HA13471A, HA13472A

Three-Phase Motor Drive with Speed Discriminator

Description

HA13471A and HA13472A are three-phase brushless DC motor drive IC of 2A/phase and 4A/phase and have following functions.

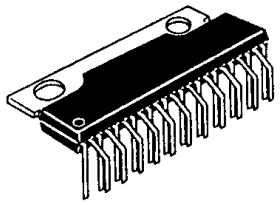
Features

- Soft switching (No spike voltage at commutation)
- Snubberless
- Large current capability
  - 2A/phase (HA13471A)
  - 4A/phase (HA13472A)
- High efficiency. Low noise driving

Functions

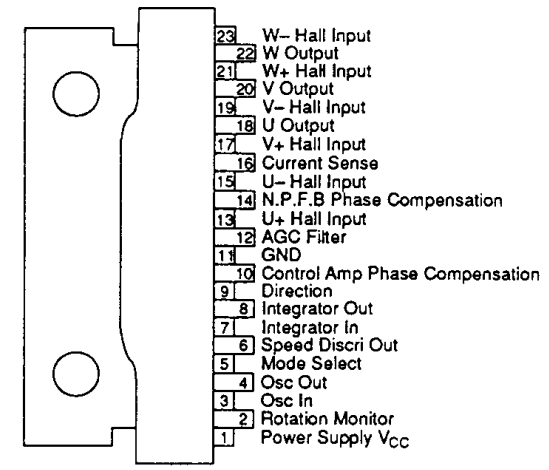
- Three phase output circuit
- Hall amp, Matrix with AGC
- Neutral point feed back
- Direction
- Output inhibit
- Oscillation circuit
- Mode select (1/4, 1/2, 1/1)
- Speed discriminator
- Integrator
- Control amp
- Current limiter
- Low voltage inhibit (LVI)
- Over temperature shutdown circuit (OTSD)

HA13471A



(SP-23TA)

Pin Arrangement

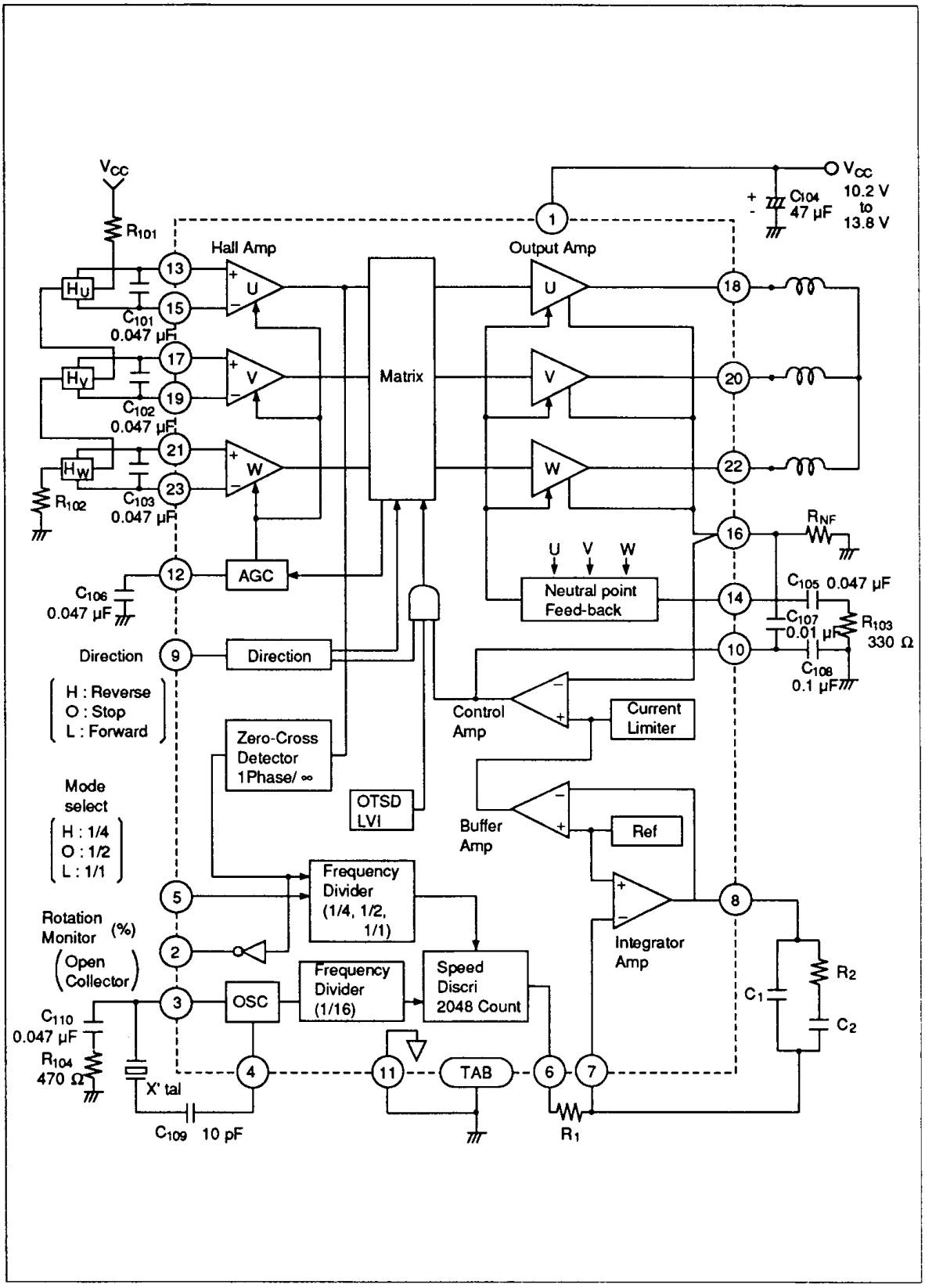


(Top View)

Ordering Information

Type No.	Package
HA13471A	SP-23TA
HA13472A	SP-23TA

Block Diagram



Absolute Maximum Ratings (Ta = 25°C)

Item	Symbol	Rating HA13471A	Rating HA13472A	Unit	Notes
Supply Voltage	V_{CC}	+15	+15	V	1
Input Voltage	V_{in}	V_{CC}	V_{CC}	V	2
Output Current	I_O	2	4	A	3
Power Dissipation	P_T	15 (at T_C = 105°C)	30 (at T_C = 60°C)	W	4
Junction Temperature	T_j	150	150	°C	5
Storage Temperature	T_{stg}	–55 to +125	–55 to +125	°C	

The absolute maximum ratings are limiting values, to be applied individually, beyond which the device may be permanently damaged. Functional operation under any of these conditions is not guaranteed. Exposing a circuit to its absolute maximum rating for extended periods of time may affect the device's reliability.

Notes: 1. Operating voltage range is 12 V ±15% (10.2 ~ 13.8 V)

2. Applied to Hall amp, Direction and Mode select Input

3. ASO of each power transistor is shown below. Operating locus must be with in the ASO

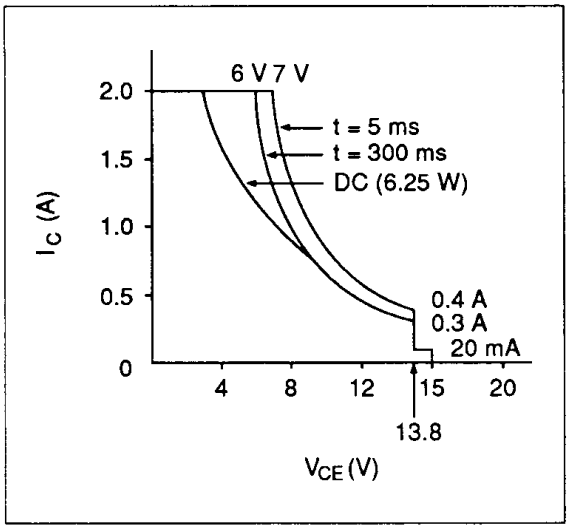


Figure 1 HA13471A

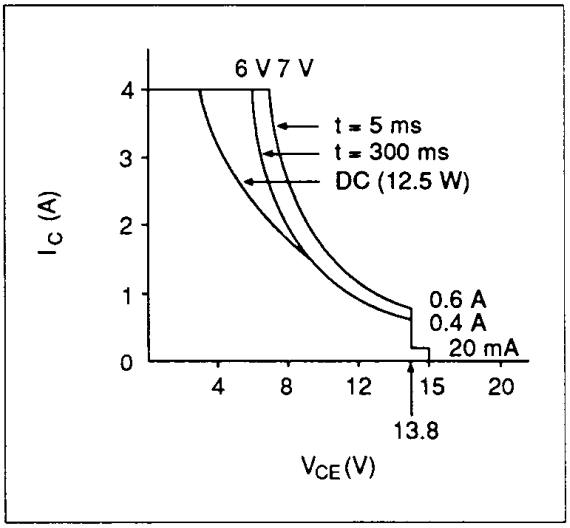


Figure 2 HA13472A

4. Thermal resistance is shown below

$\theta j - c \leq 3°C/W$

$\theta j - a \leq 40°C/W$

5. The operating junction temperature range is T_{opr} = 0°C to 125°C

Electrical Characteristics (Ta = 25°C, V_{CC} = 12 V)

Item		Symbol	Min	Typ	Max	Unit	Test Conditions	Pins	Notes
Dissipation current		I_{CC}	—	22	33	mA		1	
Hall amp	Input impedance	R_{hi}	7	10	15	kΩ		13, 15, 17,	
	Common mode voltage range	V_H	2.5	—	V_{CC} −2.5	V		19, 21, 23	4
	Differential voltage range	v_h	75	—	300	mV			
Output amp	Leak current	I_{CER}	—	—	2	mA	V_{CE} = 15 V	18, 20, 22	
	Saturation voltage	V_{sat1}	—	2.8	3.2	V	I_O = 3.0 A (1.5 A)		1
		V_{sat2}	—	1.7	2.0	V	I_O = 0.6 A (0.3 A)		1
Current limiter	Internal reference voltage	V_{ref1}	0.225	0.25	0.275	V	R_{NF} = 1.0 Ω	16	
Buffer amp	Internal reference voltage	V_{ref2}	$V_{CC}/2$ −10%	$V_{CC}/2$	$V_{CC}/2$ +10%	V		7	
	Voltage gain	G_{CTL}	−2	0	+2	dB	Pin 8 to Pin 16	16	
Integrating amp	Input bias current	I_B(ER)	—	—	±60	nA		7	
	Voltage swing	A^+	0.55	0.7	0.85	V	I_O = 0.5 mA	8	2
		A^-	−0.55	−0.7	−0.85	V	I_O = −0.5 mA		2
	Band width	BW	—	1.4	—	MHz	G_V = 0 dB		3
Speed discriminator	Output high voltage	V_{OH}	V_{CC} −0.3	—	—	V	I_O = 0.5 mA	6	
	Output low voltage	V_{OL}	—	—	0.2	V	I_O = −0.5 mA		
	Cutoff current	I_{off}	—	—	±60	nA			
	Count number		—	2048	—				
Oscillator	Frequency error	f_{err}	—	—	±0.1	%	X'tal f_{osc} = 8.0 MHz	4	
	Operating frequency	f_{osc}	—	—	8	MHz	X'tal		
Direction	Input high voltage	V_{IH}	3.6	—	—	V	Reverse	9	
	Input middle voltage	V_{IM}	2.2	—	2.8	V	Stop		
	Input low voltage	V_{IL}	—	—	1.4	V	Forward		
	Input high current	I_{IH}	—	0.54	0.8	mA	V_{IH} = 5.5 V		
	Input low current	I_{IL}	—	−0.54	−0.8	mA	V_{IL} = 0.0 V		
Driver	Input high voltage	V_{IH2}	3.6	—	—	V	Ratio; 1/4	5	
	Input middle voltage	V_{IN2}	2.2	—	2.8	V	Ratio; 1/2		
	Input low voltage	V_{IL2}	—	—	1.4	V	Ratio; 1/1		
	Input high current	I_{IH2}	—	0.54	0.8	mA	V_{IH2} = 5.5 V		
	Input low current	I_{IL2}	—	−0.54	−0.8	mA	V_{IL2} = 0.0 V		

Electrical Characteristics (Ta = 25°C, V_{CC} = 12 V) (cont)

Item		Symbol	Min	Typ	Max	Unit	Test Conditions	Pins	Notes
Rotation monitor	Output leak current	I_{CER2}	—	—	100	µA	V_{CE} = 15 V	2	
	Output low voltage	V_{OL2}	—	—	0.4	V	I_O = 1 mA		
LVI operating voltage			—	—	8.0	V			
OTSD operating temperature		T_{sd}	125	150	—	°C			3

Notes:
1. Sum of upper and lower saturation voltage.
2. Measure from V_{ref2}
3. Design guide only
4. Operating area for V_H and vh is shown below

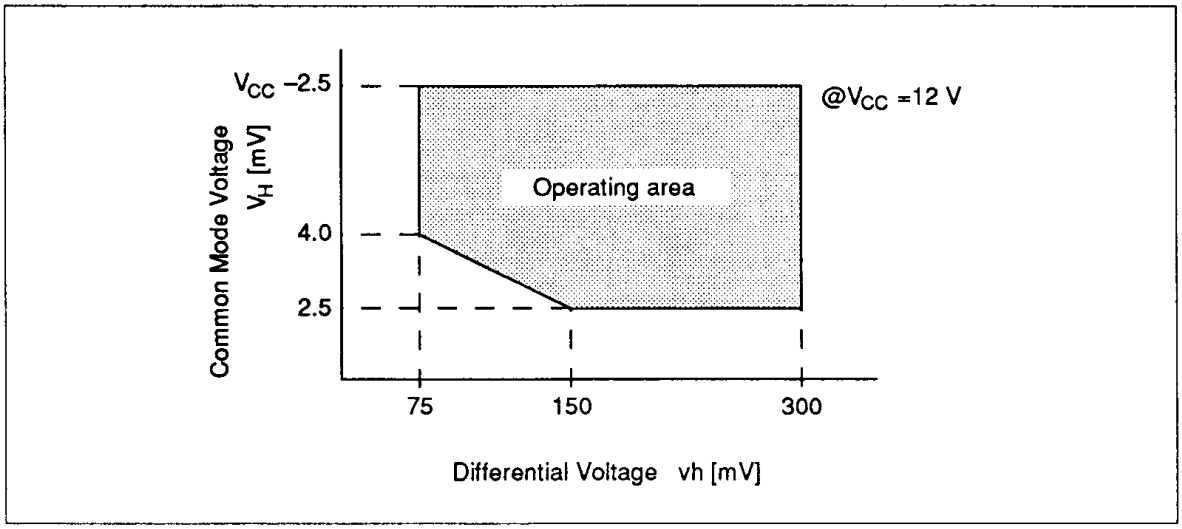
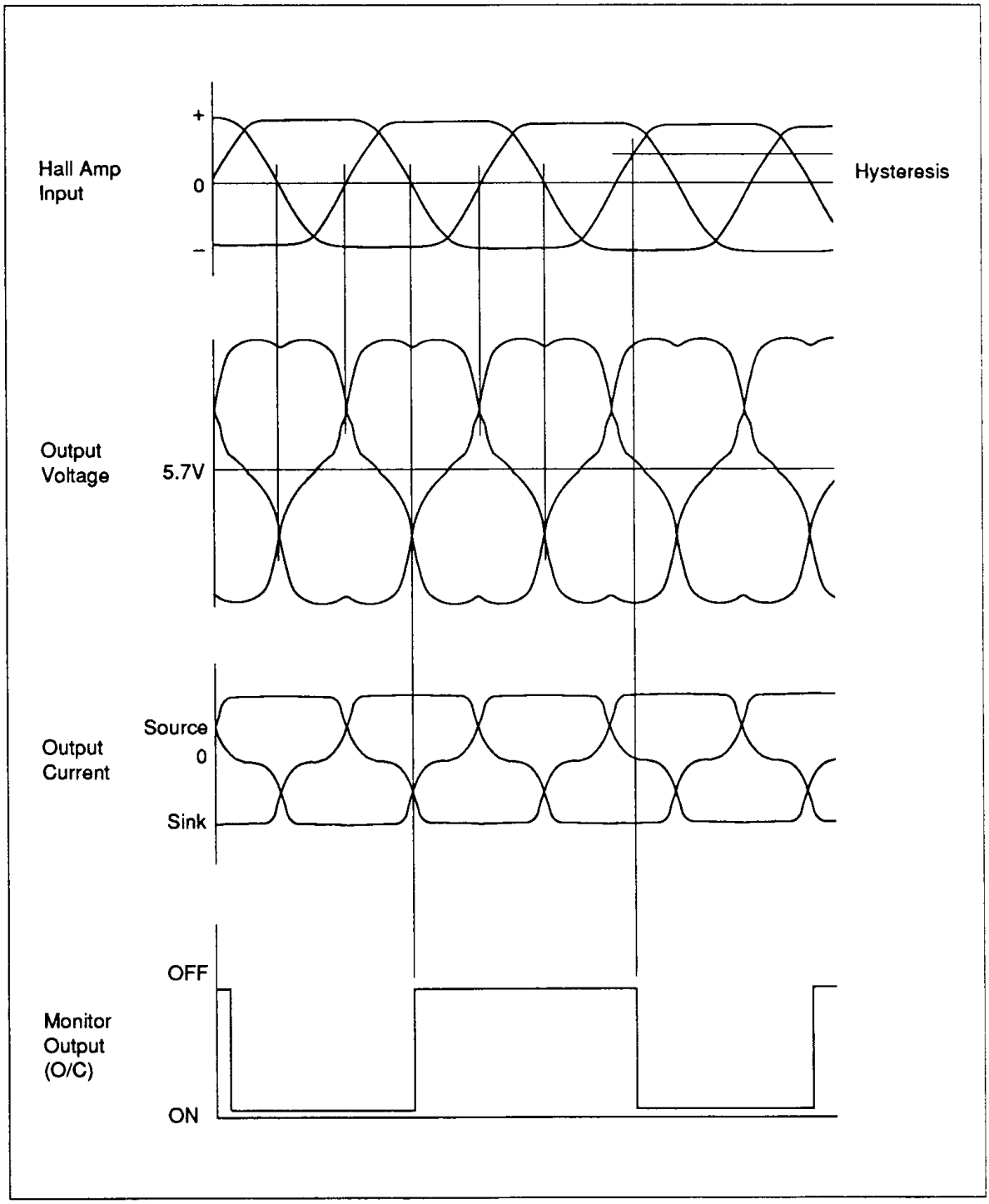


Figure 3 Hallamp Operating Area

Timing Chart



External Components

Parts No.	Recommended value HA13471A 3.5" × 2 disks	Recommended value HA13472A 5.25" × 6 disks	Purpose	Notes
R_{101}, R_{102}	560 Ω	560 Ω	Hall element bias	1
R_{103}	330 Ω	330 Ω	Stability	
R_{104}	470 Ω	470 Ω	Oscillation stability	2
R_1	470 kΩ	68 kΩ	Integral constant	3
R_2	560 kΩ	560 kΩ		
R_{NF}	0.33 Ω × 2 para	0.33 Ω × 4 para	Current detector	4
C_{101}, C_{102}, C_{103}	0.047 µF	0.047 µF	Stability	
C_{104}	≥ 47 µF	≥ 47 µF	By-pass	
C_{105}	0.047 µF	0.047 µF	NPF phase compensation	
C_{106}	0.047 µF	0.047 µF	AGC filter	
C_{107}	0.01 µF	0.01 µF	CTL Amp	
C_{108}	0.1 µF	0.1 µF	Phase compensation	
C_{109}	10 pF ±1%	10 pF ±1%	AC-coupling	
C_{110}	0.047 µF	0.047 µF	Stability	2
C_1	0.022 µF	0.022 µF	Integral constant	3
C_2	0.22 µF	0.22 µF		
D_1, D_2, D_3	—	—	Output clamp	5
X'tal	—	—	Oscillator	6

Notes:
1. Set R_{101}, R_{102} in order to get Hall element output within 75 to 300 mV_{PP}
2. Unnecessary below 4 MHz frequency
3. The optimum value depends on the motor (Inertia, Torque constant Rotation)
4. Output Current is limited as shown below
   $I_{omax} = V_{ref1}/R_{NF}$
5. It must be noted that some motors requires protection for speed discriminator misoperation
6. OSC frequency fosc is determined by following equation

$$f_{osc} = \frac{16 \times 2048 \times f_H}{m} = \frac{16 \times 2048}{m} \times \frac{No}{60} \times \frac{P}{2} \text{ (Hz)}$$

Where

f_H	:	frequency of hall amp input signal	
No	:	rotation Number	
P	:	pole Number	
m	:	frequency divider constant	
		m = 1	(@ Pin 5 = Low)
		= 2	(@ Pin 5 = Open)
		= 4	(@ Pin 5 = High)

In case of large jitter of hall amp input signal, select divider constant m as follows

4 pole motor → m = 2

8 pole motor → m = 4