Motor Driver IC Series for Tape Record System

Capstan Motor Driver for High-speed Forwarding and Rewinding VTR

BA6878EFV,BA6868FM

●Description

The BA6878EFV and BA6868FM are 3-phase, full-wave motor drivers, each of which is used with three external Hall sensors for rotor position detection. The BA6878EFV incorporates output transistors with saturation prevention circuits, and is driven by linear voltage and pseudo-linear currents. BA6868FM also incorporates a torque ripple canceling circuit, and is driven by pseudo-linear and PWM voltage. Moreover, it can respond to the high-speed operation of the motor and ensures high-precision rotation characteristic performance at low speed.

●Features

1) 180°, 3-phase full-wave pseudo-linear drive system
2) Built-in output saturation prevention circuits (on high and low sides)
3) Selective forward/reverse rotation
4) Built-in FG and hysteresis amplifiers (BA6878EFV only)
5) Built-in current limit and thermal shut down circuits
6) Direct PWM pseudo-linear drive system (BA6868FM only)
7) Built-in torque ripple canceling circuit (BA6868FM only)
8) Built-in Hall sensor bias power supply (BA6868FM only)

●Applications

Non-portable VTR

●Product line

	BA6878EFV	BA6868FM
Power supply voltage for control block	4.5～5.5V	4.5～6.0V
Power supply voltage for output block	4.5～22V	4.0～20.5V
Vcc circuit current	7.4mA	11mA
Max. output current	1500mA	1800mA
Torque reference gain	0.77 A/V	1.07 A/V
Current limit voltage	0.5V	External setting
Hall amplifier input range	1.5～Vcc-1.5V	1.5～Vcc-1.7V
Output drive system	Linear voltage and pseudo-linear current	PWM voltage and pseudo-linear current
Output saturation prevention circuit	Yes	Yes
Torque ripple canceling circuit	No	Yes
Rotation direction change	Yes	Yes
FG signal amplification circuit	Amp + hysteresis Comparator built-in	No
Package	HTSSOP-B24	HSOP-M28

●Absolute Maximum Ratings

BA6878EFV

Parameter	Symbol	Limit	Unit
Applied voltage	Vcc	7	V
Applied voltage	VM	23	V
Power dissipation	Pd	1.1 *1	W
Operating temperature range	Topr	-25～+75	℃
Storage temperature range	Tstg	-55～+150	℃
Maximum output current	Iomax	1500 *2	mA
Junction temperature	Tjmax	+150	℃

*1 Reduced by 8.8mW/°C over 25°C, when mounted on a PCB (70 mm x 70 mm x 1.6 mm, glass epoxy).

*2 Must not exceed Pd or ASO.

BA6868FM

Parameter	Symbol	Limit	Unit
Applied voltage	Vcc	7	V
Applied voltage	VM	22	V
Power dissipation	Pd	2.20 *1	W
Operating temperature range	Topr	-25～+75	℃
Storage temperature range	Tstg	-55～+150	℃
Maximum output current	Iomax	1800 *2	mA
Junction temperature	Tjmax	+150	℃

*1 Reduced by 17.6 mW/°C over 25°C, when mounted on a PCB (70 mm x 70 mm x 1.6 mm, glass epoxy).

*2 Must not exceed Pd or ASO.

●Operating Conditions

BA6878EFV

Parameter	Symbol	Limit	Unit
Operating power supply voltage range	Vcc	4.5～5.5	V
Operating power supply voltage range	VM	4.5～22.0	V
Hall amp in-phase input voltage range	VPD	1.5～Vcc-1.5	V

BA6868FM

Parameter	Symbol	Limit	Unit
Operating power supply voltage range	Vcc	4.5～6.0	V
Operating power supply voltage range	VM	4.5～20.5	V
Hall amp in-phase input voltage range	VPD	1.5～Vcc-1.7	V

●**Electrical Characteristics** (Unless otherwise specified, Ta=25℃,Vcc=5V,VM=12V)

BA6878EFV

Parameter	Symbol	Limit			Unit	Conditions
		Min.	Typ.	Max.		
＜CAP Drv＞						
Circuit current	Icc	-	7.4	11.0	mA	Ec = GND, input LLH
Hall input conversion offset	Heofs	-6	0	6	mV	
Torque reference start voltage	Ecst	2.35	2.50	2.65	V	
Output idling voltage	Ecidle	-	0	10	mV	EC=GND
Torque reference input gain	Gio	0.64	0.77	0.90	A/V	
Forward rotation reference voltage range	VEDF	-	-	2.2	V	
Reverse rotation reference voltage range	VEDR	2.8	-	-	V	
Torque limit current	ITL	0.89	1.00	1.11	A	RNF=0.5Ω
High-output voltage	VOH	1.20	1.55	1.90	V	IO=-0.8A
Low-output voltage 1	VOL	1.10	1.55	2.00	V	Io=0.8A, RNF=0.5Ω,EC<4.5V
Low-output voltage 2	VOL2	1.05	1.50	1.95	V	Io=0.8A, RNF=0.5Ω,EC=Vcc
Low-side saturation prevention off voltage	Voff	4.5	4.7	4.9	V	
＜FG Amp＞						
FGin- input current	IFGin-	-21	-43	-65	μA	
FG Amp Gain1	GFG1	26	33	-	dB	f=500Hz
FG Amp Gain2	GFG2	26	33	-	dB	f=30kHz
DC bias voltage	VBFG	2.4	2.5	2.6	V	
High FG output voltage	VFGH	-	0.3	0.6	V	IFG=-0.2mA, VFGH=Vcc-FGout
Low FG output voltage	VFGL	-	0.2	0.5	V	IFG=1mA
＜Hys Amp＞						
Hysteresis width	Vhys	32	46	60	mV	
Low hysteresis output voltage	VhysL	-	0.17	0.39	V	Ihys=1mA
Output pull-up resistance	Rhys	15	20	25	kΩ	

Parameter	symbol	Limit			Unit	Conditions
		Min.	Typ.	Max.		
＜Overall＞						
Circuit current	Icc	-	11	17	mA	Ec=GND, input LLH
＜Hall input＞						
Hall input conversion offset	Heofs	-10	-	10	mV	
Hall element power supply voltage	VHp	2.45	2.65	2.85	V	IH+=9mA
＜Torque reference＞						
Torque reference offset voltage	ECofs	-120	-	+120	mV	
Torque reference input gain	Gio	0.95	1.07	1.18	A/V	RNF=0.5Ω
Output idling voltage	ECidle	-	-	10	mV	
ECR bias voltage	VECR	2.0	2.2	2.4	V	
＜Torque limit＞						
TL-CS offset voltage	TL-CSofs	39	56	73	mV	
＜Ripple canceling＞						
Ripple canceling rate	VRcc	6.3	9.0	11.7	%	Input LLH→LMH
＜Forward/Reverse rotation selection＞						
Forward rotation reference voltage range	VEDF	-	-	2.2	V	
Reverse rotation reference voltage range	VEDR	2.8	-	-	V	
＜Output＞						
High-output voltage	VOH	0.63	0.90	1.17	V	Io=-350mA
Low-output voltage	VOL	0.42	0.60	0.78	V	Io=350mA,RNF=0.5Ω
＜Oscillator＞						
High OSC voltage	VOSCH	1.7	2.1	2.5	V	
Low OSC voltage	VOSCL	1.0	1.2	1.4	V	
Oscillating frequency	FOSC	30	50	70	kHz	COSC=1000pF

●Reference Data

BA6878EFV characteristic data

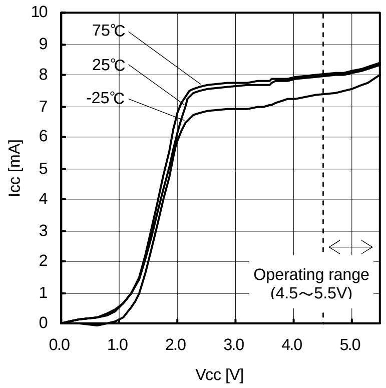


Fig.1 Circuit Current

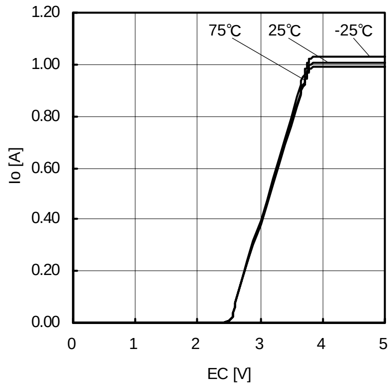


Fig. 2 Torque Reference Input Gain

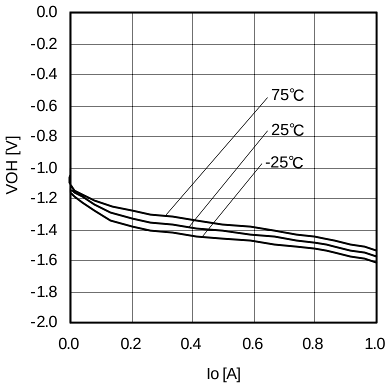


Fig. 3 High-Output Voltage (Saturation Prevention on High Side) vs Current

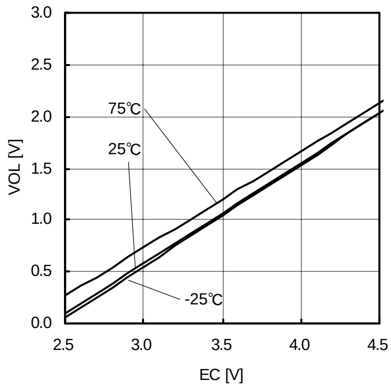


Fig. 4 Low-side Saturation Prevention vs EC

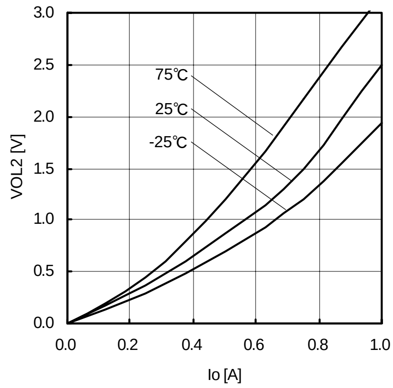


Fig. 5 Low-Output Voltage 2 vs Current

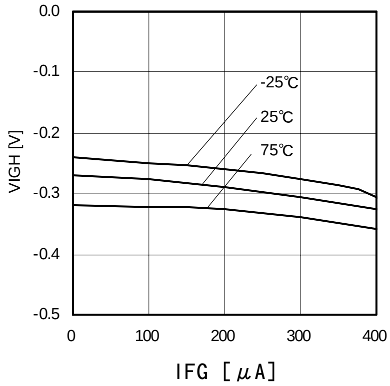


Fig. 6 High FG Output Voltage vs Current

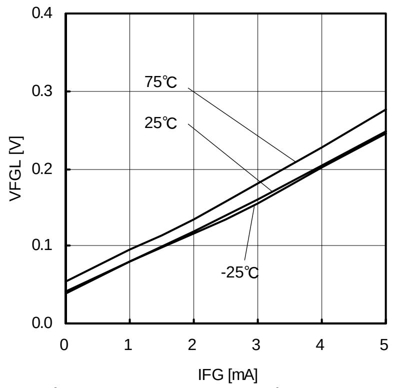


Fig. 7 Low FG Output Voltage vs Current

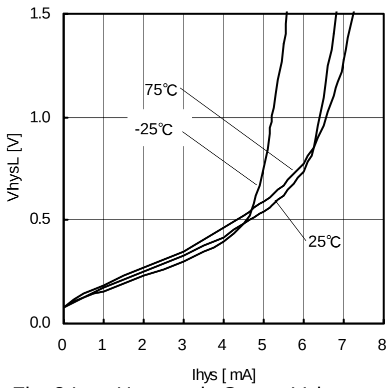


Fig. 8 Low Hysteresis Output Voltage vs Current

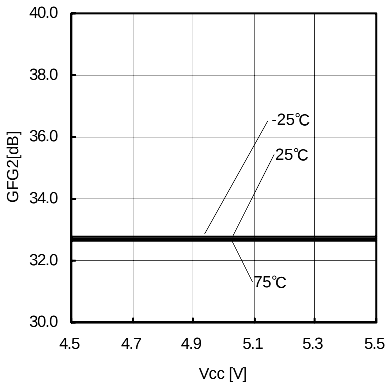


Fig. 9 FG Amp Gain 2

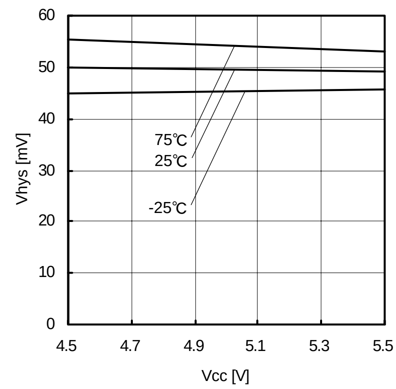


Fig. 10 Hys Amp Hysteresis Width

●**Reference Data**

BA6868FM characteristic data

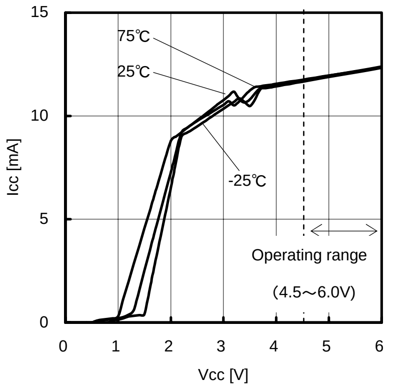


Fig.11 Circuit Current

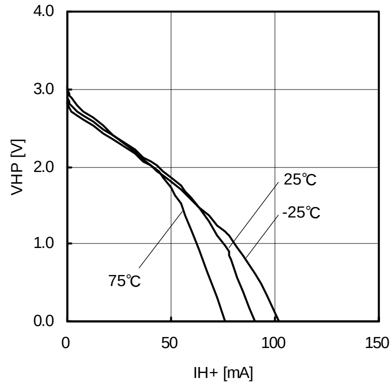


Fig.12 Hall Element Power Supply Voltage vs Current

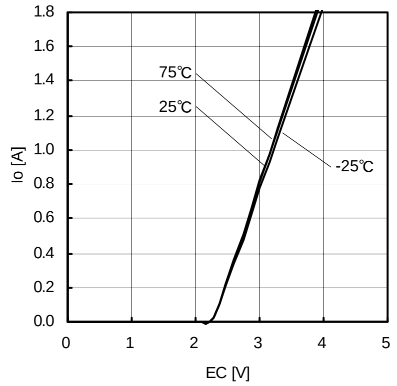


Fig.13 Torque Reference Input Gain

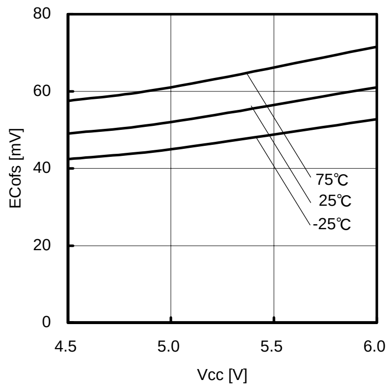


Fig.14 Torque Reference Offset Voltage

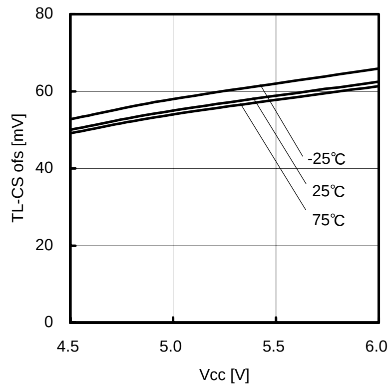


Fig.15 TL-CS Offset Voltage

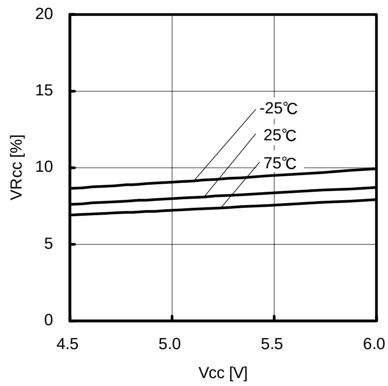


Fig.16 Ripple Canceling Rate

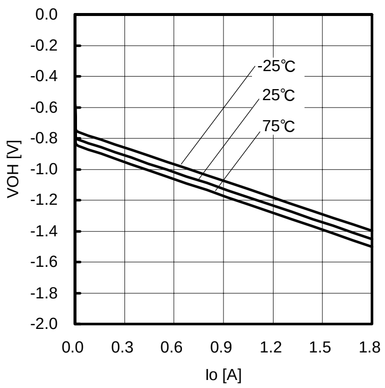


Fig. 17 High-side Output Voltage vs Current

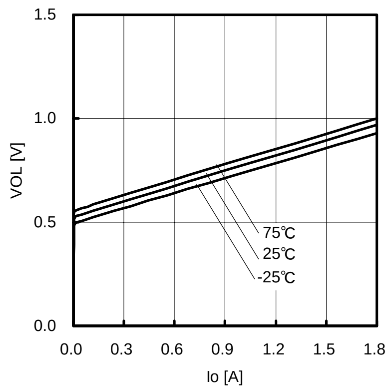


Fig. 18 Low-side Output Voltage vs Current

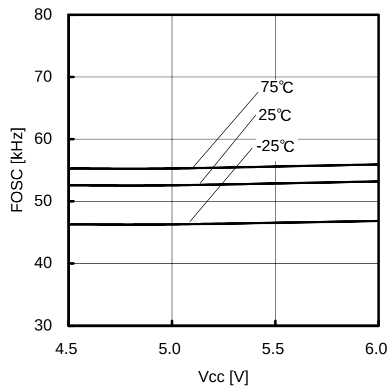


Fig. 19 Oscillating Frequency

●**Block Diagram**

BA6878EFV

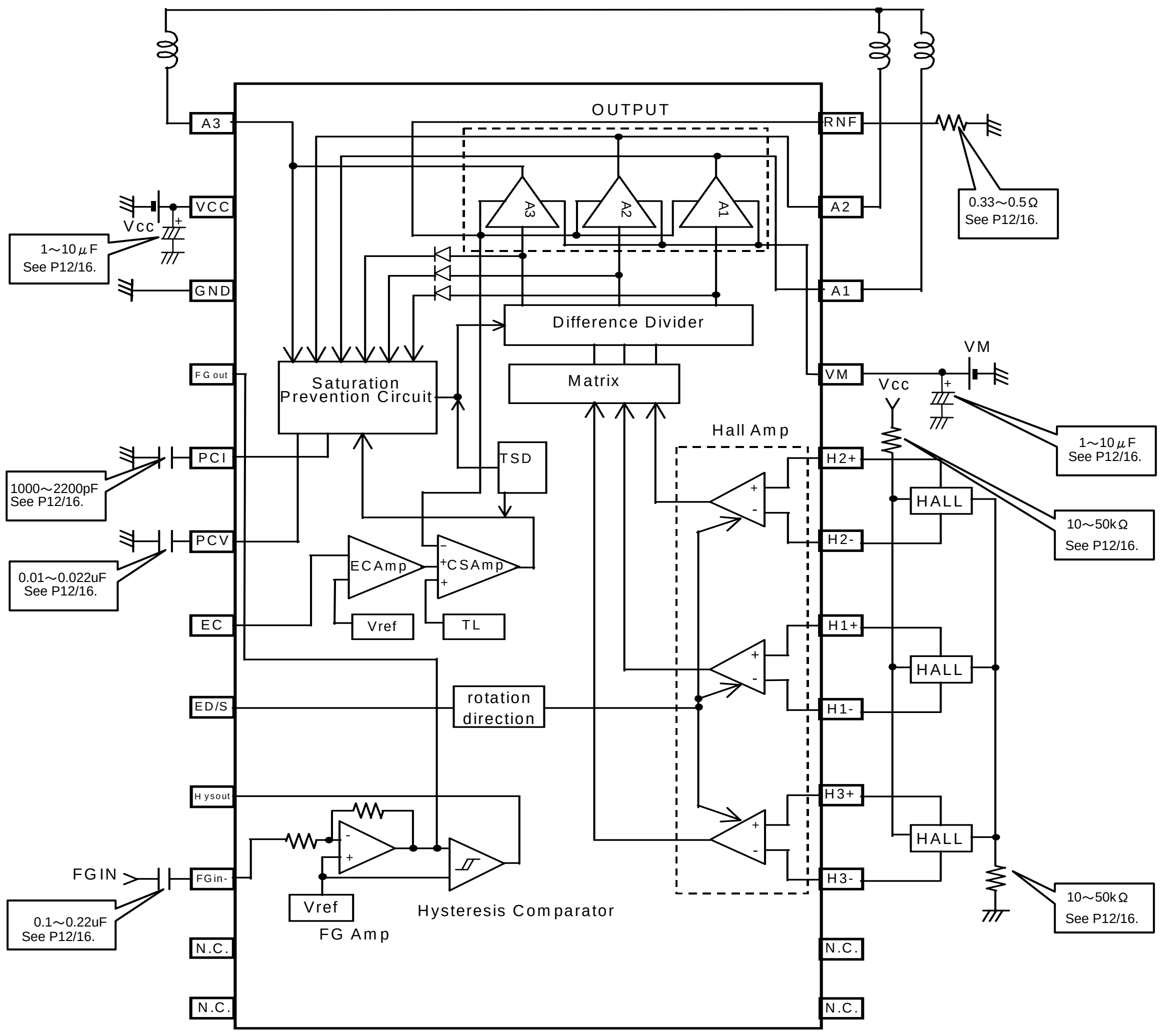


Fig.20

PIN No.	Pin name	Function
1	A3	Motor output pin
2	Vcc	Power supply pin
3	GND	GND pin
4	FGout	FG amplifier output pin
5	PCI	Capacitor connection pin for phase compensation of output saturation prevention circuit for low side
6	PCV	Capacitor connection pin for phase compensation of output saturation prevention circuit for high side
7	EC	Torque control signal input pin
8	ED/S	Rotation direction selection pin (L: Forward; H: Reverse)
9	Hysout	Hysteresis amplifier output pin
10	FGin-	FG amplifier input pin
11	N.C	
12	N.C	
13	N.C	
14	N.C	
15	H3-	Hall signal input pin
16	H3+	Hall signal input pin
17	H1-	Hall signal input pin
18	H1+	Hall signal input pin
19	H2-	Hall signal input pin
20	H2+	Hall signal input pin
21	VM	Motor power supply pin
22	A1	Motor output pin
23	A2	Motor output pin
24	RNF	Motor GND pin (resistance connection pin for output current detection)

BA6868FM

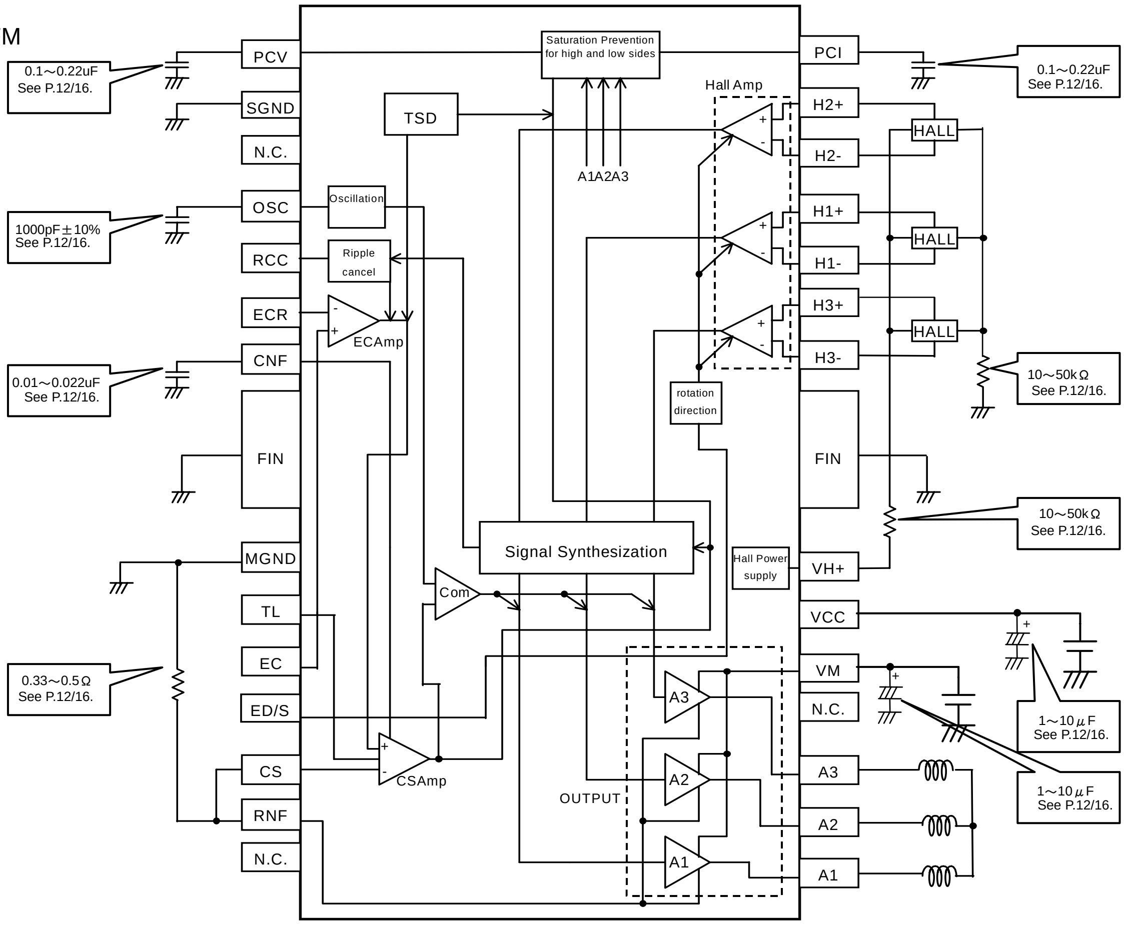


Fig.21

PIN No.	Pin name	Function
1	PCV	Capacitor connection pin for phase compensation of output saturation prevention circuit for high side
2	SGND	Signal block GND pin
3	N.C.	
4	OSC	Capacitor connection pin for oscillation circuit
5	RCC	Resistance connection pin for ripple canceling rate adjustment (connected to VCC or GND)
6	ECR	Torque reference input pin
7	CNF	Capacitor connection pin for current feedback phase compensation
8	MGND	Motor GND pin
9	TL	Torque limit setting pin
10	EC	Torque control signal input pin
11	ED/S	Rotation direction setting input pin (L: Forward rotation: H: Reverse rotation)
12	CS	Output current detection pin
13	RNF	Resistance connection pin for output current detection
14	N.C.	
15	A1	Motor output pin
16	A2	Motor output pin
17	A3	Motor output pin
18	N.C.	
19	VM	Motor power supply pin
20	Vcc	Power supply pin
21	VH+	Hall element power supply pin
22	H3-	Hall signal input pin
23	H3+	Hall signal input pin
24	H1-	Hall signal input pin
25	H1+	Hall signal input pin
26	H2-	Hall signal input pin
27	H2+	Hall signal input pin
28	PCI	Capacitor connection pin for phase compensation of output saturation prevention circuit for low side

●Block Operation

1. BA6878EFV

1-1. Hall amplifier to output

The sine wave signal of the rotor position detection, from the Hall sensor, is input into the Hall amplifier for amplification. The Matrix synthesizes a sine wave signal (that has a 30° phase delay) to the hall input signal by computing these amplified signals. Difference Divide outputs a drive basic signal by changing the amplitude of the synthesized signal in proportion to the control signal. This drive basic signal is amplified by a constant scale factor, and a current is linearly supplied from each output pin.

1-2. EC Amplifier, TL

The output current can be controlled with voltage applied to the EC pin (torque control signal input pin). The EC amplifier attenuates the voltage differential between the EC pin and Vref pin (with internal reference voltage) at a constant ratio, and provides it as input voltage to the CS amplifier.

1-3. CS Amplifier, TL

The RNF pin is the GND pin at the motor output block. Connect low resistance (0.5Ω is recommended) between the RNF and GND pins for output current detection. The voltage generated here is fed back to the input of CS amplifier. The amplitude of the drive basic signal is changed and the output current is controlled, so that this voltage will be the same as the voltage from the EC amplifier explained in 1-2. Furthermore, the TL circuit restricts the output current by providing internal reference voltage.

Torque control signal input (EC) and RNF pin voltage have the following relationship:

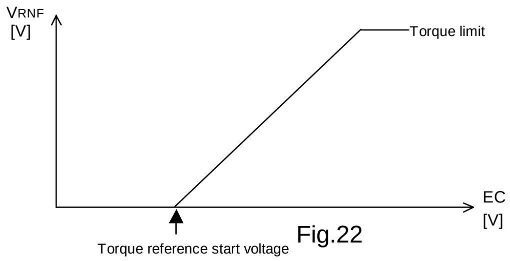


Fig.22

1-4. Saturation Prevention Circuit

The lowest voltage between the output and GND pins of the low-side output transistor (when on), and the highest voltage between the VM and output pins of the high-side transistor (when on), are detected so as to prevent the gain from dropping, as a result of the saturation of the output transistors. The output transistors are controlled to amplify signals at a constant gain. These transistors are used in the linear mode. For the phase compensation of the feedback loop, in order to detect output voltage, connect a capacitor between the GND and the PCV and between the GND and PCI pins.

1-5. Rotation Direction Change

A waveform synthesis change is made according to the voltage on the ED/S pin, which alters the relation between the input signal and output, thus selecting the forward or reverse rotation of the motor.

ED/S pin voltage < 2.2 V: Forward rotation

ED/S pin voltage > 2.8 V: Reverse rotation

1-6. FG Amplifier and Hysteresis Comparator

FG amplifier uses the internal gain setting resistance to amplify input signals at a gain of 33 dB (Typ.). The hysteresis comparator removes the noise of the linear signal output, of the FG amplifier, and changes the output into rectangular waves.

2. BA6868FM

2-1. Hall amplifier to output

The Hall amplifier receives under differential control. It amplifies sine wave signals, of rotor position detection, from the Hall sensor. Under signal synthesis control, these amplified signals are calculated, resulting in a sine wave signal with a delay of 30° to the Hall input signal. Then, a drive basic signal from the synthesized signal, with its amplitude changed in proportion to the control signal of the CS amplifier, is output. A full-wave rectified waveform is made from the waveforms of respective phases of the synthesized sine wave signals. The lowest part of the three-phase, full-wave rectified waveform is obtained, and a triangular waveform that rises and falls alternately (at an angle of 30°) is made as a ripple, canceling the reference waveform. If the output current is a trapezoid waveform, the triangular waveform (i.e. the ripple-canceling reference waveform) will be superimposed on the trapezoid waveform. This is to prevent a delicate rotation fluctuation caused by spaces in the magnetic field, that are generated by the 3-phase coils. The drive basic signal, that is pulse-wave modulated by the PWM signal for output current control, is amplified and output at constant gain. For this reason, the output voltage can supply phase current linearly in PWM drive control.

2-2. EC Amplifier

The output current can be controlled with a voltage applied to the EC pin (torque control signal input pin). The EC amplifier attenuates the voltage differential of the ECR pin at a constant ratio, and inputs the attenuated voltage to the CS amplifier. The signal of the ripple canceling reference waveform, attenuated at a constant ratio by a resistor connected between the RCC and GND pin, is superimposed on the input voltage

2-3. CS Amplifier, Comparators

The RNF pin is the GND pin at the output stage. A low resistor (with a recommended resistance of 0.33 Ω to 0.5 Ω) is connected between the RNF and GND pins for output current detection. The voltage generated here is fed back to the input of the CS amplifier, and a signal that changes the amplitude of the drive basic signal is given to the synthesis circuit. This is so that the generated voltage will become the same as that of the EC amplifier, as explained in 2-2. A duty control signal is output for PWM-on. Duty control is done by comparing the signal with the triangular waveform input for the PWM comparator.

An amplitude control signal and a duty control signal are mixed to control the output current. The output current can be restricted by providing constant voltage to the TL pin. In order to perform the phase compensation of the feedback loop for current detection, a capacitor is connected between the CNF and GND pins to prevent oscillation.

Torque reference input (EC) and RNF pin voltage have the following relationship:

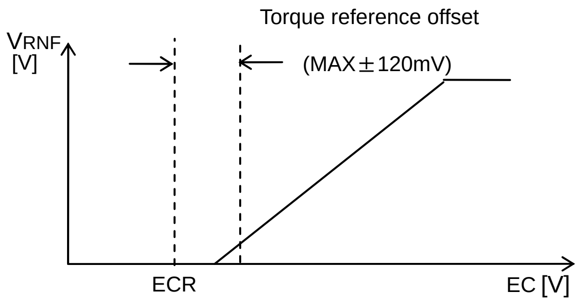


Fig.23

2-4. Torque Limit

The output current can be restricted by the voltage applied to the TL pin. Connect a resistance of approximately 0.33 Ω to 0.5 Ω between the RNF and MGND pins, and as a result, current detection is performed. As long as the voltage applied to the TL pin is VTL, the maximum output current Iomax is calculated as follows:

$$Iomax = \frac{VTL-(TL\text{-}RNFofs)}{RNF}$$

TL-RNFofs is the offset between the TL and RNF pins. RNF is the resistance for current detection between RNF and MGND pins

2-5. Saturation Prevention Circuit on High and Low Sides

The lowest voltage between the output and GND pins of the low-side output transistor (when on), and the highest voltage between the VM and output pins of the high-side transistor (when on), are detected so as to prevent the gain from dropping as a result of the saturation of the output transistors. The output transistors are controlled to amplify signals at constant gain. The output transistors are used in the linear mode, which ensures good control performance in a wide current range between small and large currents, and provides good rotation performance even if the motor is overloaded. For the phase compensation of the feedback loop, in order to detect output voltage, connect a capacitor between the GND and the PCV and between the GND and PCI pins.

2-6. Rotation Direction Change

A waveform synthesis change is made according to the voltage on the ED/S pin, which alters the relation between the input signal and output, thus selecting the forward or reverse rotation of the motor.

ED/S pin voltage < 2.2 V: Forward rotation

ED/S pin voltage > 2.8 V: Reverse rotation

2-7. Oscillation Circuit

A PWM comparator input signal is generated by connecting a capacitor to the OSC pin, charging it with a constant current, and discharging it at constant amplitude.

2-8. Hall Power Supply

The hall sensor is supplied with 2.65 V (Typ.).

●I/O Truth Table

BA6878EFV

ED/S = Low (Forward rotation)

H1+	H2+	H3+	A1	A2	A3
M	H	L	H	L	H
H	H	L	M	L	H
H	M	L	L	L	H
H	L	L	L	M	H
H	L	M	L	H	H
H	L	H	L	H	M
M	L	H	L	H	L
L	L	H	M	H	L
L	M	H	H	H	L
L	H	H	H	M	L
L	H	M	H	L	L
L	H	L	H	L	M

ED/S = High (Reverse rotation)

H1+	H2+	H3+	A1	A2	A3
M	L	H	H	L	H
H	L	H	H	L	M
H	L	M	H	L	L
H	L	L	H	M	L
H	M	L	H	H	L
H	H	L	M	H	L
M	H	L	L	H	L
L	H	L	L	H	M
L	H	M	L	H	H
L	H	H	L	M	H
L	M	H	L	L	H
L	L	H	M	L	H

BA6868FM

ED/S = Low (Forward rotation)

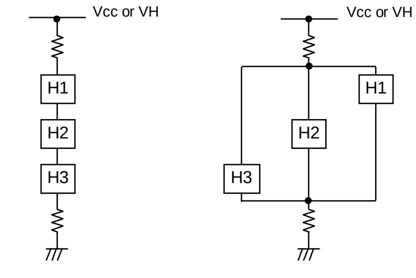
	Hall input			Output		
	H1+	H2+	H3+	A1	A2	A3
1	L	H	M	H	L	L
2	L	M	H	H	H	L
3	M	L	H	L	H	L
4	H	L	M	L	H	H
5	H	M	L	L	L	H
6	M	H	L	H	L	H

ED/S = High (Reverse rotation)

	Hall input			Output		
	H1+	H2+	H3+	A1	A2	A3
1	L	H	M	L	H	H
2	L	M	H	L	L	H
3	M	L	H	H	L	H
4	H	L	M	H	L	L
5	H	M	L	H	H	L
6	M	H	L	H	H	L

●Selecting Application Components

1) Hall bias resistance <BA6878EFV, BA6868FM>
The Hall sensor allows both serial and parallel connections. Adjust the bias resistance so that the amplitude of the Hall signal will be approximately 100 mVp-p and within the permissible Hall input voltage range. The BA6868FM is provided with the Hall power supply pin.



Serial connection Fig.24 Parallel connection

2) Connection Capacity of PCI and PCV Pins <BA6878EFV>
Capacitors connected to the PCI and PCV pins are for the saturation prevention circuits on the high and low sides, and are for phase compensation for the current feedback loop. If the capacitance is too high, poor responsiveness will result. If the capacitance is too low, the output waveform will be sensitive to oscillation. Determine the capacitance based on the servo constant.

3) Connection capacity for PCI pin, PCV pin, and CNF pin. <BA6868FM>
Capacitors connected to the PCI, PCV, and CNF pins are for the saturation prevention circuits on the high and low sides, and are for phase compensation for the current feedback loop. If the capacitance is too high, poor responsiveness will result. If the capacitance is too low, the output waveform will be sensitive to oscillation. Determine the capacitance based on the servo constant.
A capacitance of approximately 0.1 μF to 0.22 μF is suitable for the PCI pin, while a capacitance of approximately 0.1 μF to 0.22 μF is suitable for the PCV pin, and 0.01 μF to 0.022 μF for the CNF pin.

4) OSC Oscillation Circuit <BA6868FM>
By charging and discharging the capacitor connected to the OSC pin, a triangular wave will be formed at PWM frequency. If the PWM frequency is too low, the output current will cease. If the PWM frequency is too high, the output waveform cannot respond to the PWM frequency. Set the optimum PWM frequency. The optimum frequency is approximately 50 kHz, with a capacitance of 1000 pF ± 10% connected to the OSC pin.

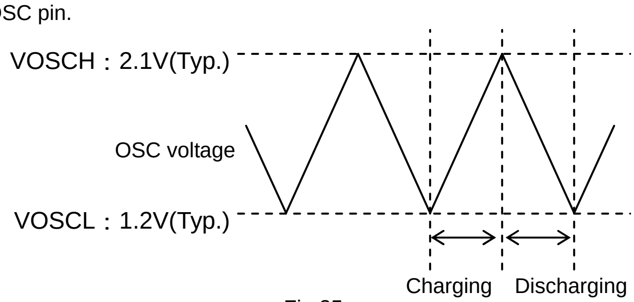


Fig.25

5) Forward/Reverse Rotation Selection <BA6878EFV, BA6868FM>
A rise of the motor output voltage of the IC is seen when changing the rotation direction of the IC in operation. This is due to the generation of BEMF voltage, generated from the coil. If this rise exceeds the maximum rating, the IC may be damaged. Therefore, set VM voltage so that the output will not exceed maximum ratings or ASO at the time of changing the rotation direction. Furthermore, in order to suppress the rise of the output voltage, connect a capacitor (approximately 1 μF to 10 μF) between VM and GND pins, and as close as possible to the IC.

6) RNF pin <BA6878EFV, BA6868FM>
In order to detect the output current, connect a small resistance (0.33 Ω to 0.5 Ω) between the RNF and GND pins. A large current flows to this resistance. Therefore, pay careful attention to the current capacity.

7) VCC and VM Pins <BA6878EFV, BA6868FM>
Select a capacitance value that can sufficiently suppress high-frequency noise.
The optimum capacitance is 1 μF to 10 μF.

●I/O Equivalent Circuit Diagrams

1) Motor Output Block <BA6878EFV>

＜BA6878EFV＞

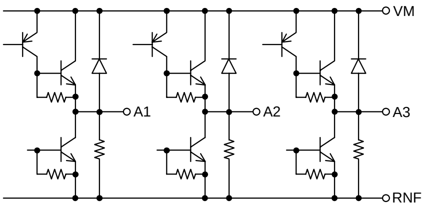


Fig.26

＜BA6868FM＞

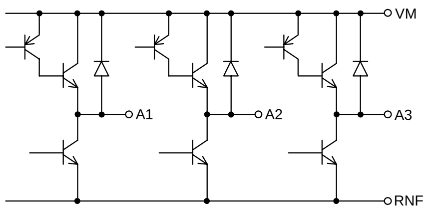


Fig.27

2) Rotation Direction Selection Pin

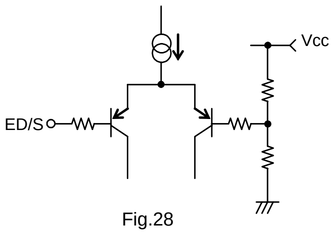


Fig.28

3) Hall Power Supply <BA6868FM>

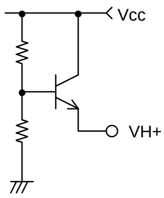


Fig.29

4) Torque Reference

＜BA6878EFV＞

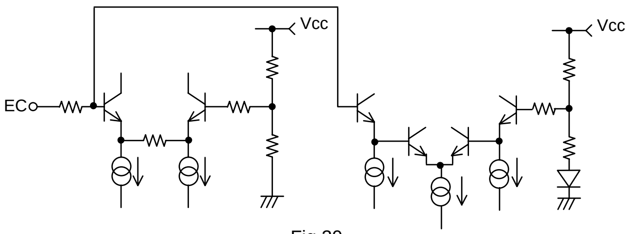


Fig.30

＜BA6868FM＞

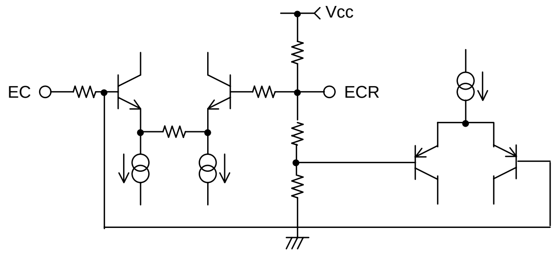


Fig.31

5) Hall input

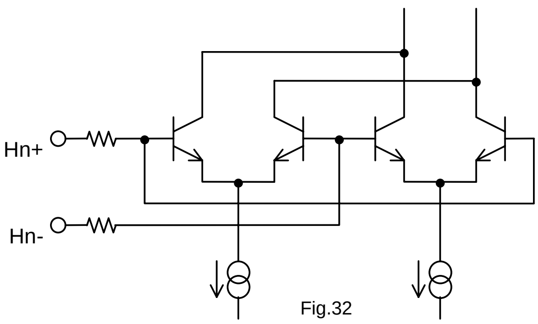


Fig.32

6) Torque Limit＜BA6868FM＞

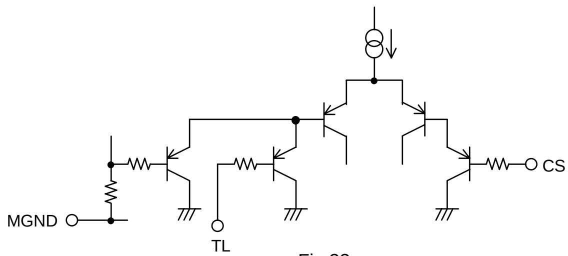


Fig.33

7) FG_Amp, Hys_Amp Input Pin

＜BA6878EFV＞

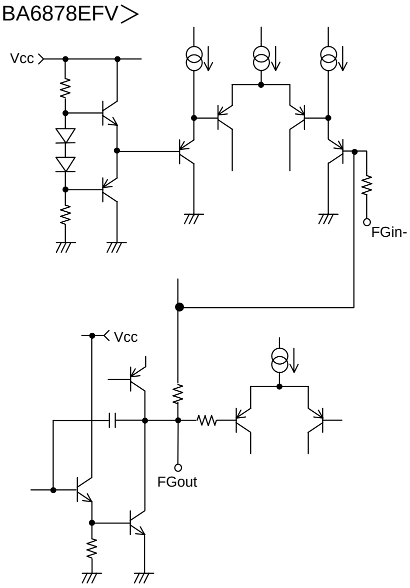


Fig.34

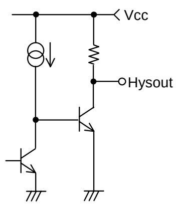


Fig.35

●**Operation Notes**

1. Absolute maximum ratings

An excess in the absolute maximum ratings, such as supply voltage, temperature range of operating conditions, etc., can break down the devices, thus making impossible to identify breaking mode, such as a short circuit or an open circuit. If any over rated values will expect to exceed the absolute maximum ratings, consider adding circuit protection devices, such as fuses.

2. Connecting the power supply connector backward

Connecting of the power supply in reverse polarity can damage IC. Take precautions when connecting the power supply lines. An external direction diode can be added.

3. Power supply lines

Design PCB layout pattern to provide low impedance GND and supply lines. To obtain a low noise ground and supply line, separate the ground section and supply lines of the digital and analog blocks. Furthermore, for all power supply terminals to ICs, connect a capacitor between the power supply and the GND terminal. When applying electrolytic capacitors in the circuit, note that capacitance characteristic values are reduced at low temperatures.

4. GND voltage

The potential of GND pin must be minimum potential in all operating conditions.

5. Thermal design

Use a thermal design that allows for a sufficient margin in light of the power dissipation (Pd) in actual operating conditions.

6. Inter-pin shorts and mounting errors

Use caution when positioning the IC for mounting on printed circuit boards. The IC may be damaged if there is any connection error or if pins are shorted together.

7. Actions in strong electromagnetic field

Use caution when using the IC in the presence of a strong electromagnetic field as doing so may cause the IC to malfunction.

8. ASO

When using the IC, set the output transistor so that it does not exceed absolute maximum ratings or ASO.

9. Thermal shutdown circuit

The IC incorporates a built-in thermal shutdown circuit (TSD circuit). The thermal shutdown circuit (TSD circuit) is designed only to shut the IC off to prevent thermal runaway. It is not designed to protect the IC or guarantee its operation. Do not continue to use the IC after operating this circuit or use the IC in an environment where the operation of this circuit is assumed.

	TSD on temperature [°C] (typ.)	Hysteresis temperature [°C] (typ.)
BA6878EFV	175	15
BA6868FM	175	175

10. Testing on application boards

When testing the IC on an application board, connecting a capacitor to a pin with low impedance subjects the IC to stress. Always discharge capacitors after each process or step. Always turn the IC's power supply off before connecting it to or removing it from a jig or fixture during the inspection process. Ground the IC during assembly steps as an antistatic measure. Use similar precaution when transporting or storing the IC.

11. Regarding input pin of the IC

This monolithic IC contains P+ isolation and P substrate layers between adjacent elements in order to keep them isolated.
P-N junctions are formed at the intersection of these P layers with the N layers of other elements, creating a parasitic diode or transistor. For example, the relation between each potential is as follows:

When GND > Pin A and GND > Pin B, the P-N junction operates as a parasitic diode.
When GND > Pin B, the P-N junction operates as a parasitic transistor.

Parasitic diodes can occur inevitable in the structure of the IC. The operation of parasitic diodes can result in mutual interference among circuits, operational faults, or physical damage. Accordingly, methods by which parasitic diodes operate, such as applying a voltage that is lower than the GND (P substrate) voltage to an input pin, should not be used.

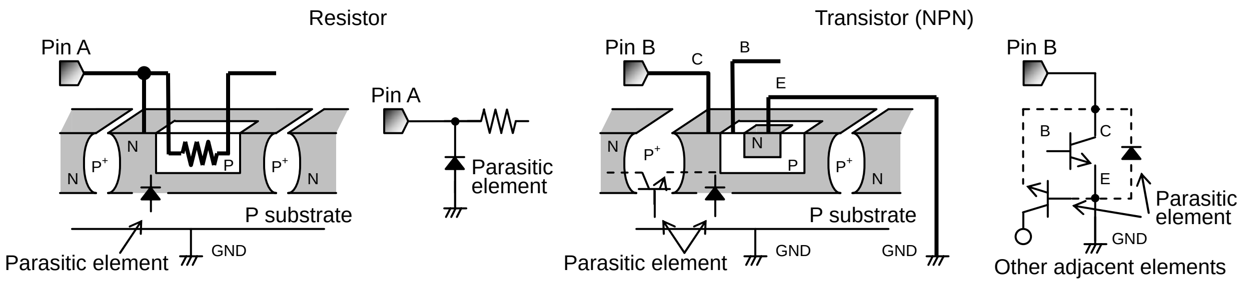


Fig. 36 Example of IC structure

12. Ground Wiring Pattern

When using both small signal and large current GND patterns, it is recommended to isolate the two ground patterns, placing a single ground point at the ground potential of application so that the pattern wiring resistance and voltage variations caused by large currents do not cause variations in the small signal ground voltage. Be careful not to change the GND wiring pattern of any external components, either.

●**Power Dissipation Reduction**

The power dissipation of the IC shows the power consumption of the IC when the ambient temperature (Ta=25°C) is at room temperature. The IC will generate heat when the IC consumes power, and the temperature of the IC chip will be higher than the ambient temperature. The power consumption of the IC is limited. The power dissipation is determined by the thermal resistance (heat dissipation performance) of the package at the permissible temperature (i.e., absolute maximum rating of the junction temperature) of the IC chip in the package. Heat generated as a result of the power consumption of the IC is dissipated from the mold resin or lead frame of the package. A parameter that obstruct the thermal dissipation is called thermal resistance and expressed by θj-a [°C/W]. From this thermal resistance, the IC temperature in the package can be estimated. Fig. 36 shows a model of thermal resistance in the package. The thermal resistance θj-a, ambient temperature Ta, chip temperature Tj, and power consumption P are obtained from the following formula:

$$\theta ja = (Tj - Ta) / Pd \quad [℃/W] \quad \cdot\cdot\cdot\cdot\cdot \quad (I)$$

The heat derating curve shows the permissible power consumption of the IC at ambient temperature. The possible power consumption of the IC decreases with an increase in ambient temperature. This slope is determined by the thermal resistance θja.
The thermal resistance θja is dependent upon various conditions, such as the chip size, power consumption, package ambient temperature, mounting conditions, and wind velocity. The derating curve shows reference values measured under specified conditions.
Fig. 37 shows the derating curves of the BA6878EFV and BA6868FM. If the BA6878EFV is used at an ambient temperature (Ta) of 25°C or higher, the power will be reduced at the rate of 8.8 mW/°C. If the BA6868FM is used at an ambient temperature (Ta) of 25°C or higher, the power will be reduced at the rate of 17.6 mW/°C, on the condition that the IC is mounted on the FR4 glass epoxy board of 70 mm x 70 mm x 1.6 mm in size (with a maximum cupper foil area of 3%).

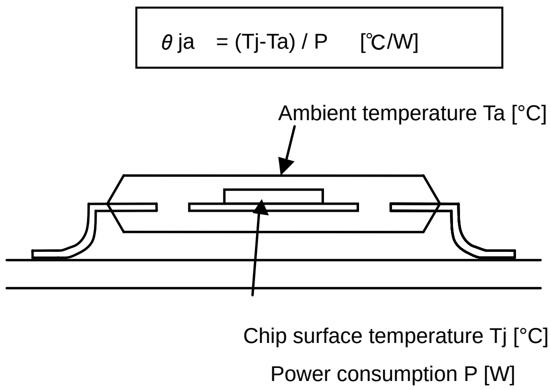
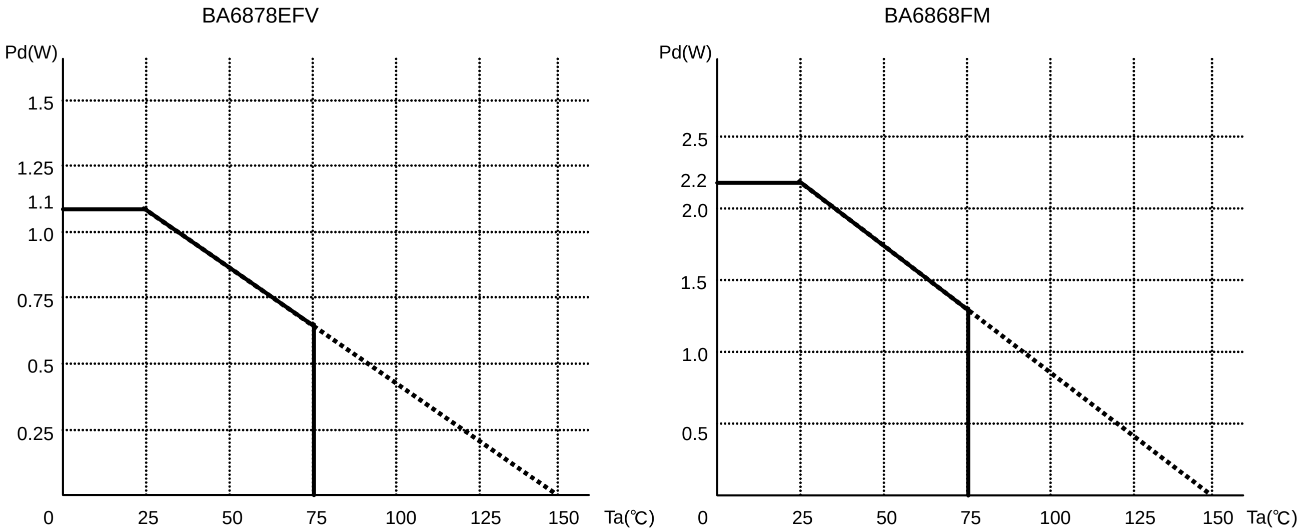


Fig. 37 Thermal Resistance



*Reduced by 8.8 mW/°C over 25°C, when mounted on a glass epoxy board (70 mm x 70 mm x 1.6 mm)

*Reduced by 17.6mW/°C over 25°C, when mounted on a glass epoxy board (70 mm x 70 mm x 1.6 mm)

Fig.38 Heat Derating Curve

● **Selecting a Model Name When Ordering**

Specify the model number when placing your order. Make sure that the combination of each item is correct, and left justify the items with no space between adjacent items.

B	A	6	8	7	8	E	F	V	−	E	2

ROHM model name
- **BA6878EFV**
- **BA6868FM**

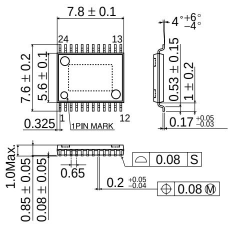
Package type
- **EFV :HTSSOP-B24**
- **FM : HSOP-M28**

E1 Reel-wound embossed taping with pin 1 on the extraction side

E2 Reel-wound embossed taping with pin 1 on the opposite side of the extraction side.

HTSSOP-B24

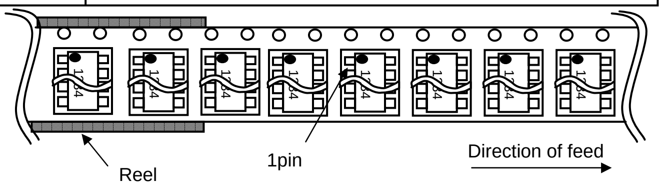
<Dimension>



(Unit:mm)

<Tape and Reel information>

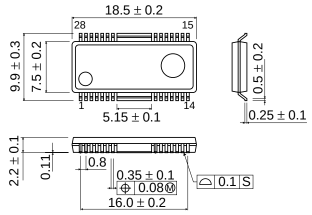
Tape	Embossed carrier tape
Quantity	2000pcs
Direction of feed	E2 (The direction is the 1pin of product is at the upper left when you hold reel on the left hand and you pull out the tape on the right hand)



※When you order , please order in times the amount of package quantity.

HSOP-M28

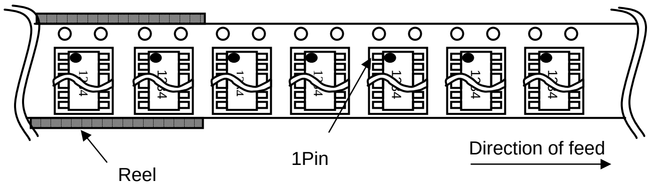
<Dimension>



(Unit:mm)

<Tape and Reel information>

Tape	Embossed carrier tape
Quantity	1500pcs
Direction of feed	E2 (The direction is the 1pin of product is at the upper left when you hold reel on the left hand and you pull out the tape on the right hand)



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