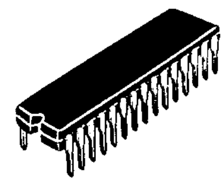
HA13484NT — Preliminary

Three-phase Brushless Motor PWM Controller with Digital Speed Control

Description

HA13484/NT are PWM control IC for general use three-phase brushless DC motor and have following functions and features.

HA13484NT



(DP-30S)

Functions

- Three-phase commutation circuit
- PWM control system
- Digital speed control system
- FG amp
- CLK oscillator
- Ready
- Direction
- Chip enable
- Current limiter
- Hall amps input dis-connection protect
- Low voltage inhibit

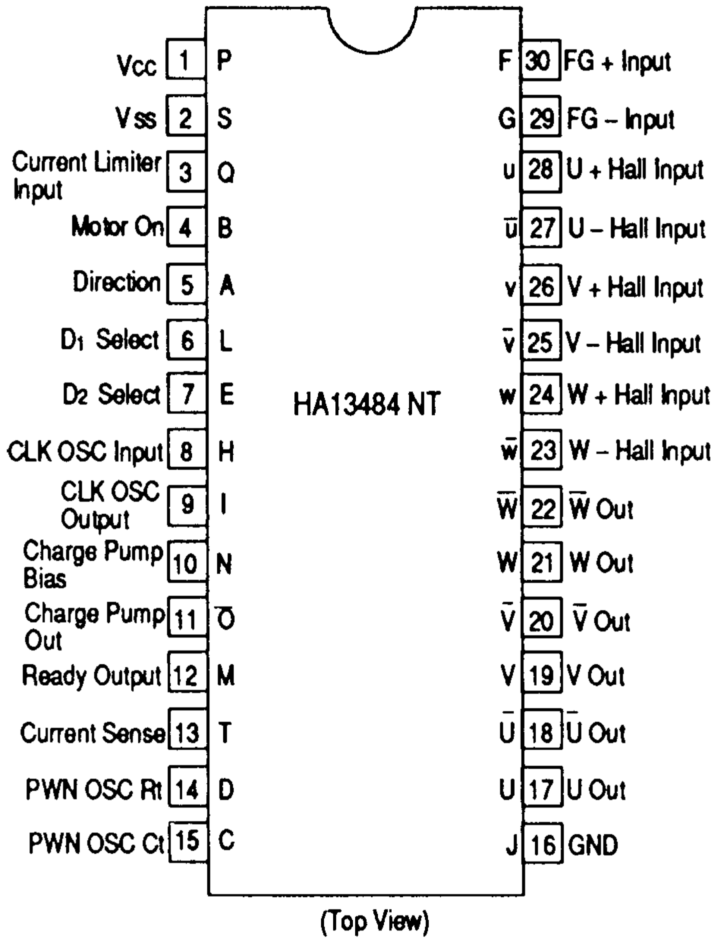
Features

- Wide operating voltage range
  4.25 to 24.5 V
- Can handle various CLK frequency
- Can adjust limiting current by DC input

Ordering Information

Type No.	Package
HA13484NT	400mil 30pin plastic shrink DIP (DP-30S)

Pin Arrangement



HA13484NT

Block Diagram

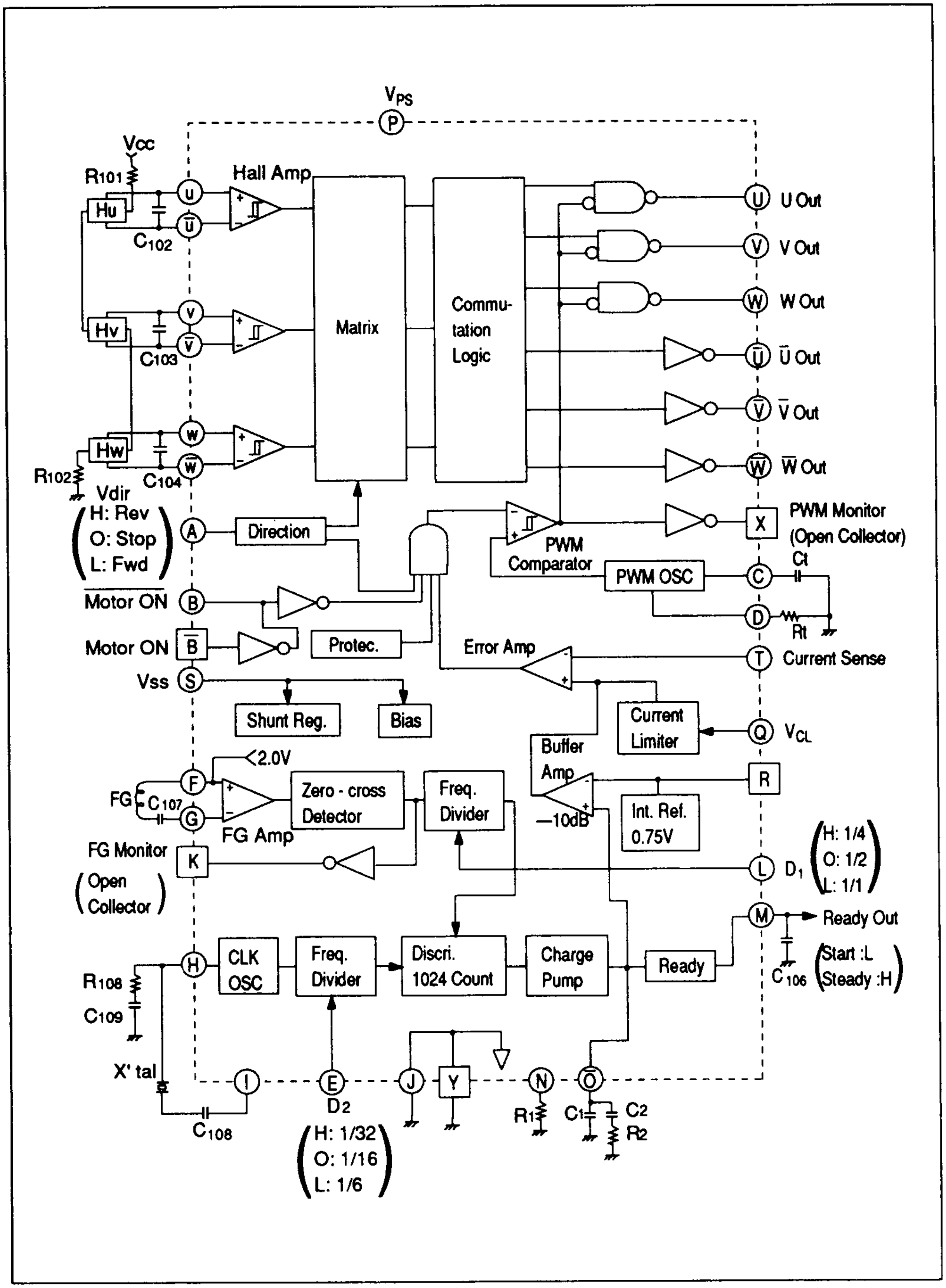


Table 1 External Components

Parts No.	Recommended value	Purpose	Note
R_{101}, R_{102}	—	Hall elements bias	1
R_{103}, R_{203}, R_{303}	—	For speed up	
R_{104}, R_{204}, R_{304}	—	For limiting sink current	2
R_{105}, R_{205}, R_{305}	—	For limiting sink current	2
R_{106}		For stability	
R_{107}	—	Bias for regurator	3
R_{108}	470 Ω	OSC stability	4
R_1, R_2	—	Integral constant	5
Rt	6.8 kΩ	Time constant ror PWM OSC	6
R_{NF}	—	Current sense	7
C_{101}, C_{102}, C_{103}	0.047 µF	For stability	
C_{104}	≥0.1 µF	Vcc by-passing	
C_{105}		For stability	
C_{106}	1.0 µF	Filter for ready	
C_{107}	1.0 µF	FG coupling	8
C_{108}	10 pF	AC coupling for OSC	
C_{109}	4700 pF	OSC stability	4
C_1, C_2	—	Integral constant	5
Ct	2200 pF	Time constant for PWM OSC	6
Q_1, Q_2, Q_3	—	Source output transistor	
Q_4, Q_5, Q_6	—	Sink output transistor	
D_1, D_2, D_3, D_4, D_5, D_6	—	Clamp diode	
X'tal	—	Reference resonator	9

Notes: 1. Set R_{101}, R_{102} in order to get hall element output more than 100 mV_{PP}.

2. R_{X04} and R_{X05} should be designed as

$$R_{X04}(k\Omega) \geq \frac{V_{CC}(V) - V_{BE}(V)}{20}, \quad R_{X05}(k\Omega) \geq \frac{V_{CC}(V)}{20}$$

Where V_{BE} is the base-emitter voltage of Q_1 to Q_3.

3. R_{107} should satisfy the following equation.

$$\frac{V_{CC}\,max(V) - 6.3}{0.06} \leq R_{107}(\Omega) \leq \frac{V_{CC}\,min(V) - 6.3}{0.03}$$

Table 3 Absolute Maximum Ratings (Ta = 25 °C)

Item	Symbol	Rating	Unit	Note
Supply voltage	V_{PS}	34.5	V	1
Input voltage	Vin	0 to Vss	V	2
Output current	Iout	30	mA	
Vss input current	Iss	60	mA	
Power dissipation	P_T	650	mW	
Operating temperature range	Topr	–20 to +70	°C	
Storage temperature range	Tstg	–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. Recommended operating voltage range as follows.
V_{PS} = 4.25 to 34.5 V
Vss = 4.25 to Vreg

2. Apply to pin A, B, $\overline{B}$, E, L and T.

Table 4 Electrical Characteristics (Ta = 25 °C, V_{PS} = 24 V, Vss = 5.0 V)

Item		Symbol	Min	Typ	Max	Unit	Test conditions	Application terminal	Note
Supply current		I_{PS}	—	2.5	4.0	mA	V_{PS} = 34.5 V	P	
		Iss	—	20	30	mA	Vss = 6.0 V	S	
Shunt reg.	Reg. voltage	Vreg	6.0	6.5	7.0	V	Iss = 30 to 60 mA	S	1
	Operating tegistance	Rd	—	—	15	Ω	Iss = 30 to 60 mA		

Electrical Characteristics (Ta = 25 °C, V_{PS} = 24 V, V_{SS} = 5.0 V) (cont)

$\overline{\text{Motor ON}}$ & Motor ON	Input low voltage	V_{IL1}	—	—	0.8	V		B, $\overline{B}$	
	Input high voltage	V_{IH1}	2.0	—	—	V			
	Input current	I_{I1}	—	—	±10	μA	Vin = 0 V to Vss	B	
		I_{IL1}	—	60	200	μA	Vin = 0 V	$\overline{B}$	
		I_{IH1}	—	—	±10	μA	Vin = Vss		
Direction D_1 & D_2	Input low voltage	V_{IL2}	—	—	1.0	V		A, E, L	
	Input middle voltage	V_{IM2}	1.75	—	2.75	V			
	Input high voltage	V_{IH2}	3.5	—	—	V			
	Input current	I_{I2}	—	—	±10	μA	Vin = 0 V to Vss		
Hall amp	Input common mode voltage range	V_H	2.1	—	V_{PS} −1.9	V		u, $\overline{u}$, v, $\overline{v}$, w, $\overline{w}$	
	Hysteresis	HYS_H	—	20	—	mV			2
	Input current	I_H	—	—	±15	μA	Vh = 12 V		
Output	Leak current	I_{CER}	—	—	100	μA	V_{CE} = 34.5 V	U, $\overline{U}$, V, $\overline{V}$, W, $\overline{W}$	
	Saturation voltage	Vsat	—	—	0.4	V	Iout = 20 mA		
	Transition time	t_{pHL}	—	0.25	—	μs	R_L = 1.2 kΩ turn-on	U, V, W	
		t_{pLH}	—	0.3	—	μs	turn-off		
PWM OSC	Rt bias voltage	V_{Rt}	—	1.25	—	V	Rt = 6.8 kΩ	D	
	Operating frequency range	fp	5	—	100	kHz		C	
	Amplitude	A	—	2.0	—	V_{PP}			
Error amp	input current	Ier	—	—	±5	μA	Vi = 0 to 1.0 V	T	
Buffer amp	Int. ref. voltage	V_{ref1}	—	0.75	—	V		R	
	Voltage gain	Gctl	—	−10	—	dB	Pin 0 to T	T	

Electrical Characteristics (Ta = 25 °C, V_{PS} = 24 V, V_{SS} = 5.0 V) (cont)

Current limiter	Input current	I_{CL}			±5	μA	V_{CL} = 0 to Vss	Q	
	Offset voltage	V_{OS}	−10	−25	−40	mV	V_{CL} =0 to 1.0 V		
Charge Pump	R_1 bias voltage	V_{R1}	—	1.25	—	V	R_1 = 15 kΩ	N	
	Charge current	I_{CHA}	—	$\frac{VR_1}{4R_1}$	—	A	R_1 =15 kΩ	O	
	Discharge current	I_{DIS}	—	$-\frac{VR_1}{4R_1}$	—	A	R_1 = 15 kΩ		
	Leak current	Ioff	—	—	±50	nA			
FG amp	Input bias voltage	V_{FG}	—	1.95	—	V		F	
	Input resistance	R_{FG}	—	800	—	Ω		F, G	
	Input voltage range	V_{inFG}	8	—	50	mV_{PP}			
	Noise margin	nd	—	—	2	mV_{PP}	Differential noise		
		nc	—	—	1.0	V_{PP}	Common mode noise		
CLK OSC	Maximumfrequency	fc	—	—	8.0	MHz		I	
Discri	Count number	N	—	1024	—	—		—	
Ready	Input threshold voltage	V_{IL3}	—	V_{ref1}	—	V		O	3
		V_{IH3}	—	V_{ref1} +3V_{CL}	—	V			
	Output current	Ir+	—	300	—	μA	Vout = 2 V Source	M	
		Ir−	—	−300	—	μA	Sink		
	Output low voltage	V_{OL3}	—	—	0.4	V			
	Output high voltage	V_{OH3}	4.5	5.0	5.5	V			
PWM & FG monitor	Leak current	I_{CER4}	—	—	±10	μA	Vout = 34.5 V	K, X	
	Output low voltage	V_{OL4}	—	—	0.4	V	Iout = 1.0 mA		
Protect	LVI threshold	Vsd	—	3.75	—	V		S	

Notes: 1. See Figure 1. And Rd can be calculated as:
$Rd(\Omega) = 33.3\ \Delta\ Vreg(V)$
2. See Timing chart.
3. See Figure 2.

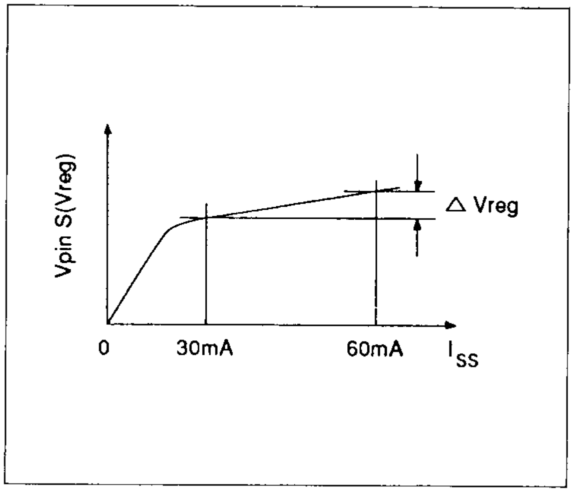


Figure 1.

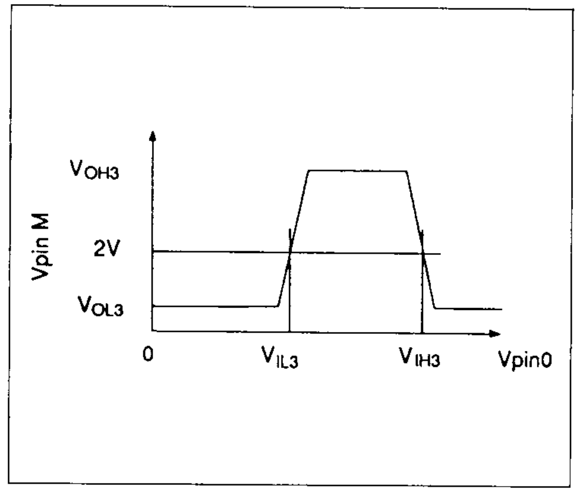


Figure 2.

4. Not necessary if the CLK frequency is less than 4MHz.
5. The integral constant can be designed as

$$\omega_0 \leq \frac{2\pi f_{FG} D_1}{20} \quad \text{(rad/s)}$$

$$\frac{R_2}{R_1} = \frac{4}{9.55} \cdot \frac{\omega_0 R_{NF} N_0 J}{V_{R1} G_{ctl} K_T}$$

$$R_1 \leq 30(k\Omega)$$

$$C_1 = \frac{1}{\sqrt{10}\ \omega_0 R_2} \quad \text{(F)}$$

$$C_2 = 10C_1 \quad \text{(F)}$$

Where
ω_0=Servo loop's time constant
f_{FG}=FG frequency (Hz)
D_1=Frequency divider ratio
R_{NF}=Current sense resistor (Ω)
N_0=Rotation number (rpm)
V_{R1}=Charge pump reference voltage, 1.25 V
Gctl=Control gain, 0.316
J=Inertia moment (kg·cm·s^2)
K_T=Torque constant (kg·cm/A)

6. The PWM frequency fp can be calculated as

$$f_p \doteq \frac{V_{Rt}}{8C_t R_t} \quad \text{(Hz)}$$

Where V_{Rt} is the Rt reference voltage, 1.25 (V).
7. The limiting current I_{omax} will be

$$I_{omax} = \frac{V_{CL}(V)}{R_{NF}(\Omega)} \quad \text{(A)}$$

8. C_{107} can be designed using the following equation as an guide line.

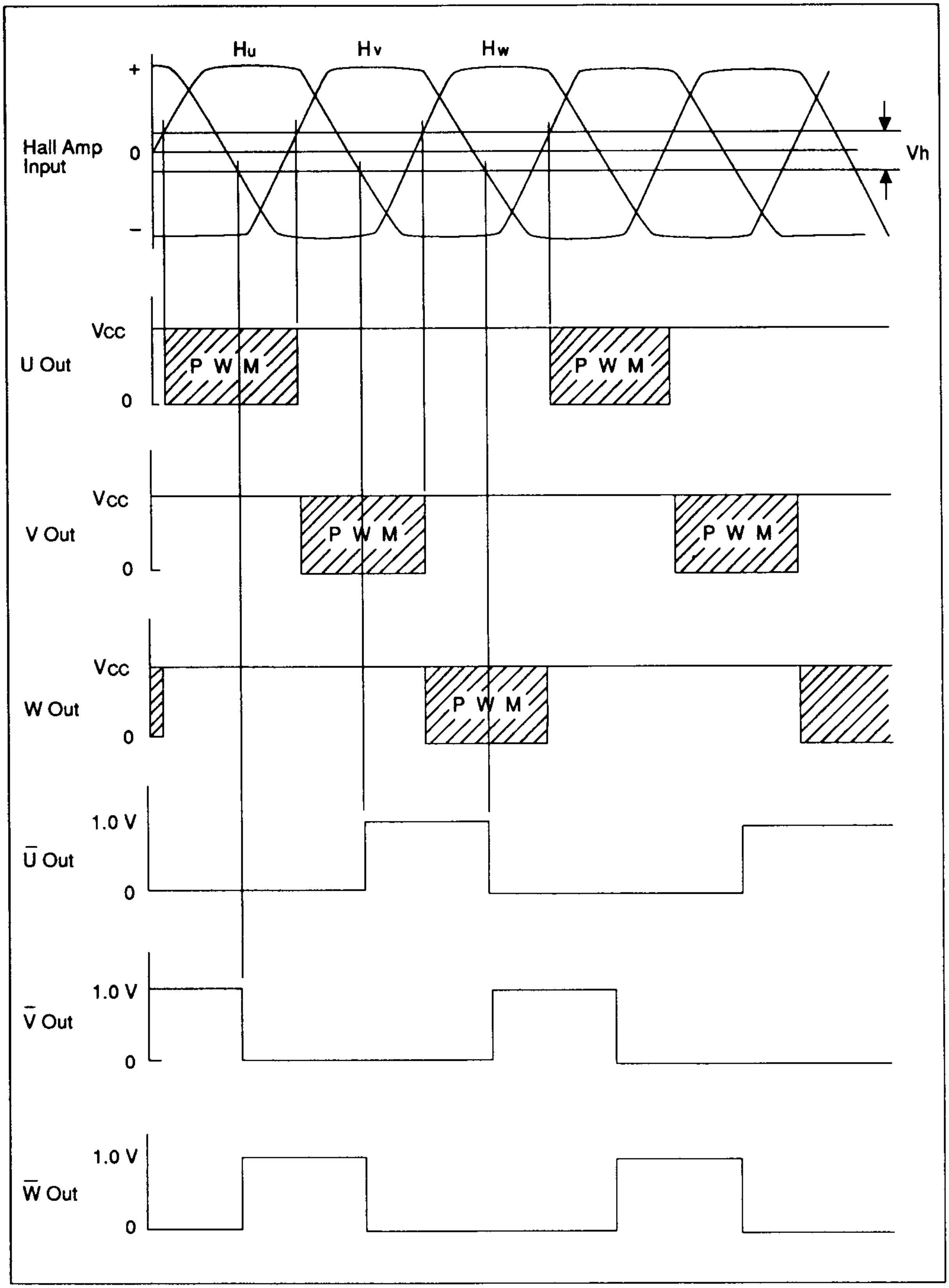
$$C_{107} \geq \frac{1}{2500\ f_{FG}} \quad \text{(F)}$$

9. The relationship between FG frequency and X'tal frequency is as follows.

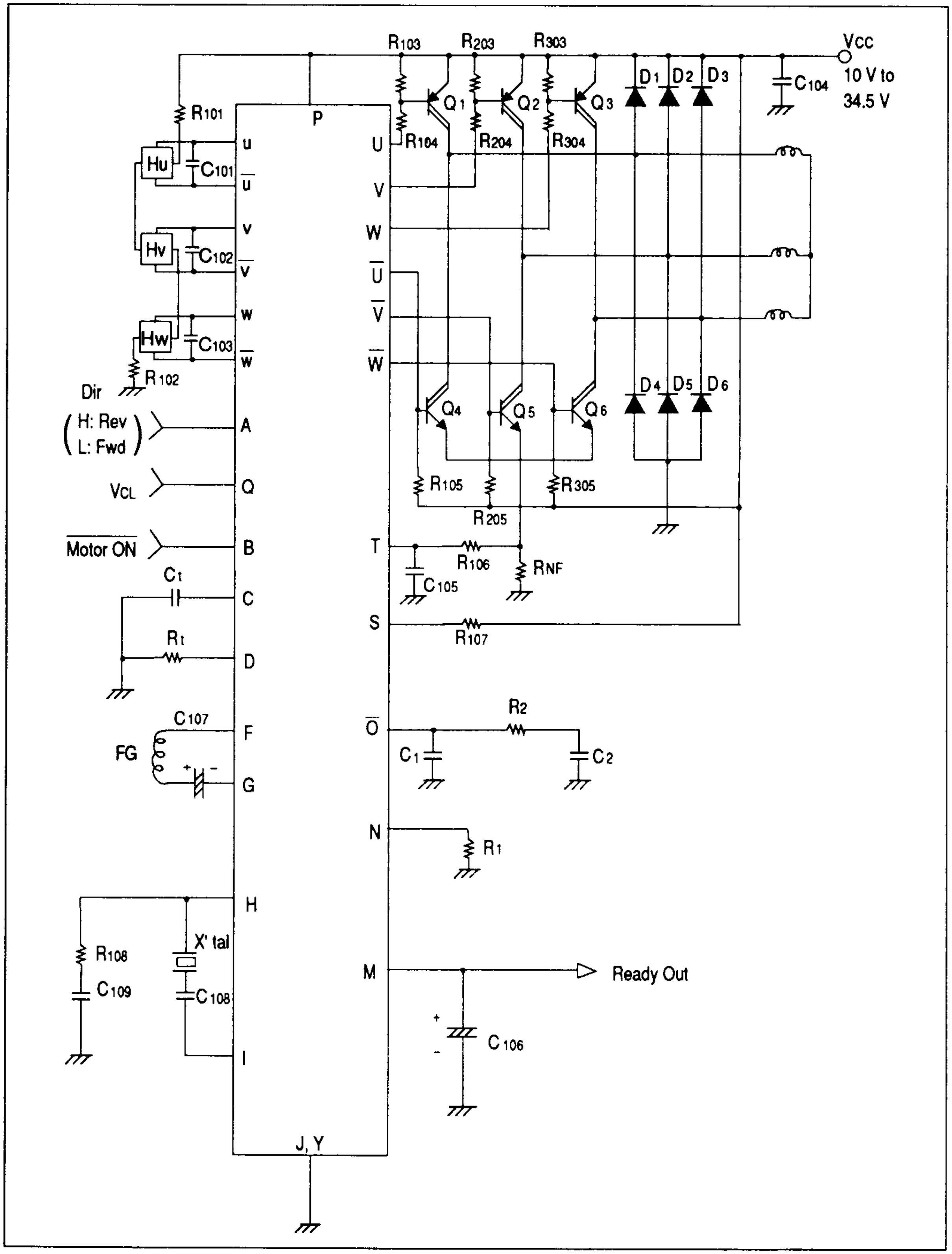
$$X'tal = \frac{8188\ D_1 f_{FG}}{D_2} \quad \text{(Hz)}$$

Where D_1 and D_2 are frequency divider ratio.

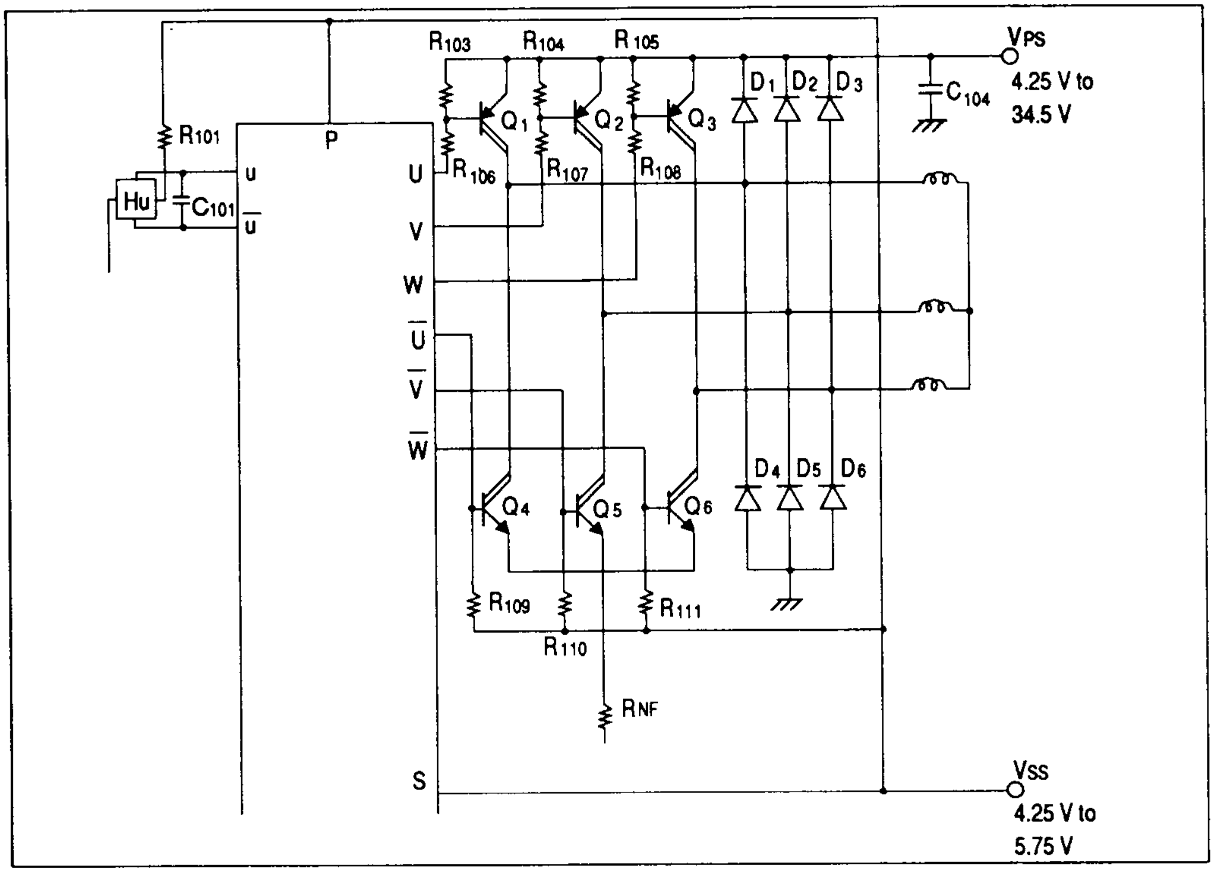
Timing Chart



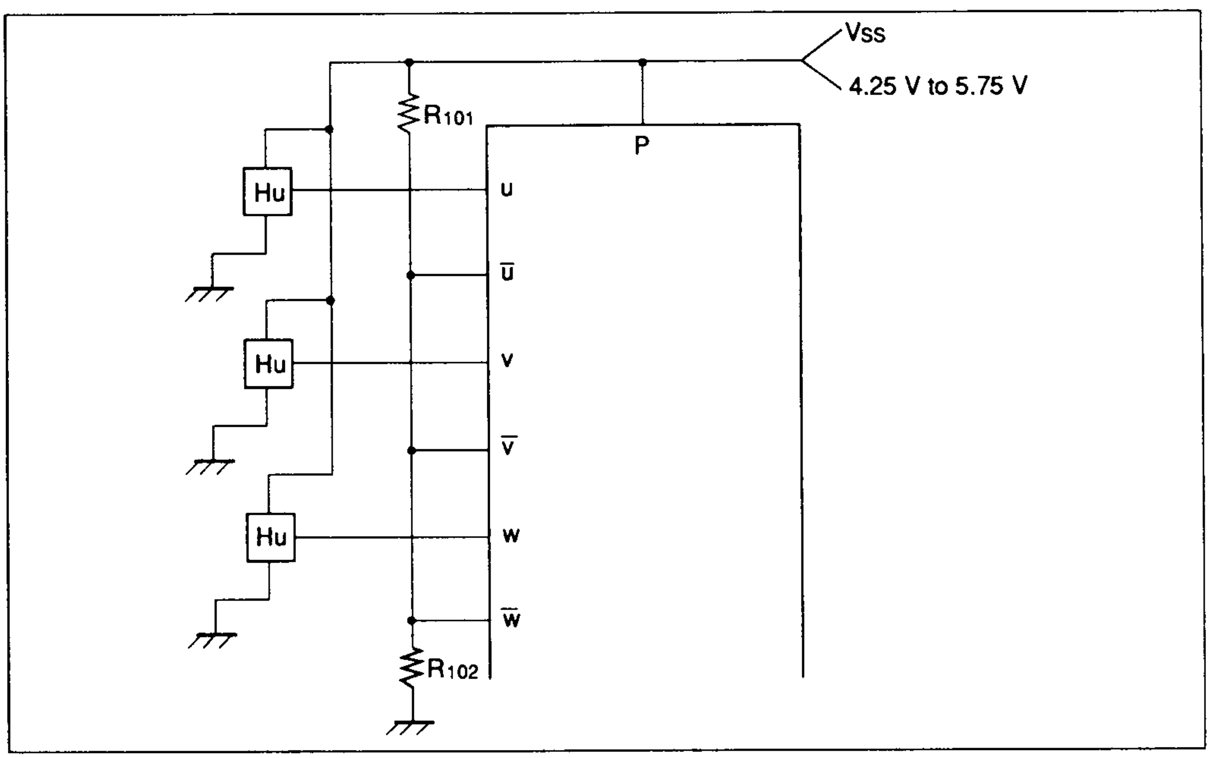
Application



Single Supply



Dual Supply



For Hall IC