2-Phase half-wave motor pre driver for fan motor

BA6901F

BA6901F is a 2-phase half-wave motor pre driver for fan motors. This IC has lock detection, and automatic restart functions as motor protection function.
Variable speed control is possible by charge-discharge pulse circuit and PWM input. This IC incorporates current limit circuit, hall signal output pin, and alarm signal output pin.

●Applications

Fan motors

●Features

1) Lock detection, automatic restart circuit.
2) Hall signal output.
3) Alarm signal output.
4) Current limit circuit.
5) PWM control (PWM pulse signal input).
6) Charge-discharge pulse circuit (Possible to control of variable speed by charge-discharge pulse circuit and PWM input).
7) Thermal shut down circuit.

●Absolute maximum ratings (Ta = 25°C)

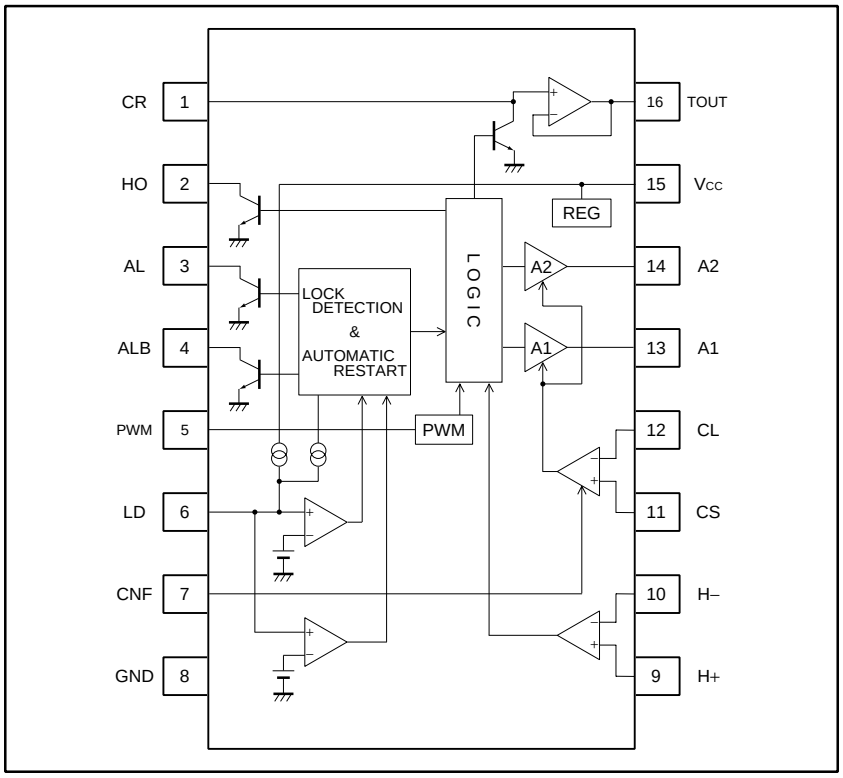
Parameter	Symbol	Limits	Unit
Power supply voltage	V_{CC}	36	V
Power dissipation	Pd	625 *1	mW
Operating temperature	Topr	−25~+75	°C
Storage temperature	Tstg	−55~+150	°C
Output current	I_{OUT}	70 *2	mA
Signal output voltage	V_{SO}	36	V
Signal output current	I_{SO}	15	mA
Junction temperature	Tjmax	150	°C

*1 To use at temperature above 25°C reduce 5.0mW / °C.
(On 70.0mm×70.0mm×1.6mm glass epoxy board.)
*2 This value is not to be over Pd and ASO.

●Recommended operating conditions (Ta = 25°C)

Parameter	Symbol	Min.	Typ.	Max.	Unit
Operating supply voltage	V_{CC}	3.5	–	28.0	V

●**Block diagram**

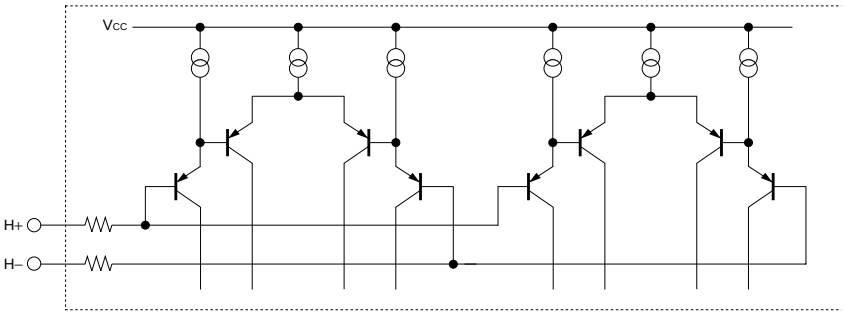


●**Pin descriptions**

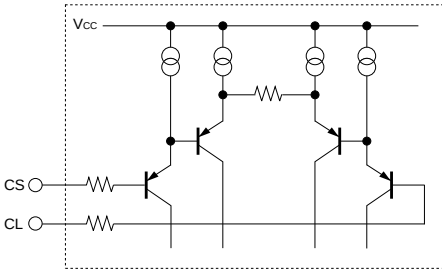
Pin No.	Pin name	Function
1	CR	Connection terminal of capacitor and resistor for charge-discharge pulse circuit
2	HO	Hall signal output terminal
3	AL	Alarm output terminal
4	ALB	Alarm output terminal (Reverse signal output of AL)
5	PWM	PWM input terminal (H,OPEN : output ON, L : output OFF)
6	LD	Connection terminal of capacitor for Lock detection, Auto restart
7	CNF	Connection terminal of capacitor for phase compensation
8	GND	GROUND terminal
9	H+	Hall signal input terminal
10	H–	Hall signal input terminal
11	CS	Current sence input terminal
12	CL	Current limit input terminal
13	A1	Output terminal
14	A2	Output terminal
15	Vcc	Power supply terminal
16	TOUT	Charge-discharge pulse output terminal

●**Input / output truth circuit**

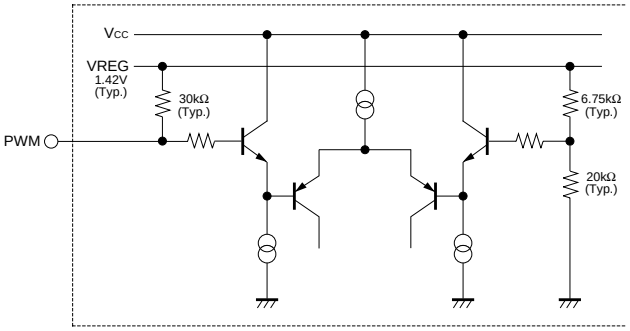
Hall input



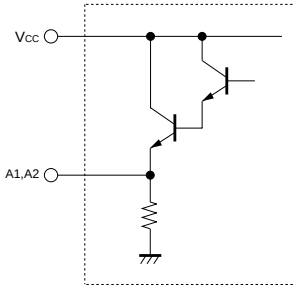
Current limit input



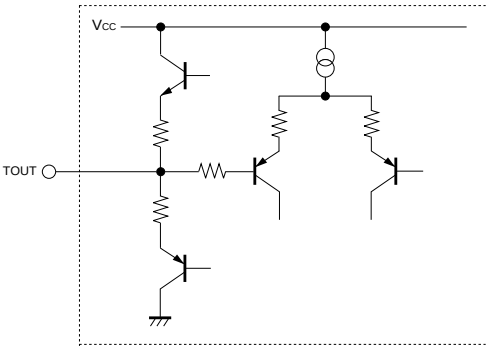
PWM input



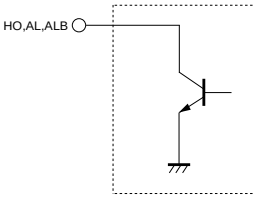
Output



Charge-discharge pulse output



Signal output



● **Electrical characteristics** (unless otherwise noted, Ta = 25°C, V_{CC} = 12V)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
Circuit current	I_{CC}	3.0	7.0	12.0	mA	At output : OFF
Hall input hysteresis	Vhys	±4	±10	±20	mV	VCOM=6.0V
Charge current of capacitor for lock detection	ILDC	2.0	5.0	8.0	μA	VLD=1.5V
Discharge current of capacitor for lock detection	ILDD	0.2	0.5	0.8	μA	VLD=1.5V
Charge-discharge current ratio of capacitor for lock detection	rCD	4	10	16	–	rCD=ILDC / ILDD
Clamp voltage of capacitor for lock detection	VLDCL	1.60	2.40	3.20	V	
Comparison voltage of capacitor for lock detection	VLDCP	0.25	0.60	0.95	V	
Output H voltage	VOH	–	1.5	2.0	V	I_O=–10mA vs. V_{CC} voltage
Hall signal outputn L voltage	VHO	–	0.10	0.50	V	IHO=5mA
Alarm output L voltage	VAL	–	0.10	0.50	V	IAL=5mA, AL, ALB terminal
CL-CS offset voltage	VofsCS	75.0	92.0	99.5	mV	CL=100mV
Response time for current limit	TCS	–	50	150	μsec	
PWM input voltage H	VPWMH	2.0	–	–	V	At output : ON
PWM input voltage L	VPWML	–	–	0.8	V	At output : OFF
Charge-discharge pulse comparison voltage	VCRCP	0.26	0.35	0.44	V	
Charge-discharge pulse output voltage H	VTOH	0.7	1.0	1.3	V	ITO=–0.5mA vs. V_{CC} voltage
Charge-discharge pulse output voltage L	VTOL	0.7	1.0	1.3	V	ITO=0.5mA

◎ This product isn't designed for protection against radioactive rays.

●Circuit operation

•Lock detect circuit, automatic restart circuit

Charge and discharge time at motor lock condition varies with the value of external capacitor at LD terminal, and is given by the following equation.

$$\text{Ton (Charge time)} = \frac{C \times (VLDCL - VLDCP)}{ILDC}$$

$$\text{Toff (Discharge time)} = \frac{C \times (VLDCL - VLDCP)}{ILDD}$$

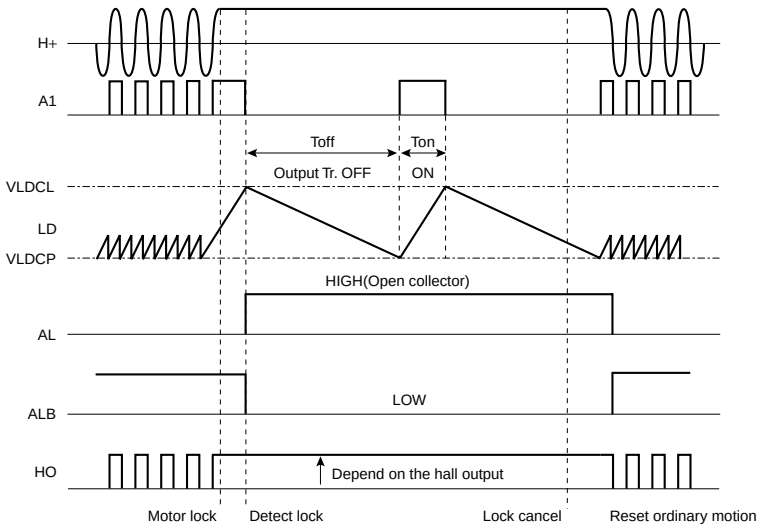
C	:	Value of capacitor at LD terminal		
VLDCL	:	Clamp voltage of capacitor	(2.40V	Typ.)
VLDCP	:	Comparison voltage of capacitor	(0.60V	Typ.)
ILDC	:	Charge current of capacitor	(5.0μA	Typ.)
ILDD	:	Discharge current of capacitor	(0.5μA	Typ.)

The following value shows charge time and discharge time at C=1.0μF for reference.

Charge time=0.36sec. (Output : ON)

Discharge time=3.60sec. (Output : OFF)

Shows timing chart of LD terminal.



•CL, CS, CNF terminal

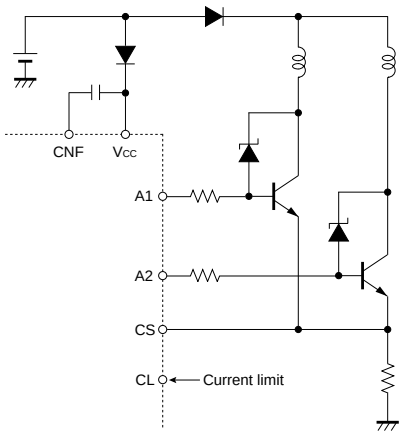
Output current is limited by voltage (VCL) that inputting to the CL terminal.
Resistor (RNF) of the output current detection is connected between emitter of the external output transistor and GND, and output current is detected by inputting the voltage which occurred in that resistor to the CS terminal. Output current is restricted as the electric potentials of the CL and the CS terminals are equal. But, there is offset between the CL terminal and the CS terminal. Value of current limit is found by the following equation.

$$\text{Value of current limit} = \frac{\text{VCL} - \text{VCL\_CSofs}}{\text{RNF}}$$

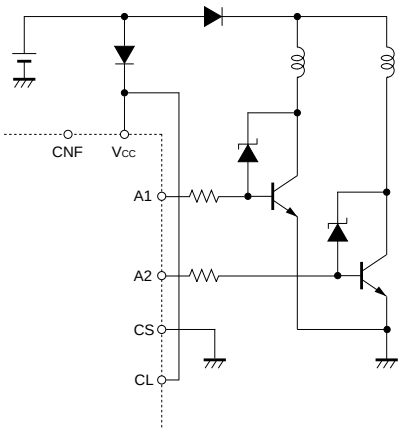
VCL_CSofs : Offset between CL terminal and CS terminal

This offset is not the one written at electrical characteristics table, but the value determined under condition that the external output transistors are connected. Be careful of this value, because it varies according to the external transistor. The lager hFE of the output transistor makes the offset smaller, and smaller hFE makes it larger.

For output current limitation, a capacitor for the phase compensation between the CNF terminal and the Vcc terminal is needed.
However, when an output current limit isn't needed, CS terminal is fixed on the low level (GND), and CL terminal is fixed on the high level (Vcc), and the capacitor of the CNF terminal isn't necessary.



(a) In the case that the current limit is applied.

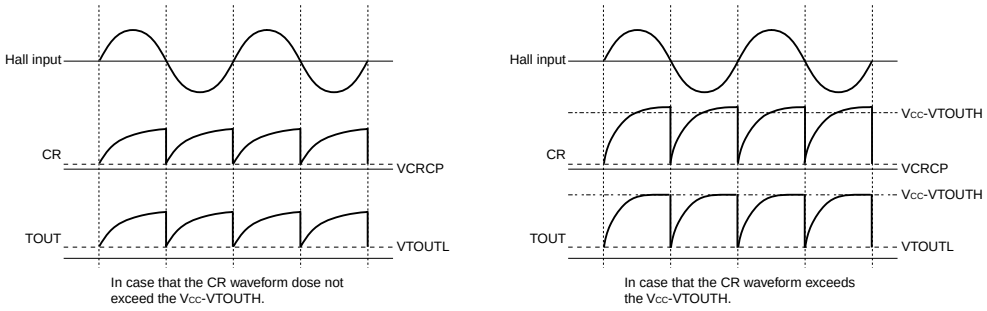


(b) In the case that the current limit isn't applied.

•CR, TOUT terminal

By connecting the external capacitor and resistor to the CR terminal, the saw tooth wave is produced by the charge-discharge of the capacitor which are corresponding to the cycle of the hall signal.
The saw tooth wave of CR terminal varies with the external capacitor and resistor.
The waveform of the CR terminal passes through the buffer amplifier and is outputted to TOUT terminal.
The input voltage range of the CR terminal for the buffer amplifier of TOUT is 0.26V~Vcc.
In case that the signal of the CR terminal is out of the range, outputted TOUT signal is not the same as the CR signal.
And, the voltage range of the TOUT terminal waveform is different from the CR terminal.

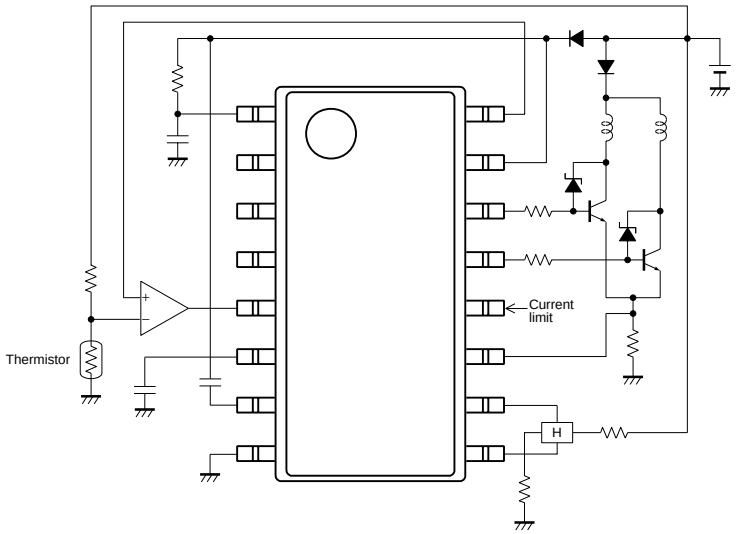
CR : VCRCP (0.35V ; Typ.) ~ Vcc
TOUT : VTOUTL (1.0V ; Typ.) ~ Vcc – VTOUTH (1.0V ; Typ.)



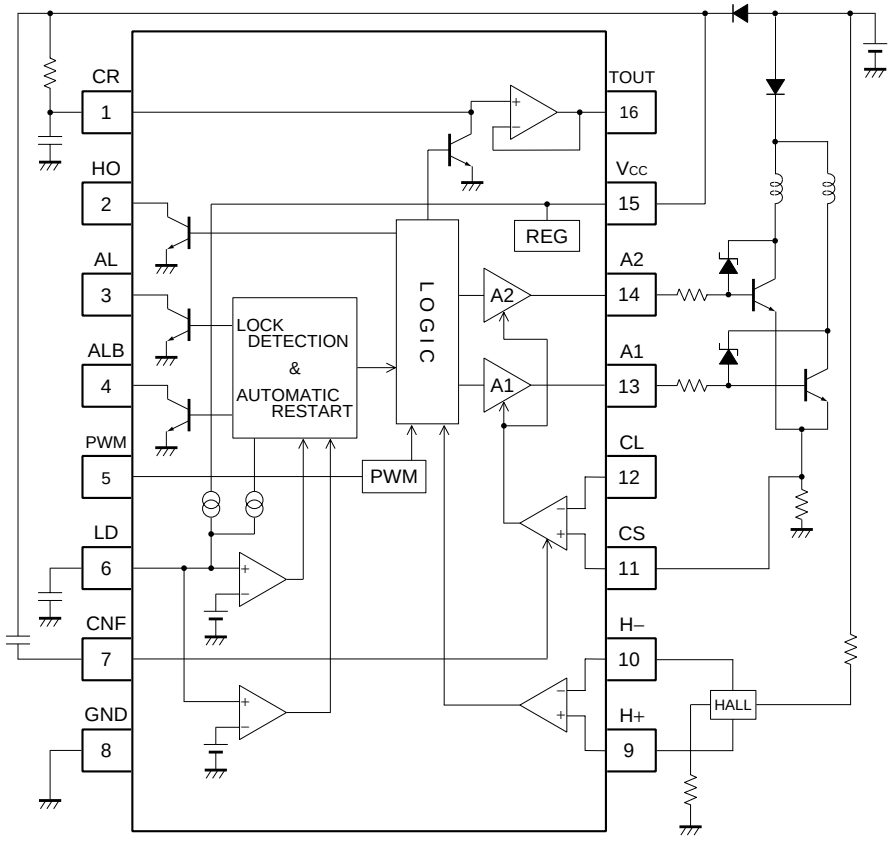
Timing chart for CR terminal, TOUT terminal

•PWM terminal

If the signal inputted to the PWM terminal is L (less than 0.8V), output (A1, A2) is forced to be turned off. For the normal operation of output (A1, A2), PWM signal is needed to be H (more than 2.0V).
In case that PWM terminal is open, outputs are in the normal operation mode, because the PWM terminal is pulled up with resistor (30kΩ : Typ.) in the IC.
The application circuit example that changes the rotation speed of fan motor dependent on ambient temperature by using charge-discharge pulse circuit, PWM input and the thermistor is shown below.



●**Application example**

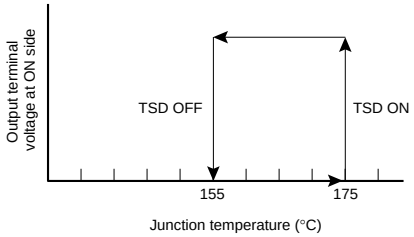


●**Operation notes**

1) Thermal shut down (TSD)

This IC is built-in TSD.

TSD has the temperature hysteresis.



TSD ON (Typ. : 175°C)
All output transistor OFF.

TSD OFF
Reset ordinary motion.
(It has the temperature hysteresis of 20°C <Typ.>)

2) Power dissipation

Power consumption (PC) of BA6901F is calculated to the following equation.

$$Pc = Pc1 + Pc2 + Pc3$$

(1) Pc1 : Power consumption by circuit current

$$Pc1 = V_{CC} \times I_{CC}$$

(2) Pc2 : Power consumption of output terminal

$$Pc2 = (V_{CC} - VOH) \times Io$$

VOH is H voltage of output (A1 or A2).

Io can be decreased by using the transistor of high hFE rank and it is effective to consumption electric power reduction.

(3) Pc3 : Power consumption of HO, AL and ALB terminal

$$Pc3 = VHO \times IHO + VAL \times IAL + VALB \times IALB$$

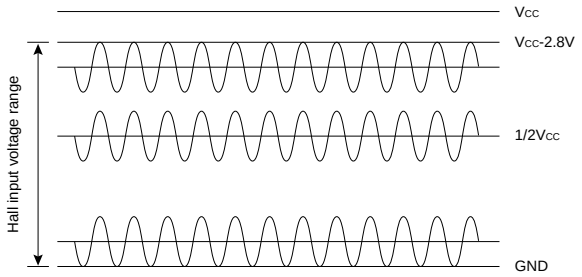
VHO is L voltage of Hall signal output (HO).

VAL and VALB are L voltage of lock detection output (AL or ALB).

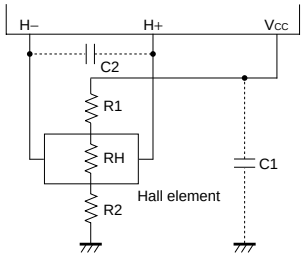
IHO, IAL and IALB are current of HO, AL or ALB.

Please care to the terminal design not to exceed the allowable power dissipation.

3) Hall signal input terminal (H+, H–)



Hall Amp input bias voltage



Hall amp of BA6901F has input hysteresis (±10mV : Typ.)

$$\text{Hall Amp input current} = \frac{V_{CC}}{R1 + R2 + RH}$$

RH : Impedance of Hall element

Please adjust hall Amp input bias voltage by value of R1, R2 so that hall signal contains amplitude, input within range 0V~ (V_{CC}–2.8V).

In case V_{CC} noise influence the hall signal by board wiring pattern, please connect capacitor C1 like above figure.

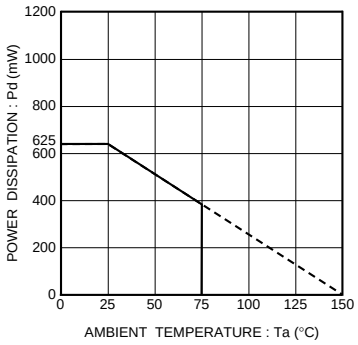
In the case of long board wiring pattern from hall element to hall signal input terminal, please connect capacitor C2 like above figure.

4) GND

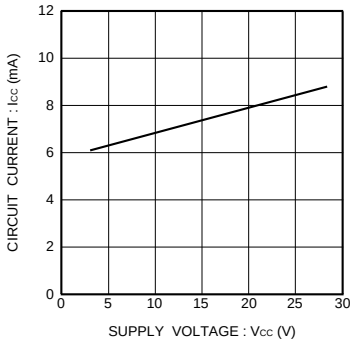
Please keep up the voltage of GND less than the voltage of another terminal surely.

5) This product is produced with strict quality control, but destroyed in using beyond absolute maximum ratings. Once IC destroyed, a failure mode cannot be defined (like short-mode or open-mode). Therefore, physical security counter measure, like fuse, is to be given when a specific mode to be beyond absolute maximum ratings is considered.

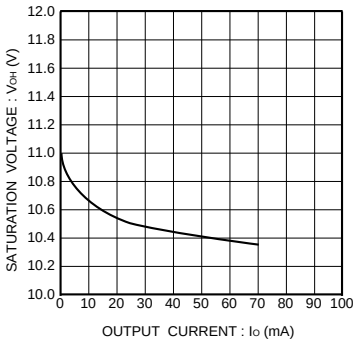
●Electrical characteristic curves



Power dissipation

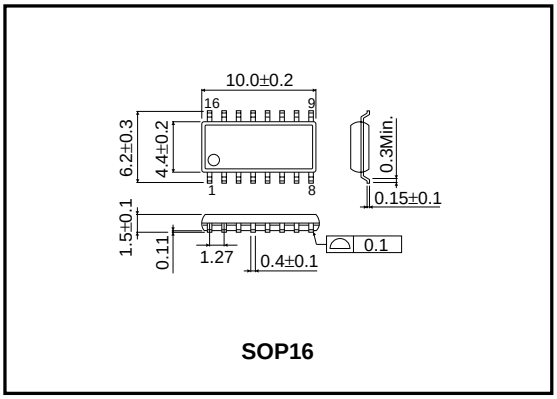


Supply current–Supply voltage characteristic



Output "H" voltae–Output current characteristic

●External dimensions (Units : mm)



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