

TOSHIBA BIPOLAR LINEAR INTEGRATED CIRCUIT SILICON MONOLITHIC

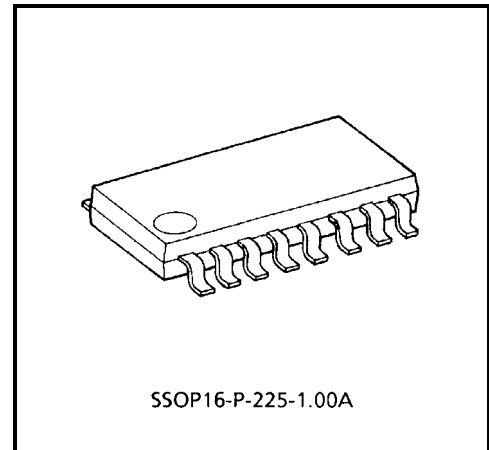
TA8416F

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.

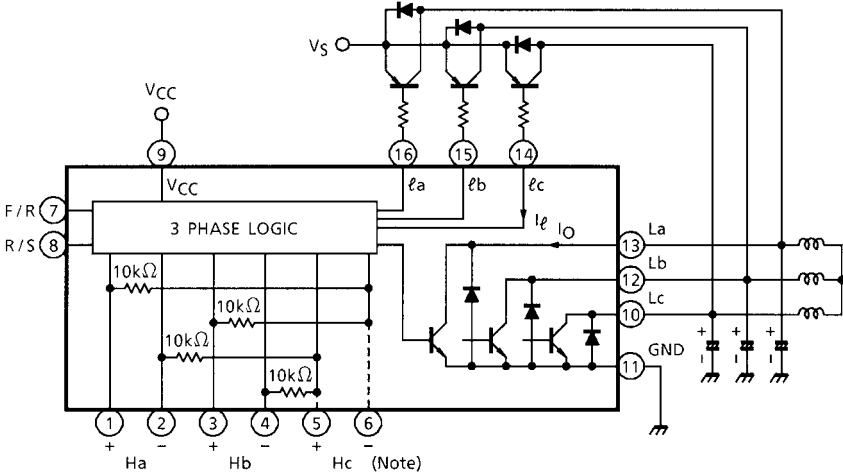
FEATURES

- 3 phase bipolar / unipolar Hall Motor Driver
- Low voltage use
- Voltage drive type
- Stand-by function for longer battery life
- MFP16 Flat package sealed
- 2 Hall Sensor drive available
- Operating supply voltage : $V_{CC} = 1.8 \sim 7.2 \text{ V}$
 $V_S = 0.2 \sim 7.2 \text{ V}$
- Output current : $I_O (\text{MAX.}) = 0.7 \text{ A (AVE.)}$
 $= 1.3 \text{ A (PEAK)}$
- Built-in thermal shut down circuit



Weight: 0.14 g (Typ.)

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.)} = 1.8~7.2 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 (FR input, pin (7))

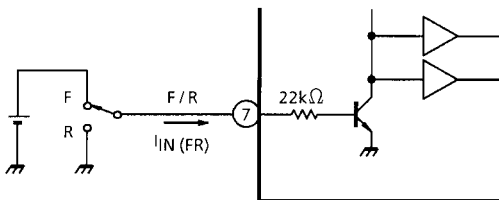
Motor rotation direction is controlled by this terminal. More than 1 V of control voltage becomes motor forward rotation and less than 0.4 V of this voltage becomes motor reverse rotation.

22 kΩ of input resistance is equipped in series of this terminal. Therefore input current is calculated by following equation.

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

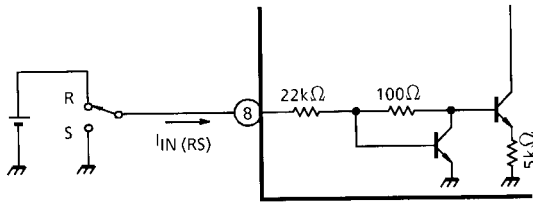
$$(V(7) = 3 V)$$

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



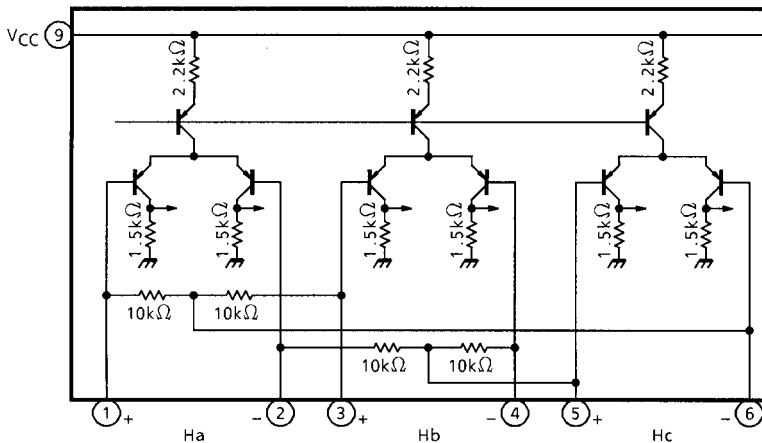
2. Start / stand-by control input (RS input, pin (8))

Start (Run) and stand-by modes are controlled by this terminal.
 Operating voltage are more than 1 V (Start or Run) and less than 0.5 V (Stand-by).
 Supply current becomes less than 100 μ A in Stand-by mode.



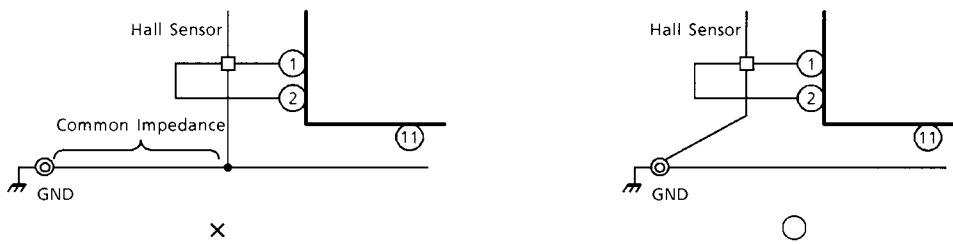
3. Hall sensor inputs ($H_a^{+,-}$, $H_b^{+,-}$, $H_c^{+,-}$, pin (1), (2), (3), (4), (5), (6))

Hall Sensor Inputs for position sensing.
 2 Hall Sensor Drive is also available by 4 pcs of 10 k Ω matrix resistors connect to $H_a^{+,-}$ and $H_b^{+,-}$ 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 2~3 mV.
 We recommend to input more than 20 mV_{p-p} to get good W / F characteristics.

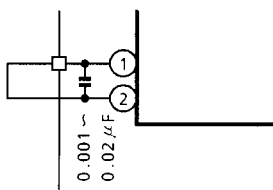


Wide DC operating range of $0 \sim V_{CC} - 1.2 \text{ V}$ is accomplished by PNP input circuit and also built in hysteresis restricts mis-function caused by external noise.

But care should be taken not to have a common impedance between Hall Sensor GND lines and the power GND line for stable operations.



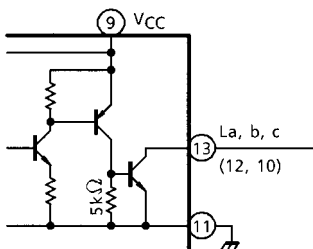
To decrease noise problems, we recommend to connect noise suppression capacitance ($0.001 \sim 0.02 \mu\text{F}$) between each Hall Input Terminal.



4. Output terminals (La, Lb, Lc, pin (10), (12), (13))

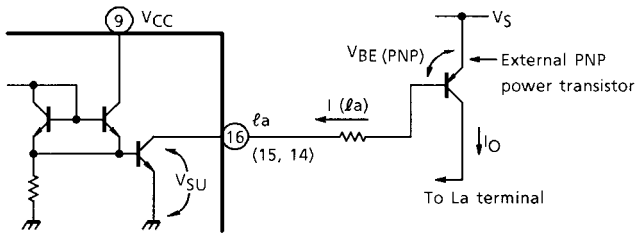
This IC is designed for use 3 phase unipolar drive applications, but Bipolar drives also available with additional 3 transistors.

Care should be taken with back electron motive force generated by coil not to over the specified voltage.



5. Pre-drive stage (Ia, Ib, Ic, pin (16), (15), (14))

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



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

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

$$K_O \geq 2$$

h_{fe} : h_{fe} of PNP transistor

I_O : Output current

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	H	L	L	H	0	0	1	0	1	0
		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	L	H	H	1	0	0	0	0	1
		L	L	H	0	1	0	0	0	1
		H	L	H	High Impedance			High Impedance		
		H	L	L						
		H	H	L						
L	H	L								
L	H	H								

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

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

MAXIMUM RATINGS (Ta = 25°C)

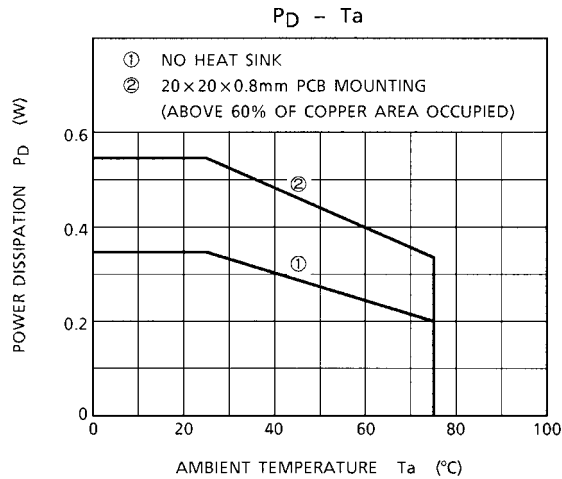
CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	V _{CC}	8	V
	V _S	8	
Output Current	I _O	0.7	A
	I _t	20.0	mA
Power Dissipation	P _D	350 (Note 1)	mW
		550 (Note 2)	
Operating Temperature	T _{opr}	-30~80	°C
Storage Temperature	T _{stg}	-55~150	°C

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.

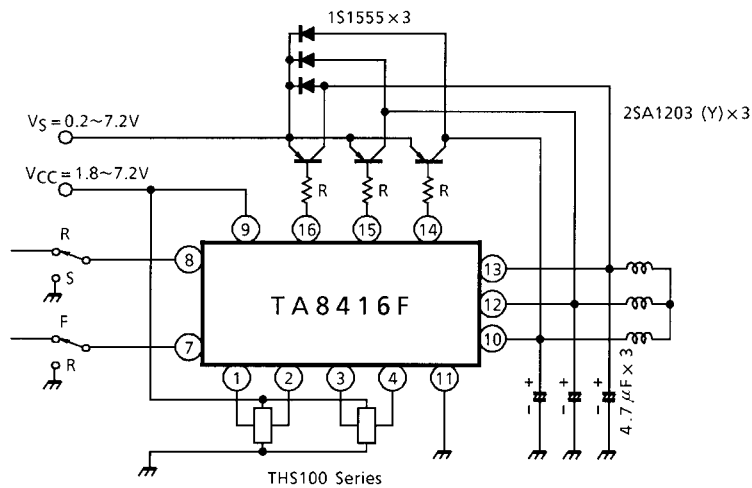
ELECTRICAL CHARACTERISTICS (Ta = 25°C)

CHARACTERISTIC		SYMBOL	TEST CIR-CUIT	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	
		I _{CC3}		Stand-by mode output "OPEN" V _{CC} = 3 V	—	0	100	μA
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	
	ta, tb, tc Side	V _{SU}	—	I _t = 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
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
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



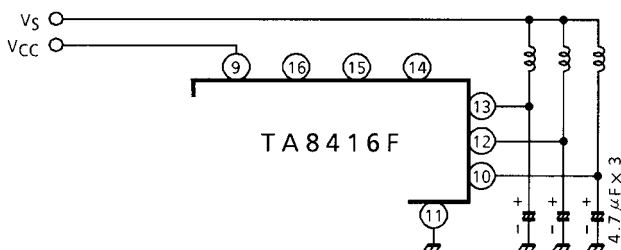
APPLICATION CIRCUIT

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 ($4.7 \mu F \times 3$) 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

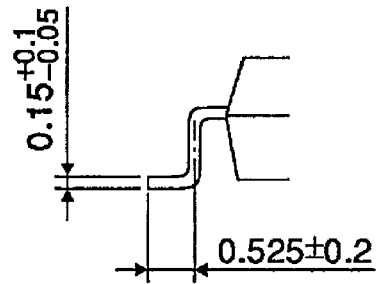
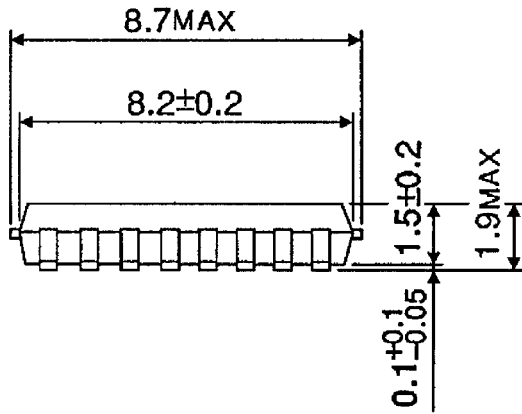
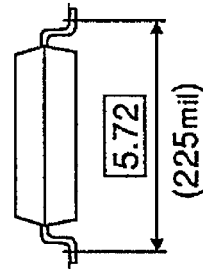
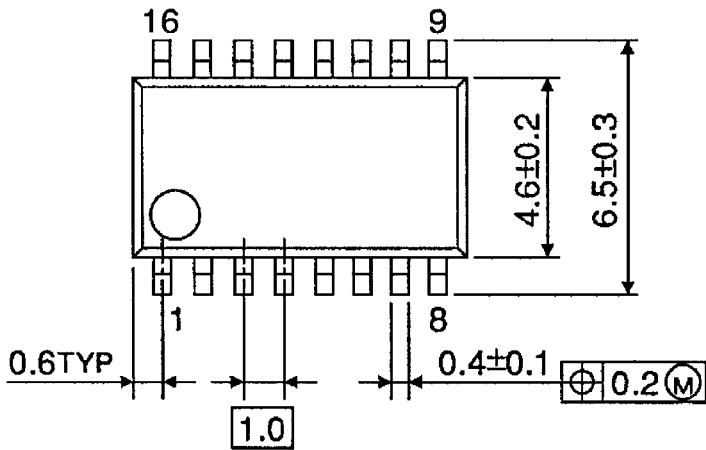


- Note:
- Other circuit and configurations are all the same to APPLICATION CIRCUIT 1.
 - Care should be taken with BEMF value generated by coils that not increase specified value of output transistor withstand voltage.
 - Utmost care is necessary in the design of the output line, V_S and GND line since IC may be destroyed due to short-circuit between outputs, air contamination fault, or fault by improper grounding.

PACKAGE DIMENSIONS

SSOP16-P-225-1.00A

Unit: mm



Weight: 0.14 g (Typ.)

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