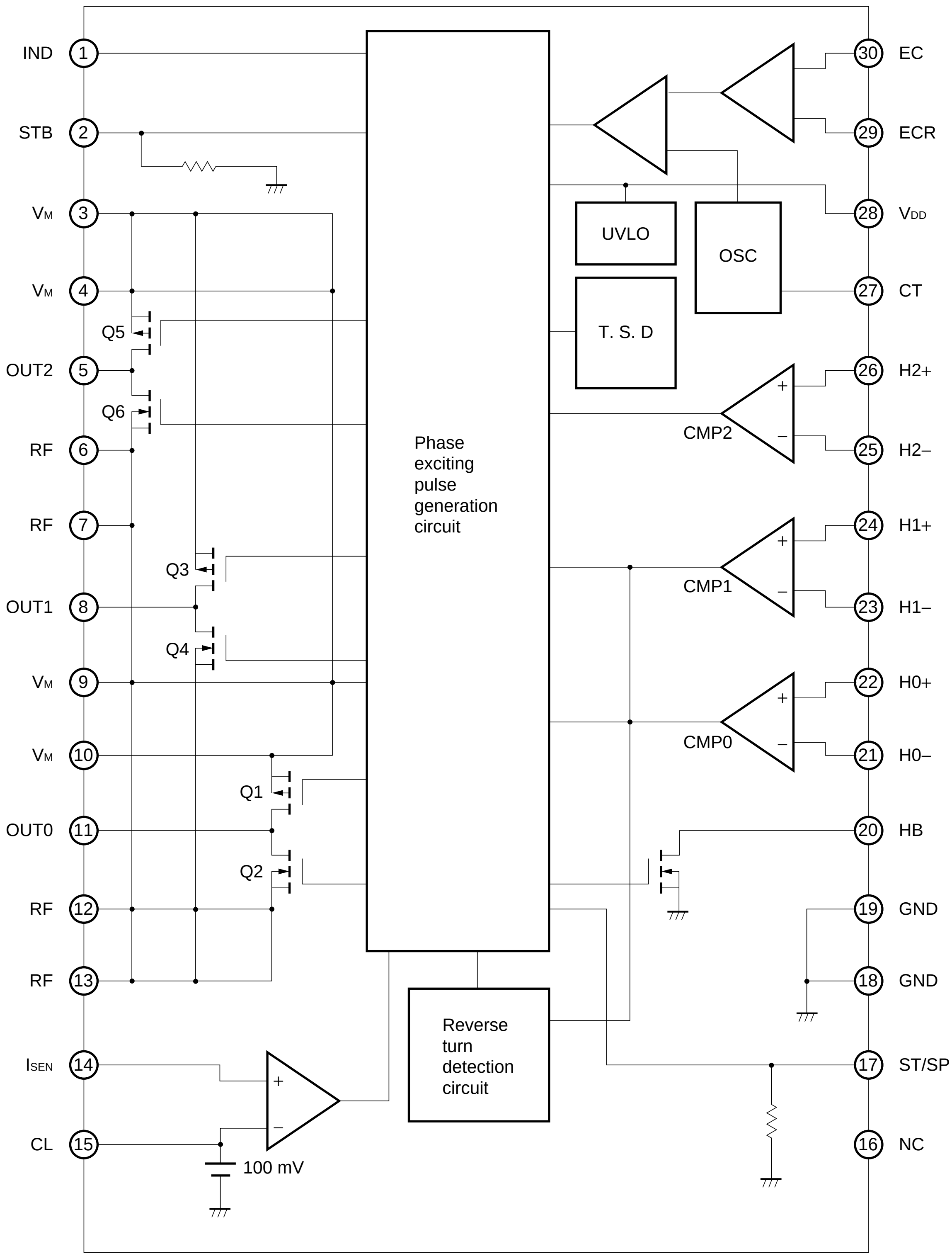
PIN CONNECTION



Pin No.	Pin name	Terminal function
1	IND	Index signal output terminal
2	STB	Standby mode input terminal
3	V_M	Supply voltage input terminal for motor part
4	V_M	Supply voltage input terminal for motor part
5	OUT2	Motor connection terminal (W-phase)
6	RF	3 pahse bridge common terminal
7	RF	3 phase bridge common terminal
8	OUT1	Motor connection terminal (V-phase)
9	V_M	Supply voltage input terminal for motor part
10	V_M	Supply voltage input terminal for motor part
11	OUT0	Motor connection terminal (U-phase)
12	RF	3 phase bridge common terminal
13	RF	3 phase bridge common terminal
14	I_{SENSE}	Sense resistance connection terminal
15	C_L	Over current detection voltage filter terminal
16	NC	No connection
17	ST/SP	Start/Stop input terminal
18	GND	Ground terminal
19	GND	Ground terminal
20	HB	Hall bias terminal
21	H0–	Hall signal input terminal (U-phase)
22	H0+	Hall signal input terminal (U-phase)
23	H1–	Hall signal input terminal (V-phase)
24	H1+	Hall signal input terminal (V-phase)
25	H2–	Hall signal input terminal (W-phase)
26	H2+	Hall signal input terminal (W-phase)
27	C_T	Oscillation frequency setting condenser connection terminal
28	V_{DD}	Supply voltage input terminal for control part
29	ECR	Control standard voltage input terminal
30	EC	Control voltage input terminal

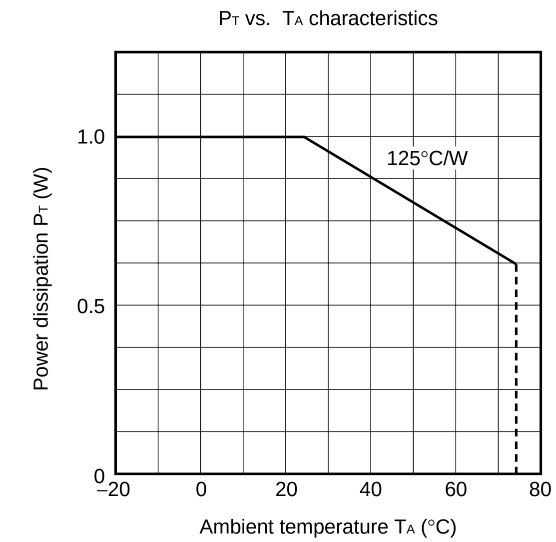
Caution Plural terminal (V_M, RF, GND) is not only 1 terminal and connect all terminals.

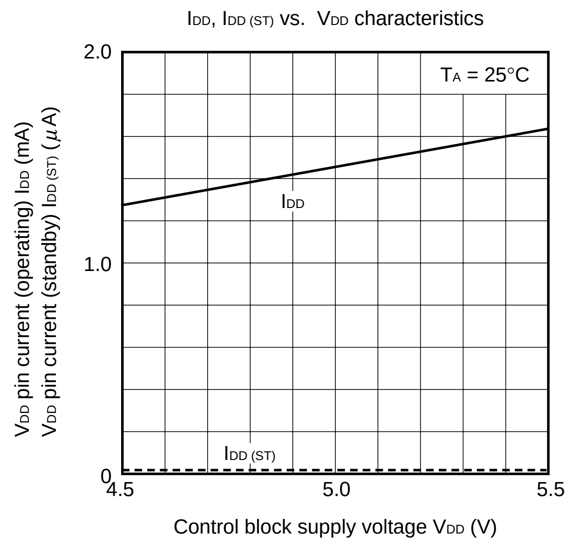
BLOCK DIAGRAM

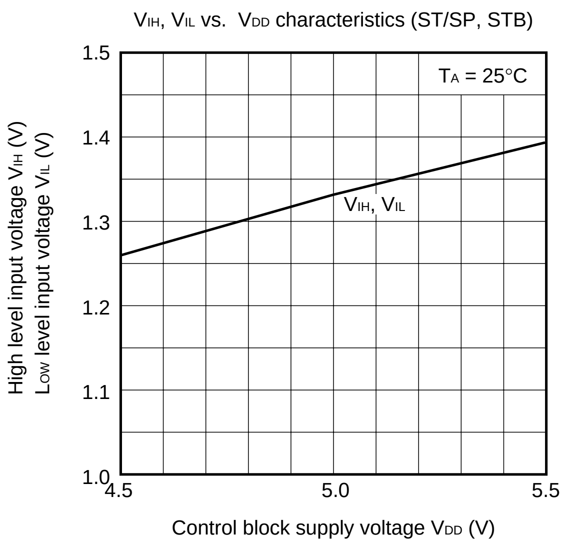


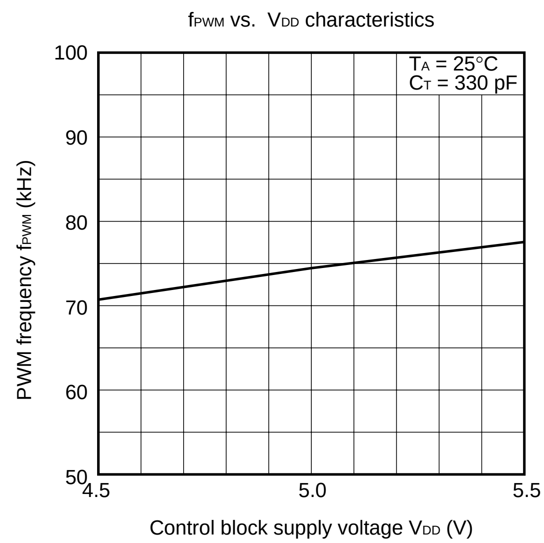
Caution Plural terminal (V_M, RF, GND) is not only 1 terminal and connect all terminals.

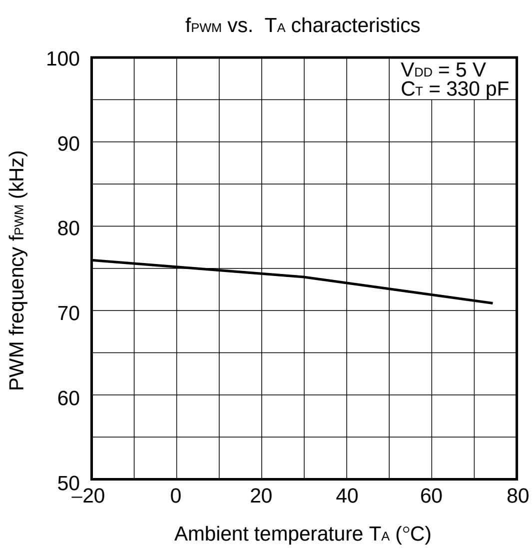
TYPICAL CHARACTERISTICS (T_A = 25°C)

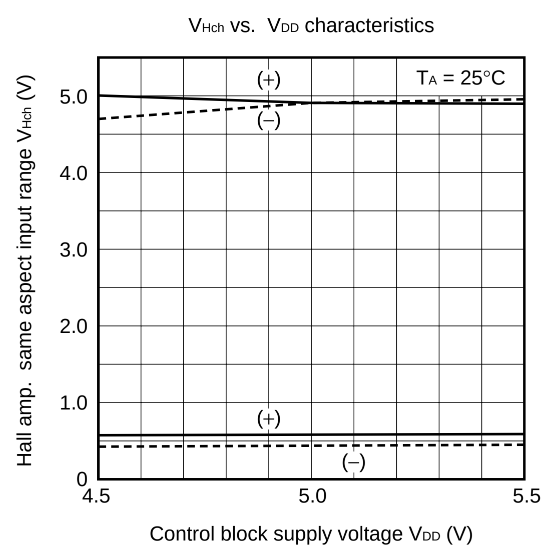




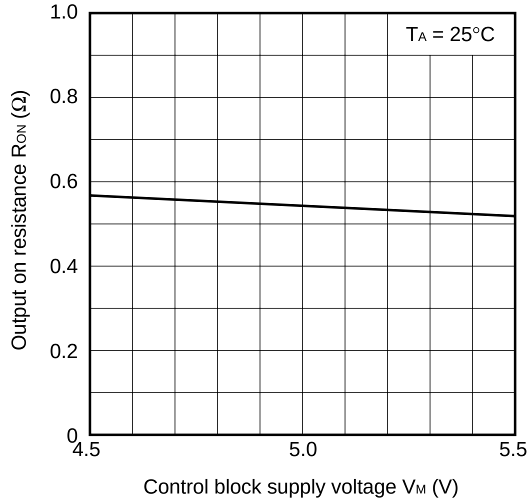




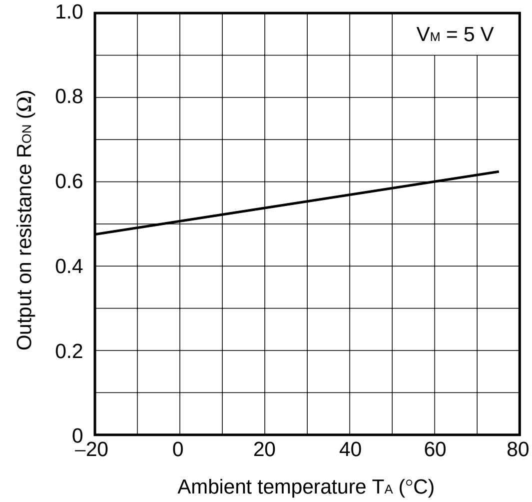




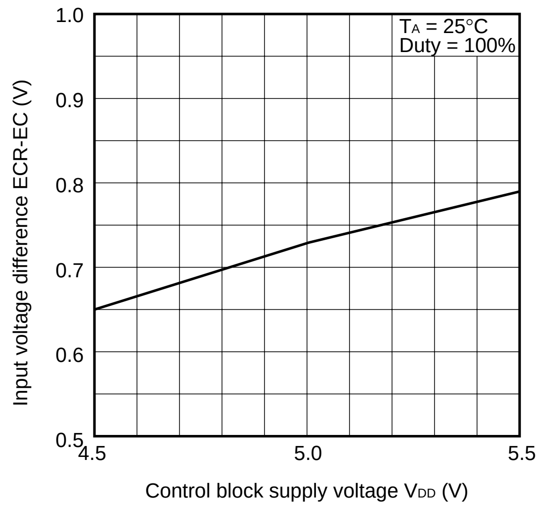
RON, vs. VM characteristics



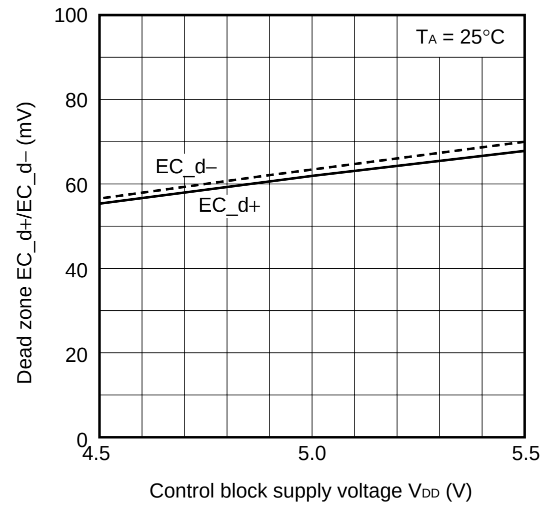
RON, vs. TA characteristics



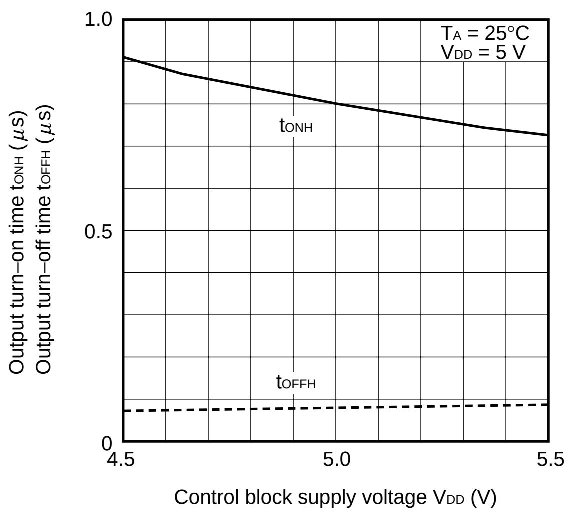
(ECR-EC) vs. VDD characteristics



EC_d+/EC_d– vs. VDD characteristics



tONH, tOFFH vs. VM characteristics



FUNCTION OPERATION TABLE

(1) ST/SP (start/stop) function

ON/OFF of the movement can be set up under the condition which makes oscillation circuit work. Setting is done with ST/SP terminal.

When ST/SP terminal is high level, it becomes active (operating) condition. And, when ST/SP terminal is low level, it becomes stop condition. It becomes short brake condition under the stop condition.

- **ST/SP = "H"**

Input signal (Hall amplifier output)				Operation mode	exciting phase
CMP 0	CMP 1	CMP 2	PWM		
H	H	L	H	ON	W → V
H	H	L	L	OFF	
H	L	L	H	ON	W → U
H	L	L	L	OFF	
H	L	H	H	ON	V → U
H	L	H	L	OFF	
L	L	H	H	ON	V → W
L	L	H	L	OFF	
L	H	H	H	ON	U → W
L	H	H	L	OFF	
L	H	L	H	ON	U → V
L	H	L	L	OFF	

In addition, the movement in OFF varies in the product.
Loop is composed through parasitic diode of the high-side MOSFET. (μPD16873/μPD16873A)
Loop is composed through channel of the high-side MOSFET. (μPD16873B/μPD16873C)

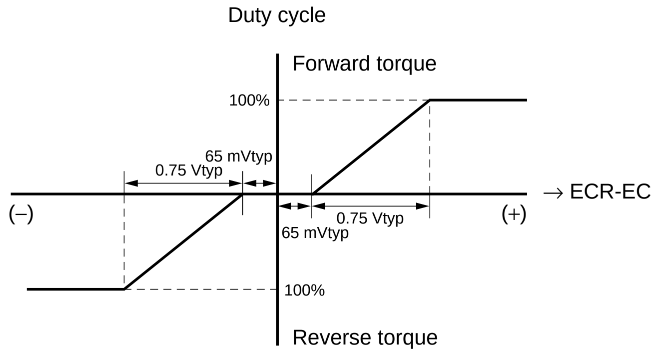
- **ST/SP = "L"**

Input signal (Hall amplifier output)				Operation mode
CMP 0	CMP 1	CMP 2	PWM	
–	–	–	–	Stop (short brake)

It becomes short brake condition. (High side switch is "ON" and low side switch is "OFF")

(2) Torque order

The relation between difference (ECR-EC) in control standard voltage (ECR) and control voltage (EC) and the torque is as follows.



Input voltage difference (ECR-EC) and output PWM duty becomes related to the proportion.
In addition, it becomes reverse brake when input voltage is ECR < EC. It stops after the reverse rotation of the motor is detected under reverse braking mode. If input voltage difference is zero (ECR = EC), it becomes short brake mode.

Input voltage difference	Output mode
ECR > EC	Forward turn
ECR = EC	Stop (short brake)
ECR < EC	Reverse turn[Note]

Note After detecting reverse, it stops.

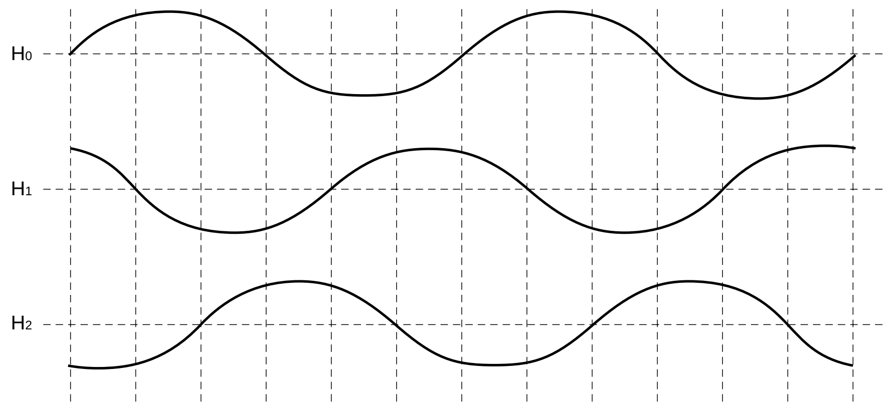
(3) Standby mode

By the setting of standby mode, the power supply inside μPD16873 can be made off.
Each output terminal at the time of standby mode becomes high impedance. Also, the oscillation block inside, too, stops and it is possible for the circuit current to reduce.

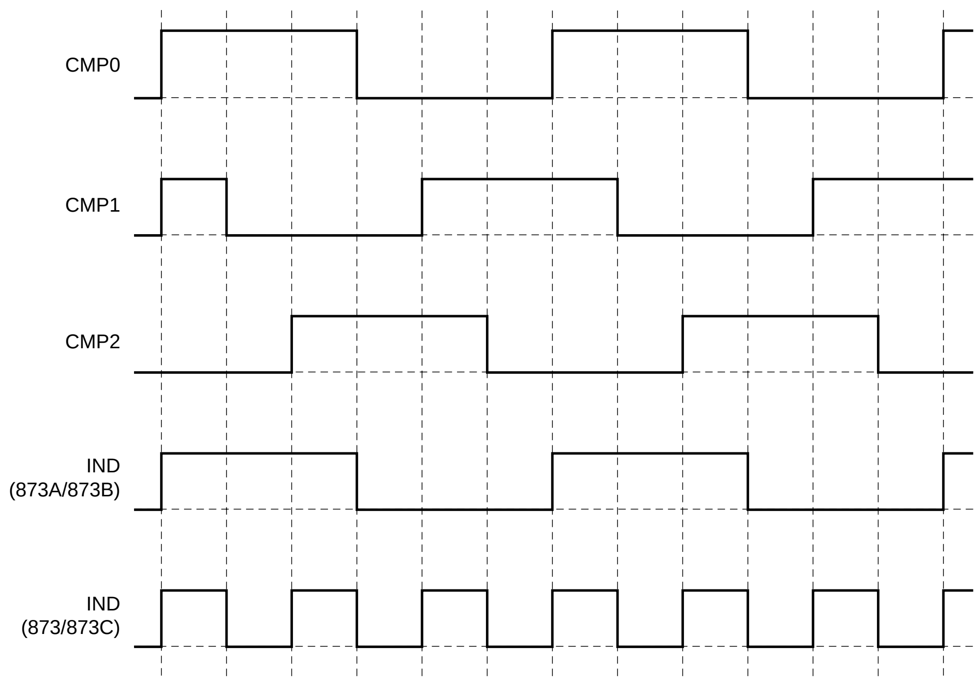
STB terminal	Operation mode
“H” level	Regular mode
“L” level	Standby mode

TIMING CHART

(1) Hall signal input



(2) CMP signal

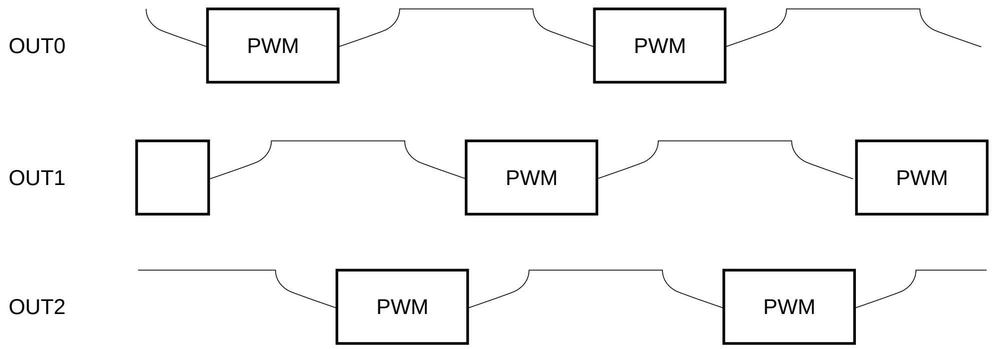


(3) Output MOSFET drive and comparator choice

Q1		($\overline{\text{SW}}$)	($\overline{\text{SW}}$)		ON	ON		($\overline{\text{SW}}$)	($\overline{\text{SW}}$)		ON	ON	
Q2		SW	SW					SW	SW				
Q3	($\overline{\text{SW}}$)		ON	ON		($\overline{\text{SW}}$)	($\overline{\text{SW}}$)		ON	ON		($\overline{\text{SW}}$)	($\overline{\text{SW}}$)
Q4	SW					SW	SW					SW	SW
Q5	ON	ON		($\overline{\text{SW}}$)	($\overline{\text{SW}}$)		ON	ON		($\overline{\text{SW}}$)	($\overline{\text{SW}}$)		ON
Q6				SW	SW					SW	SW		

Remark μPD16873/A are not synchronous switching. (Normal type PWM)
μPD16873B/C are synchronous switching of high-side MOSFET. (Synchronous type PWM)

(4) Output terminal voltage wave



Caution

(1) About output current

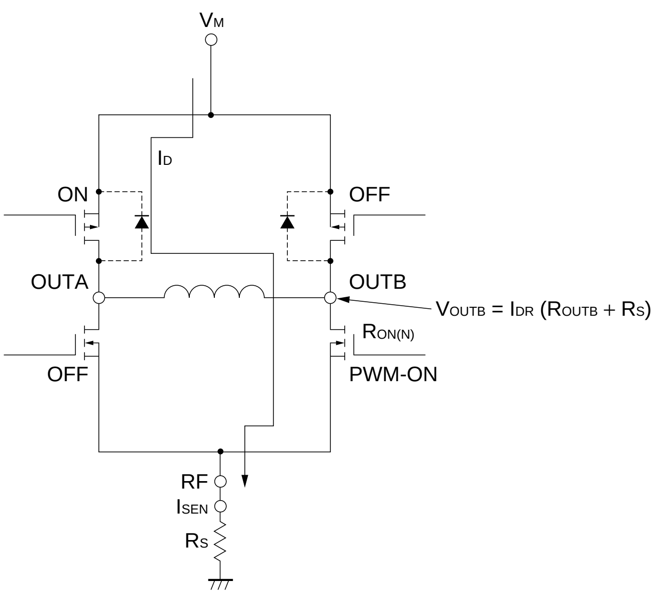
The rated ouptut current differs depending on whether the motor revolves at a constant speed (steady state), is started (steady state), or Reverse brake is applied. The rated DC current when the motor revolves at a constant speed is 0.5 A, and the rated instantaneous current when the is started is 1.3 A. When the motor is stopped by using Reverse brake, the maximum current is 1.9 A.

When use Reverse brake, a current exceeding that when the motor revolves at a constant speed (immediately before a brake is applied) instantaneously flows because of the counter electromotive force due to the motor inductance. Determine the value of over current for steady state, taking the peak current for using Reverse brake to the motor into consideration.

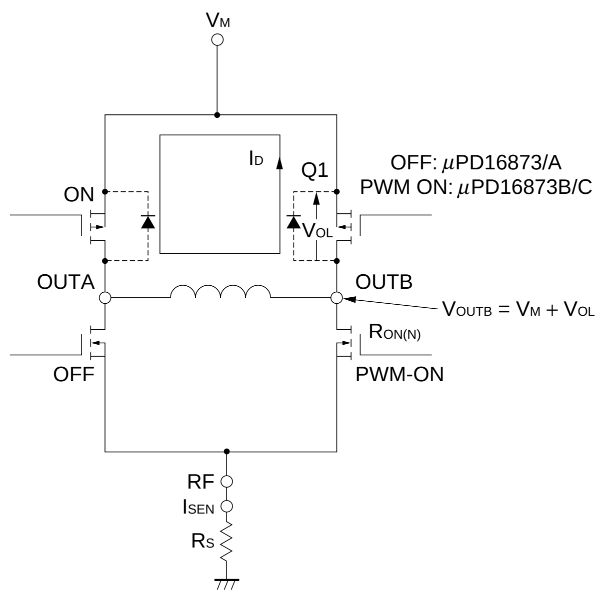
(2) About output pin voltage

Output terminal (OUT0, OUT1, OUT2) takes the voltage which exceeds a motor power supply during following counter current.

Maximum rate of output pin voltage is 6.7 V. Be careful that an output terminal doesn't take a voltage over 6.7 V.

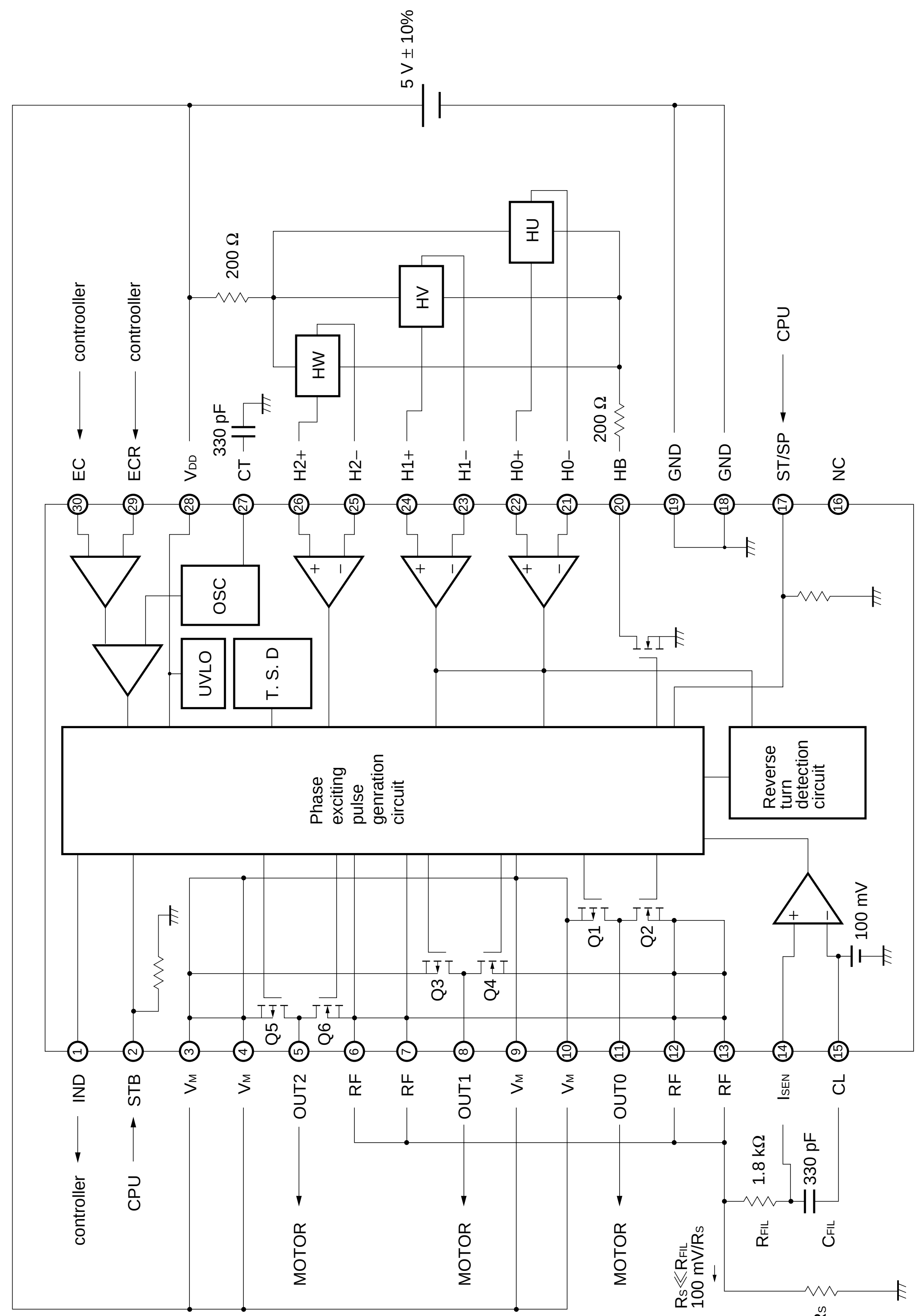


Lower Nch MOC: PWM-ON time



Lower Nch MOC: PWM-OFF time

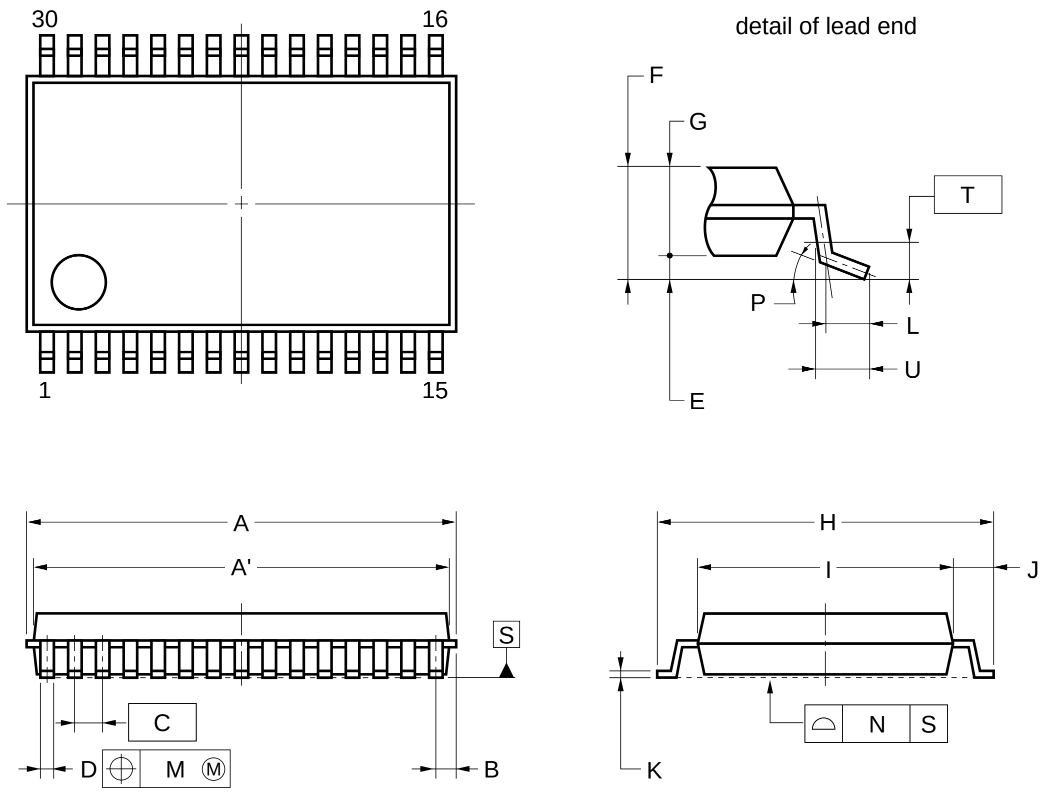
APPLICATION CIRCUIT EXAMPLE



Caution **If hall elements connected series, please change hall bias resistances, and hall signal include into same aspect input range of hall amplifier.**

PACKAGE DIMENSION

30-PIN PLASTIC TSSOP (7.62mm(300))



NOTE

Each lead centerline is located within 0.10 mm of its true position (T.P.) at maximum material condition.

ITEM	MILLIMETERS
A	9.85±0.10
A'	9.7±0.1
B	0.375
C	0.65 (T.P.)
D	0.24±0.05
E	0.1±0.05
F	1.2 MAX.
G	1.0±0.05
H	8.1±0.1
I	6.1±0.1
J	1.0±0.1
K	0.145±0.025
L	0.5
M	0.10
N	0.10
P	$3°{}^{+5°}_{-3°}$
T	0.25
U	0.6±0.15

S30MC-65-6A4

RECOMMENDED SOLDERING CONDITIONS

Solder this product under the following recommended conditions.
For soldering methods and conditions other than those recommended, consult NEC.

For details of the recommended soldering conditions, refer to information document **“Semiconductor Device Mounting Technology Manual**”.

Soldering Method	Soldering Conditions	Recommended Condition Symbol
Infrared reflow	Package peak temperature: 235°C; Time: 30 secs. max. (210°C min.); Number of times: 3 times max.; Number of day: none; 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: 3 times max.; Number of day: none; Flux: Rosin-based flux with little chlorine content (chlorine: 0.2 Wt% max.) is recommended.	VP15-00-3
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

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

NOTES FOR CMOS DEVICES

① PRECAUTION AGAINST ESD FOR SEMICONDUCTORS

Note:

Strong electric field, when exposed to a MOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop generation of static electricity as much as possible, and quickly dissipate it once, when it has occurred. Environmental control must be adequate. When it is dry, humidifier should be used. It is recommended to avoid using insulators that easily build static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work bench and floor should be grounded. The operator should be grounded using wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions need to be taken for PW boards with semiconductor devices on it.

② HANDLING OF UNUSED INPUT PINS FOR CMOS

Note:

No connection for CMOS device inputs can be cause of malfunction. If no connection is provided to the input pins, it is possible that an internal input level may be generated due to noise, etc., hence causing malfunction. CMOS devices behave differently than Bipolar or NMOS devices. Input levels of CMOS devices must be fixed high or low by using a pull-up or pull-down circuitry. Each unused pin should be connected to V_{DD} or GND with a resistor, if it is considered to have a possibility of being an output pin. All handling related to the unused pins must be judged device by device and related specifications governing the devices.

③ STATUS BEFORE INITIALIZATION OF MOS DEVICES

Note:

Power-on does not necessarily define initial status of MOS device. Production process of MOS does not define the initial operation status of the device. Immediately after the power source is turned ON, the devices with reset function have not yet been initialized. Hence, power-on does not guarantee out-pin levels, I/O settings or contents of registers. Device is not initialized until the reset signal is received. Reset operation must be executed immediately after power-on for devices having reset function.