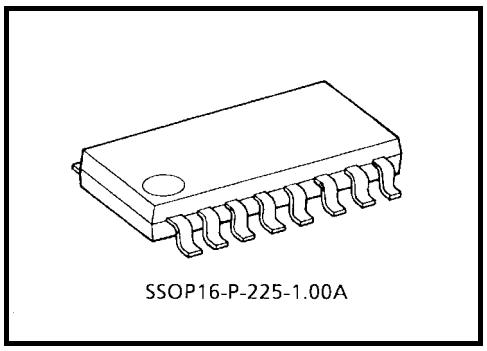
TOSHIBA Bipolar Linear Integrated Circuit Silicon Monolithic

TA8416F

Low Voltage Use 3-Phase Hall Motor Driver

TA8416F is low voltage use 3-phase Hall Motor Driver IC with stand−by function designed especially for portable VCR, Head Phone Stereo and other battery operated electrical equipment motor drive applications.

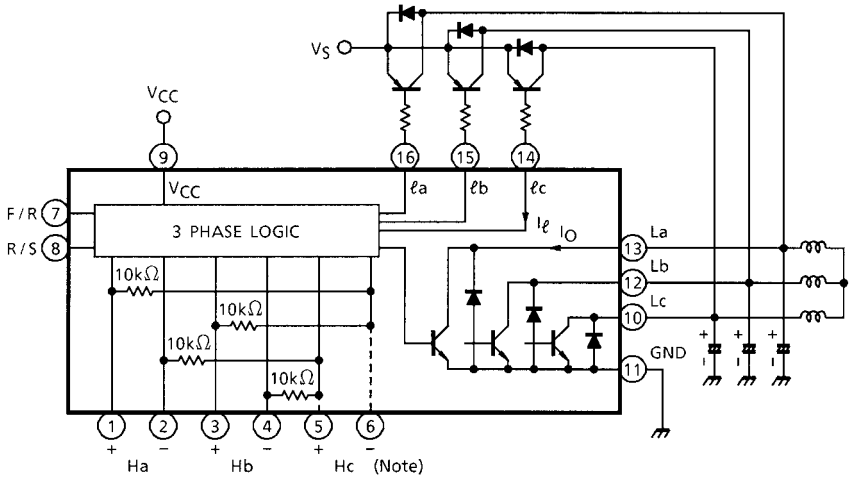


Weight: 0.14 g (typ.)

Features

- 3-phase bipolar/unipolar Hall motor driver
- Low voltage use
- Switching between forward and reverse rotation
- Voltage drive type
- Stand−by function for longer battery life
- MFP16 Flat package sealed
- 2 Hall sensor drive available
- Operating supply voltage : V_{CC} = 1.8 to 7.2 V
  V_S = 0.2 to 7.2 V
- Output current : I_O (max) = 0.7 A (AVE.)
  = 1.3 A (PEAK)
- Built−in thermal shutdown circuit

Block Diagram



Note: Refer to pin function 3.

Pin Function

Pin No.	Symbol	Function Description	Remark
1	H_a^+	a−phase Hall Amp. positive input terminal.	—
2	H_a^-	a−phase Hall Amp. negative input terminal.	—
3	H_b^+	b−phase Hall Amp. positive input terminal.	—
4	H_b^-	b−phase Hall Amp. negative input terminal.	—
5	H_c^+	c−phase Hall Amp. positive input terminal.	—
6	H_c^-	c−phase Hall Amp. negative input terminal.	—
7	F / R	Rotation direction control input terminal.	H: Forward, L: Rererse
8	R / S	Start / Stand by control Input terminal.	H: Start, L: Stand−by
9	V_{CC}	Power supply input terminal.	V_{CC} (opr.) = 1.8 to 7.2 V
10	L_c	c−phase drive output terminal.	—
11	GND	GND terminal.	—
12	L_b	b−phase drive output terminal.	—
13	L_a	a−phase drive output terminal.	—
14	ℓ_c	c−phase Pre−drive stage output terminal.	Connect to external PNP Transistor's Base
15	ℓ_b	b−phase Pre−drive stage output terminal.	Connect to external PNP Transistor's Base
16	ℓ_a	a−phase Pre−drive stage output terminal.	Connect to external PNP Transistor's Base

Terminal Description

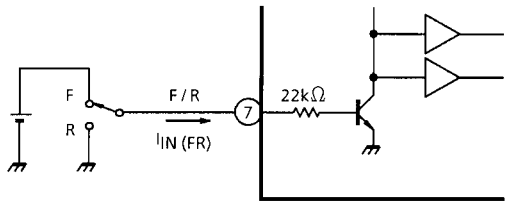
1. Rotation direction control input (F/R input, pin (7))

Motor rotation direction is controlled by this terminal. More than 1 V of control voltage becomes motor forward rotation and less than 0.4 V of this voltage becomes motor reverse rotation.
22 kΩ (±25%) of input resistance is equipped in series of this terminal. Therefore input current is calculated by following equation.

$$I_{IN\ (FR)} = \frac{V_{(7)} - V_{BE}}{22 \times 10^3\ \Omega} = \frac{3V - 0.7V}{22 \times 10^3\ \Omega} \approx 100\ \mu A$$

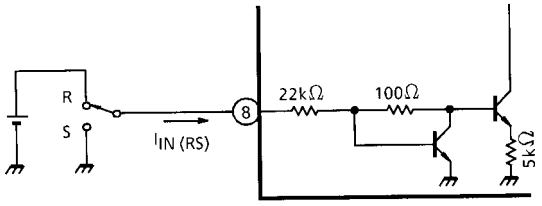
$$(V_{(7)} = 3\ V)$$

And the open mode as well as GND mode of the terminal, there's no input current flow.



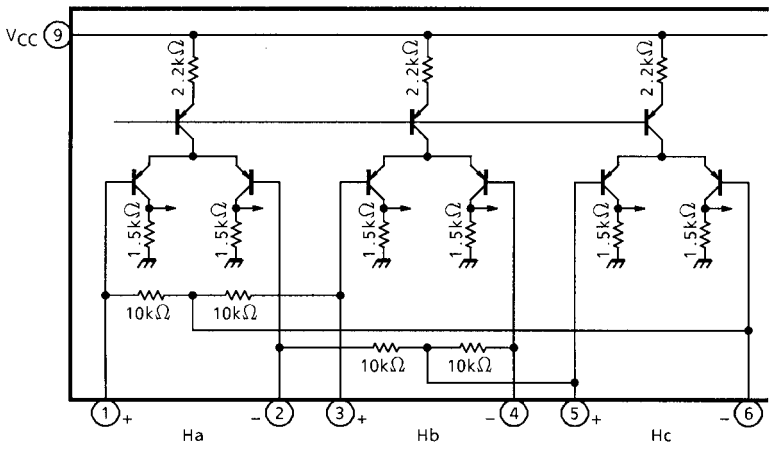
2. Start/stand−by control input (R/S input, pin (8))

This control input is used to stop and start the motor.
Like the F/R input, the R/S input operates on active-high logic. The input current is in sink mode. If the input is 1 V or higher, it causes the motor to run. If it is 0.5 V or lower, it keeps the motor on standby.
When the motor is on standby, the Hall-effect device signal amplifier current and the I2L injector current are turned off, leading to a supply current of 100 μA or lower.

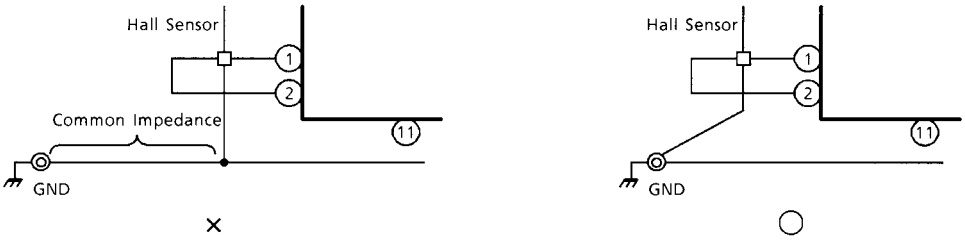


3. Hall sensor inputs ($Ha^{+,-}$, $Hb^{+,-}$, $Hc^{+,-}$, pin (1), (2), (3), (4), (5), (6))

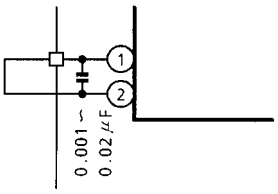
Hall Sensor Inputs for position sensing.
2 Hall Sensor Drive is also available by 4 pcs of 10 kΩ matrix resistors connect to $Ha^{+,-}$ and $Hb^{+,-}$ terminals.
But, in case of lower speed application, poor precision sensor positioning and good torque ripple and W / F characteristics required.
We recommend to use 3 Hall Sensors for stable operations. Input sensitivity is 20 mV_{p-p} (Typ), but actual value is 2 to 3 mV.
We recommend to input more than 20 mV_{p-p} to get good W/F characteristics.



Wide DC operating range of 0 to V_{CC} − 1.2 V is accomplished by PNP input circuit and also built in hysteresis restricts mis−function caused by external noise.
But care should be taken not to have a common impedance between Hall Sensor GND lines and the power GND line for stable operations.

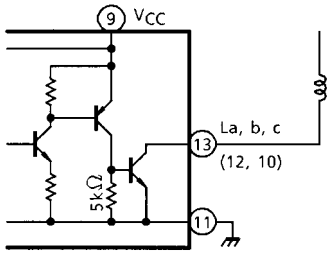


To decrease noise problems, we recommend to connect noise suppression capacitance (0.001 to 0.02 μF) between each Hall Input Terminal.



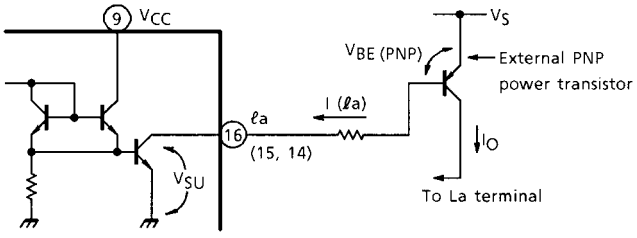
4. The drive output pins (La, Lb, and Lc, that is, pins 13, 12, and 10) have an open-collector configuration.

This IC is designed for use 3 phase unipolar drive applications, but Bipolar drives also available with additional 3 transistors.
Care should be taken with back electron motive force generated by coil not to over the specified voltage.



5. Pre−drive stage (ℓa, ℓb, ℓc, pin (16), (15), (14))

Open collector type Pre−drive stage required current are calculated by following equation.



$$I(\ell a) = K_O \cdot \frac{I_O}{h_{fe}}$$

$K_O \geq 2$
h_{fe} : h_{fe} of PNP transistor
I_O : Output current

$$I(\ell a) = \frac{V_S - V_{BE(PNP)} - V_{SU}}{R}$$

Summing that, $V_{BE\ (PNP)} = 0.7$ V, $V_{SU} = 0.2$ V

$$R = \frac{h_{fe}(V_S - 0.9)}{K_O \cdot I_O}$$

For Example, $V_S = 3$ V, $h_{fe} = 100$, $I_O = 0.7$ A, $K_O = 2$

$R = 150\ \Omega$

Function

Rotation Control		Position Sensing Input			Upper Side Output			Lower Side Output		
F/R	R/S	Ha	Hb	Hc	ℓa	ℓb	ℓc	La	Lb	Lc
H	H	H	L	H	1	0	0	0	1	0
		H	L	L	1	0	0	0	0	1
		H	H	L	0	1	0	0	0	1
		L	H	L	0	1	0	1	0	0
		L	H	H	0	0	1	1	0	0
		L	L	H	0	0	1	0	1	0
L	H	H	L	H	0	1	0	1	0	0
		H	L	L	0	0	1	1	0	0
		H	H	L	0	0	1	0	1	0
		L	H	L	1	0	0	0	1	0
		L	H	H	1	0	0	0	0	1
		L	L	H	0	1	0	0	0	1
—	L	H	L	H	High impedance			High impedance		
		H	L	L						
		H	H	L						
		L	H	L						
		L	H	H						
		L	L	H						

H: $V_H^+ > V_H^-$ 1: ON

L: $V_H^+ < V_H^-$ 0: OFF

Maximum Ratings (Ta = 25°C)

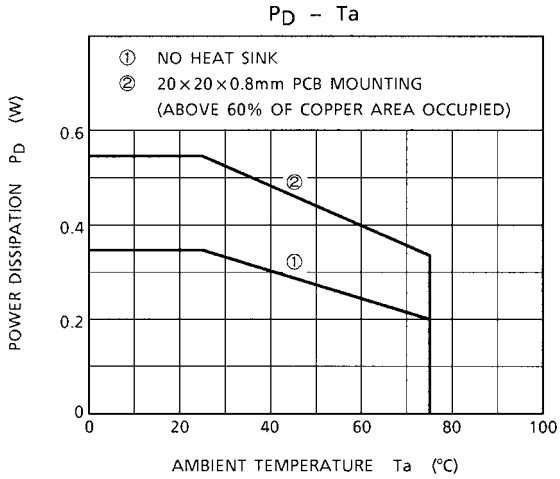
Characteristics	Symbol	Rating	Unit
Supply voltage	V_{CC}	8	V
	V_S	8	
Output current	I_O	0.7	A
	I_ℓ	20.0	mA
Power dissipation	P_D	350 (Note 1)	mW
		550 (Note 2)	
Operating temperature	Topr	−30 to 80	°C
Storage temperature	T_{stg}	−55 to 150	°C

Note 1: No heat sink

Note 2: This rating is obtained by mounting on 20 × 20 × 0.8 mm PCB that occupied above 60% of copper area.

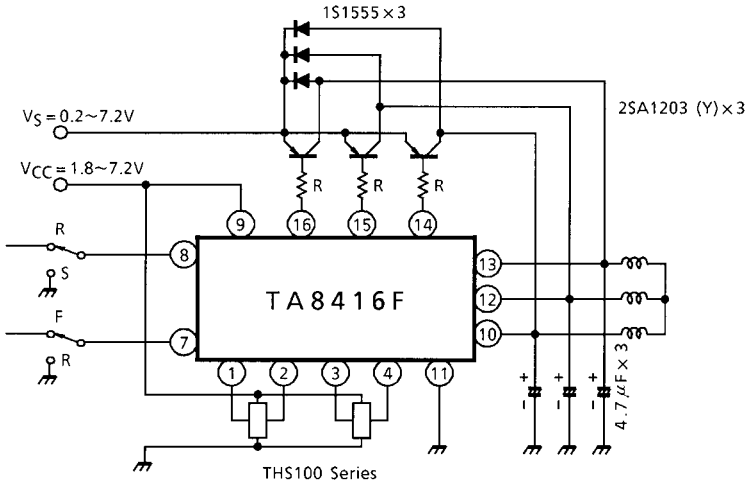
Electrical Characteristics (Ta = 25°C)

Characteristics			Symbol	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Supply current			I_{CC1}	—	V_{CC} = 3 V, output “OPEN”	—	2.7	4.0	mA
			I_{CC2}		V_{CC} = 6 V, output “OPEN”	—	3.0	5.0	μA
			I_{CC3}		Stand−by mode output “OPEN” V_{CC} = 3 V	—	0	100	
Saturation voltage	La, Lb, Lc side		V_{SL-1}	—	I_O = 0.1 A	—	0.2	—	V
			V_{SL-2}		I_O = 0.6 A	—	0.6	1.0	
	ℓa, ℓb, ℓc side		V_{SU}	—	I_ℓ = 10 mA	—	0.1	0.2	
Position sensing input	Sensitivity		V_H	—	—	—	20	—	mV_{p-p}
	Operating DC level		CMR		—	0	—	V_{CC} −1.2	V
Diode forward voltage			V_F	—	I_F = 0.7 A	—	1.2	—	V
Rotation control input voltage	Operating voltage	Forward	V_{SWD}	—	—	1.0	—	—	V
		Reverse	V_{RVS}	—	—	—	—	0.4	
	Operating current		$I_{IN\ (FR)}$	—	$V_{F/R}$ = 3 V	—	100	200	μA
Start / Stand−by Control Input Voltage	Operating voltage	Run	V_{RUN}	—	—	1.0	—	—	V
		Stand−by	V_{ST}	—	—	—	—	0.5	
	Operating current		$I_{IN\ (RS)}$	—	$V_{F/R}$ = 3 V	—	100	200	μA
Saturation voltage differential (La, Lb, Lc Side)			ΔV_S	—	I_O = 200 mA, La, Lb, Lc	—	20	—	mV
Leakage current			I_L	—	V = 8 V	—	0	100	μA
Thermal shut−down circuit operating temperature			T_{SD}	—	Junction temperature	140	—	—	°C



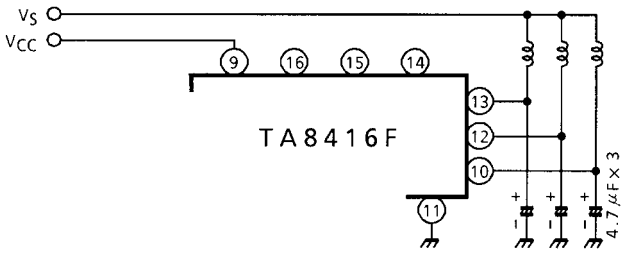
Application Circuit

1. 3 phase full wave application



Note:
- V_S and V_{CC} terminals connecting application also available.
- We recommend to use TOSHIBA Ga−As type Hall Sensor THS100 series.
- Output capacitans (4.7 μF × 3) are for noise suppression use.
  It is required to increase the value if the vibration noise is so loud.

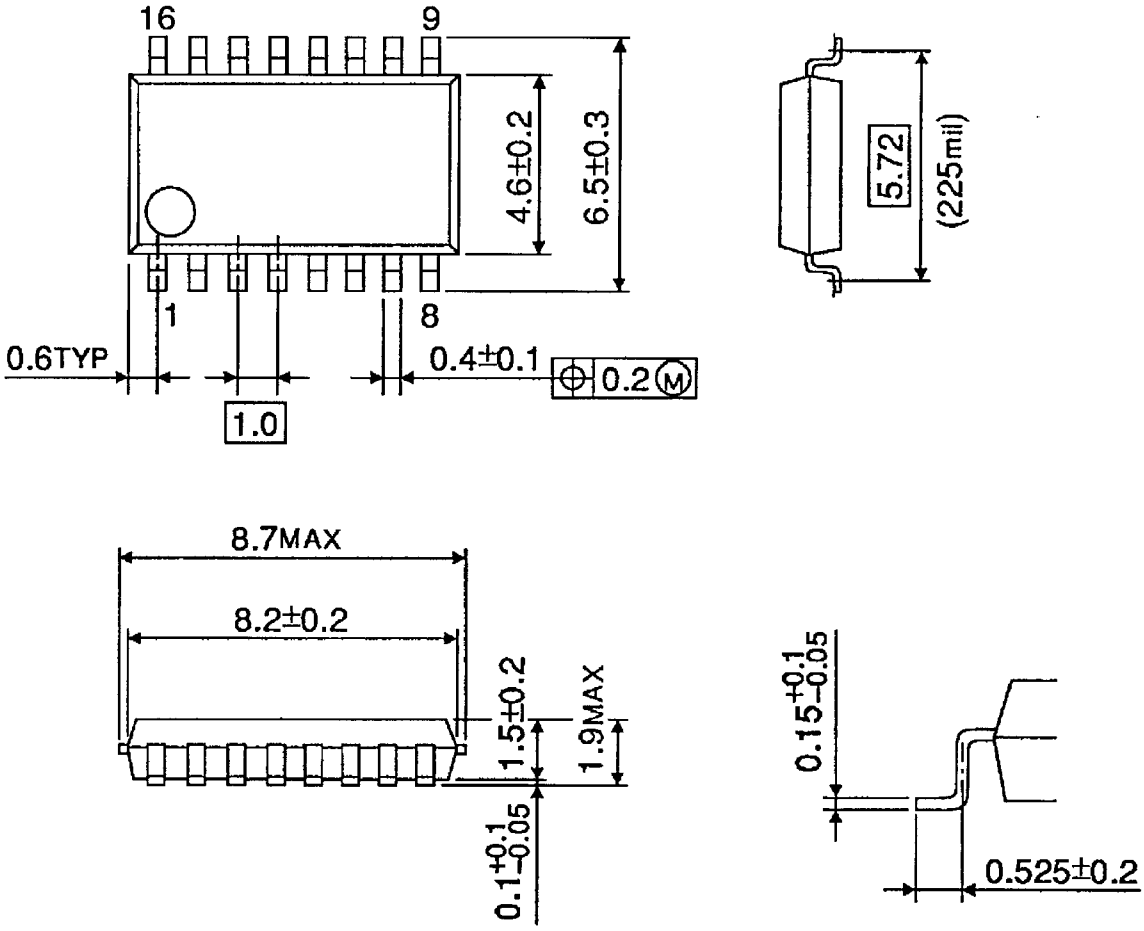
2. 3 phase half wave application



Note:
- Other circuit and configurations are all the same to APPLICATION CIRCUIT 1.
- Care should be taken with BEMF value generated by coils that not increase specified value of output transistor withstand voltage.
- Utmost care is necessary in the design of the output line, V_{CC} (V_M, V_S, V_{EE}) and GND line since IC may be destroyed due to short−circuit between outputs, to supply fault, or to ground.

Package Dimensions

SSOP16-P-225-1.00A Unit : mm



Weight: 0.14 g (typ.)

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