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Eastern System and Semiconductor Design

EA10
General FAN Motor Driver

General Description

EA10 is ASIC for motor drive in small power application. To drive FAN motor, this device produces suitable driving current around 130mA. Specially for coreless inductor FAN application, it has a gain to realize rising and falling time slope. EA10 has fixed gain around 34dB and it has Built-in TACO function with minimal number of external component. Driving output signal can be easily controlled by hall element which is connected directly to the IC it self.

It has a advanced feature of soft-switching. There are no switching noise problem. EA10 is molded small outline package which has a benefit to reduce the size of FAN.

General Feature

- Output Driving current rate
  Normal operation Vcc = 12V, Icc = 130mA
  Locked condition Vcc= 12V, Icc(max)=180mA
- Low Output Drop < 1.5V (at Icc(max))
- Few External components
- Short circuit protection included.

Application

- Personal computer
- Consumer and OA electrics

Small Outline

8 Pins

Pin Description

Number	Name	I/O	Description
1	OUT+	Output	FAN Inductor Driving Current + out
2	VCC		5 ~ 12 V DC supply
3	OUT-	Output	FAN Inductor Driving Current - out
4	P-GND		Power Ground
5	IN+	Input	Hall sensor + Input pin
6	IN-	Input	Hall sensor - Input pin
7	TACO	Output	Open collector FAN speed pin
8	S-GND		Signal Ground

Absolute Maximum Rating (Note 2)

Supply peak voltage	18V
Supply operating voltage	14V
Package dissipation	300mW
Output peak current	200mA
Storage Temperature	-65 ~ 150℃
Operating Temperature	0 ~ 55℃
Junction Temperature	150℃

Electrical Characteristics (Note 1,2,3)

T_A = 25℃

Characteristics	Symbol	Test Condition	Min	Typ	Max	Units
Supply Voltage	Vcc	-	4.5	-	13.2	V
Quiescent Current	Iccq	Vcc=12V	-	10	20	mA
Operation Output Driving Current	Idrv	Vcc=12V	-	-	130	mA
Locked Output Driving Current	Ilock	Vcc=12V	-	-	180	mA
Drive Amplifier Gain	Gv	See application Hint	30	34	38	dB
Input Resistance	Rin	-	50	-	-	Kohm
Input Offset Voltage	Vios	-	-	5	-	mV
Input Common mode voltage range	Vicr		-	Vcc-2	-	V
Minimum Input Voltage	Vin(p-p)	See application Hint	300	-	-	mV

Note 1: All voltages are measured with respect to the ground pin, unless otherwise specified.

Note 2: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is functional, but do not guarantee specific performance limits. Electrical Characteristics state DC and AC electrical specifications under particular test conditions which guarantee specific performance limits. This assumes that the device is within the Operating Ratings. Specifications are not guaranteed for parameters where no limit is given, however, the typical value is a good indication of device performance

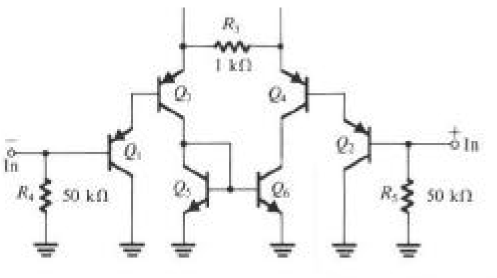
Note 3: Defending on the load condition, current rate can be estimated. Normal FAN application use coreless inductor which has DC resistance around 70ohm(12V) and 12ohm(5V). This device grantees maximum current around 200mA. User can be choose optimized load condition within electrical maximum rating.

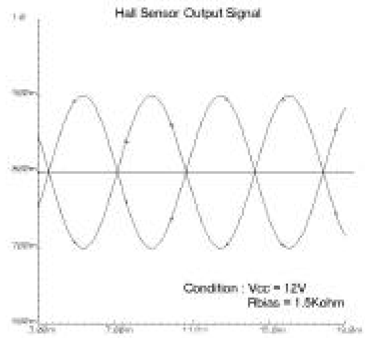
Application Hints

Input circuit configuration

EA10 consists of an input differential amplifier utilizing Q1 and Q2 as emitter followers for input buffering, and Q3 and Q4 as a differential pair with an emitter resistor R3. The two resistors R4 and R5 provide dc paths to ground for the base currents of Q1 and Q2, thus enabling the input signal source to be capacitively coupled to either of the two input terminals

The schematic shows that both inputs are biased to ground with a 50Kohm resistor. The base current of the input transistors is about 250nA, so the inputs are at about 12.5mV when left open. If the dc source resistance driving the EA10 is higher than 250Kohm it will contribute very little additional offset (about 2.5mV at the input, 50mV at the output). If the dc source resistance is less than 10Kohm, then shorting the unused input to ground will keep the offset low. For dc source resistances between these values we can eliminate excess offset by putting a resistor from the unused input to ground, equal in value to the dc source resistance. Of course all offset problems are eliminated if the input is capacitively coupled.



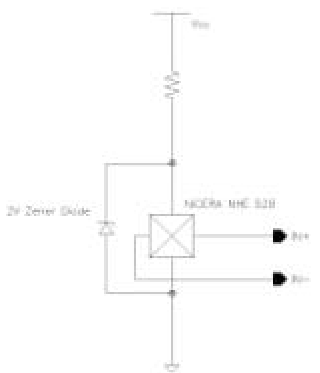


Hall sensor output characteristic at 12V application
Bias resistor : 1.5 Kohm
Output V(p-p) : 320 ~ 420mV
Output Vdc : 0.8+/-0.1V
Output Resistance : 240 ~ 550 ohm

Hall sensor output characteristic at 5V application
Bias resistor : 2.5 Kohm
Output V(p-p) : 46 ~ 52mV
Output Vdc : 0.25+/-0.1V
Output Resistance : 240 ~ 550 ohm

Recommended Input condition

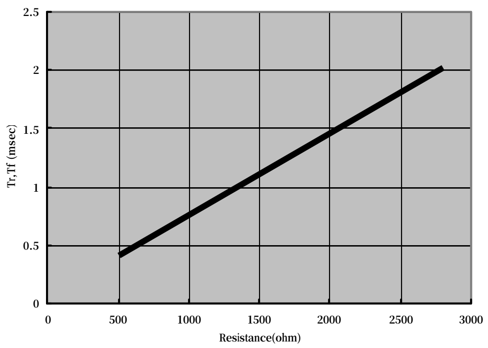
Hall Device Input condition can be controlled by user application. As a bias resistance value, output hall voltage swing amplitude changed. It has a linearity, so easily it can be set. To control the output signal, We can changed input condition by bias resistor value. Hall sensor biasing resistor value makes effect to output of hall voltage directly. Defend on the supply voltage hall voltage can be changed.



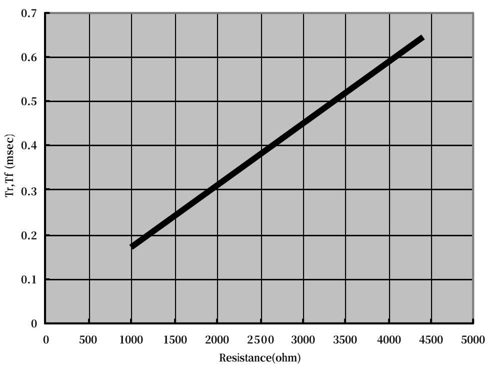
Output Tr, Tf control

Output voltage Tr, Tf can be controlled by Hall device bias hall voltage directly. In case of coreless FAN motor. Tr, Tf time is very important factor. Hard switching may cause a unexpected noise. Also performance of FAN can be decided by proper output wave. This factor dominantly follow gain characteristics. EA10 has a fixed gain around 34dB. With a 200mV(p-p) input signal, output wave has around 1msec(0.5msec, 5V) rising and falling time. If input signal is increased rising and falling time will increased, and If input signal decreased then vice versa. Optimized operating condition with good performance of FAN could be achieved by trimming bias resistor

Hall bias resistor & Tr,Tf time(12V, Temp=55, Load=70ohm)



Hall bias resistor & Tr,Tf time (5V, Temp=55, Load=12ohm)



Hall sensor output voltage peak to peak is decided by bias current I_{bias}. Simulation and laboratory can be prove the relation between bias current and hall output voltage. To calculate hall output voltage, Resistance of hall device have to keep in mind. Hall device bias current is decided with bias resistor and hall device resistance. Spec of hall device indicate that hall device resistance is around 240 ~ 550 ohm. This range is too wide to approach correct equation. So this value is extracted by laboratory. It has around 300ohm. Using this value, we have a fixed bias resistance, then I_{bias} is easily calculated. In 12V application. If we use 1.5kohm, then I_{bias} is approximately 6mA. At this condition, output measured hall voltage is 100mV(peak). Through we changed resistor value from 1kohm to 5kohm, we get a simple expression.

$$V_{OUT(peak)} \ ?\ 16?\ I_{bias}$$

In case of 5V application, supply voltage is only 4.3V, even this condition, absolute value is little bit different to 12V. but, linearity is almost same as above. Resistor control bias current have a big deviation which can make possibility of hall output voltage(Vm) change. Also hall sensor has their typical deviation(NECERA NHE528 Rank 4 : 168 ~ 204mV). At worst case, Vm can be varied with resistor variation. To solve this problem, To make a stable Vm, hall bias voltage has to fixed. It can be fixed using voltage stabilizer. We strongly recommend use 2V zener diode. It has a effect to make stable Vm and protection of hall sensor.

Note 4: Hall voltage equation has a deviation of measuring equipment. It maybe be adapted in actual application. This information show the trend of hall output voltage as a bias resistance.

Coreless inductor driving method

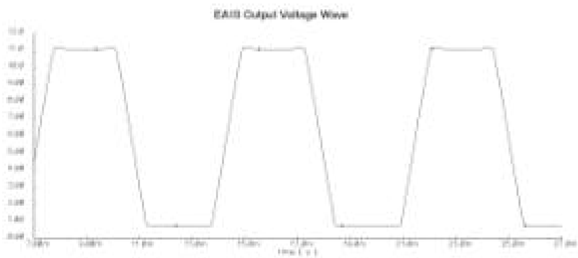
To make suitable driving signal for coreless inductor FAN, The driving current has to change slowly. It is called soft-switching. In case of coreless inductor FAN, hard switching can be used because cored inductor has magnetic hy steresis. It can compensate high slew rate switching. But, in case of coreless inductor, there are no hysteresis, as a currents change, magnetic field also change very rapidly. It may has possibility of electrical noise of FAN.

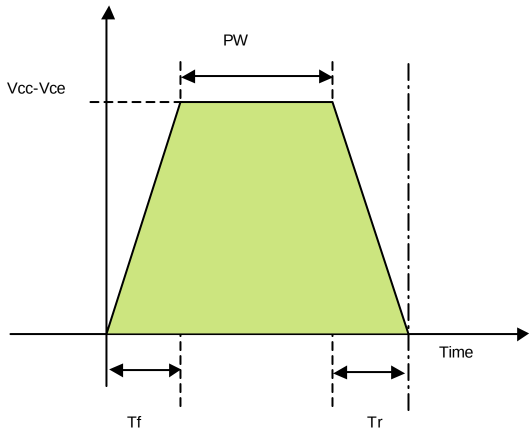
When we use 4mH, 100ohm dc resistance coreless inductor, In 12V operation, normally over 0.6msec rise time is recommendable. In case of 5V operation, it maybe more shorter. As a load inductor condition we need to control these rising and falling time. To make a large tougue, the on-time must be long, soft-switching could decrease output power and efficiency. So as a application and load condition. Rising and falling time need to set for optimized operation

Power Calculation

All kind of amplifier pursuit to reduce the dissipate power. EA10 designed using high efficiency output circuit topology. In this general motor drive application, load current is very big. It is dominant factor of efficiency. To make a higher efficiency, we need to reduce the unexpected output drop voltage. Normal quasi-complement output drivers has a drop voltage about 2Vbe+Vce. But, EA10 has a improved output configuration. It has only Vbe+Vce. If we calculate simply with output driving current 200mA, then saving power is 140mV(Vbe=0.7).

To calculate output power, we need to apply typical method, because of output wave is not a complete sinusoidal wave. In case of audio signal, we can easily calculate the power using rms value. In motor driving, output wave is totally saturated and truncated. So it need to check with graphical method.





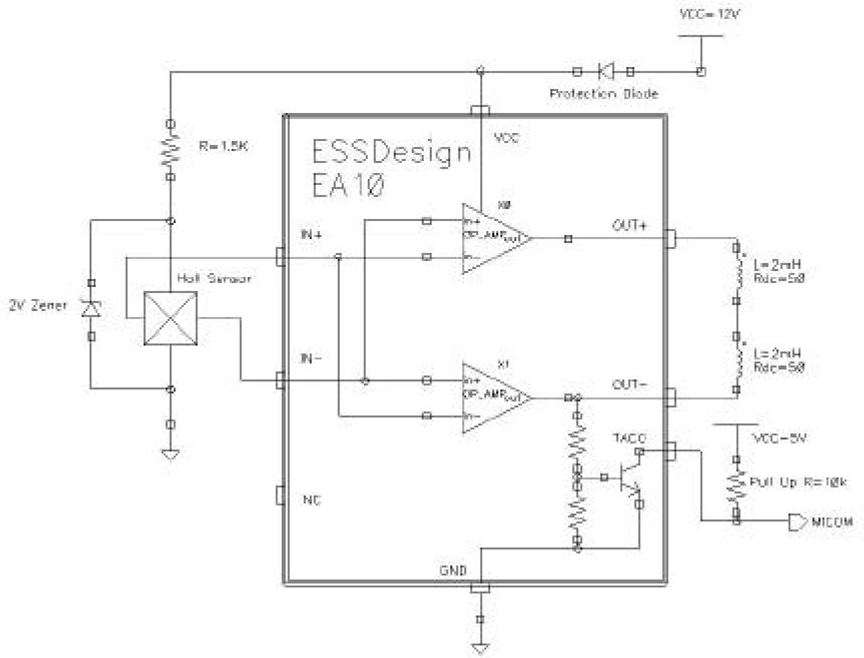
$$Pdc\ (\max)\ ?\ Vcc\ ?\ Icc$$

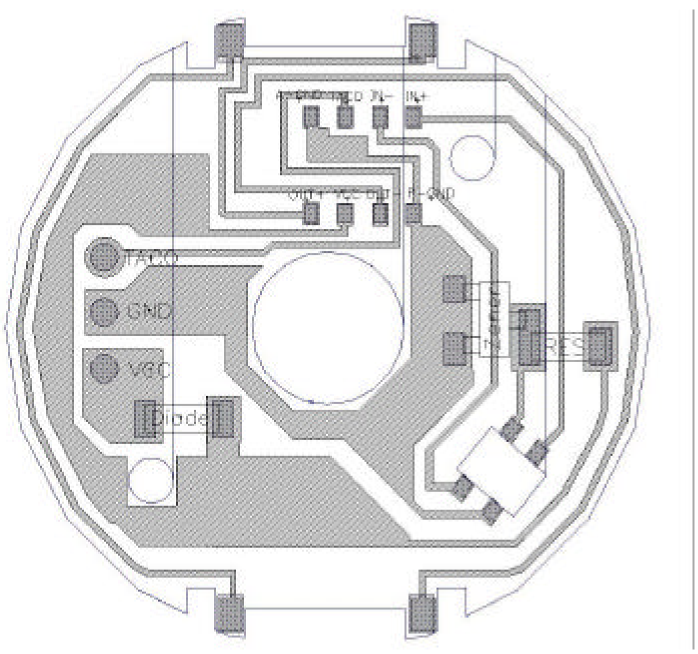
$$Pavg\ ?\ \frac{[(Vcc\ ?\ 2Vce)\ ?\ Iout\ ?\ PW\ ?\ (Vcc\ ?\ 2Vce)\ ?\ Iout\ ?\ \frac{Tr\ ?\ Tf}{2}]}{Tr\ ?\ PW\ ?\ Tf}$$

$$Efficiency\ ?\ \frac{Pavg}{Pdc\ (\max)}\ ?\ 100\ (\%)$$

Typical Applications

FAN Driver configuration





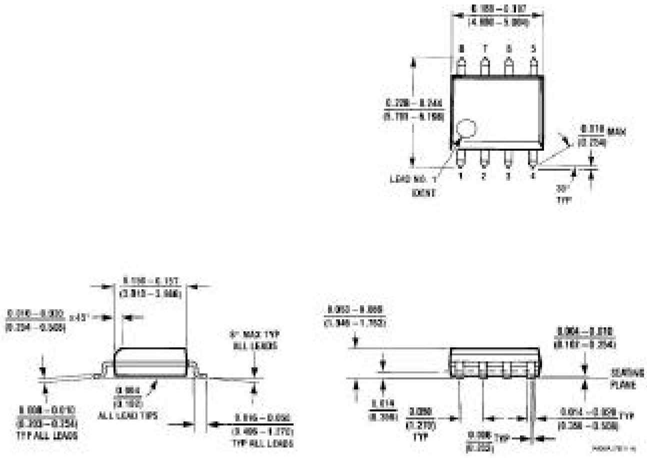
Note 5: Hall Sensor : NiCERA NHE528

Note 6: Zener Diode : BZX84C series

Note 7: TACO Pull Up Resistor : 10Kohm

Note 8: Protection Diode needed to protect reverse connection of VCC to ground.

Physical Dimensions inches (millimeters) unless otherwise noted



SO Package (M)

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