AVAGO TECHNOLOGIES

Analog Isolation using Linearity Optocouplers, HCNR201/200

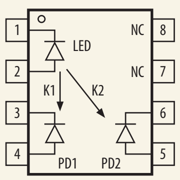
Introduction

Analog isolation is still widely used in motor drives, power monitoring, etc whereby applications typically use inexpensive analog voltage control for speed, intensity or other adjustments.

The HCNR201/200 analog optocoupler is commonly added to isolate the analog signal in the front end module of an application circuitry. The optocoupler will be placed between the analog input and the A/D converter to provide isolation of the analog input from the mixed signal ADC and other digital circuitries. The HCNR201/200 is an excellent solution for many of the analog isolation problems.

Key Features and Specifications

TThe HCNR201/200 analog optocoupler consist of a single LED with two photodiodes, PD1 and PD2 as shown in the diagram below. The two photodiodes are closely matched, with PD1 on the input side and the PD2 on the output side of the application circuitry. The output current of the photodiode is linearly related to the light output of the LED. Having an input photodiode, PD1 allows a direct monitoring of the LED condition, hence stabilizing the light output of the LED. With close matching of the two photodiodes and with suitable application circuitry, HCNR201/200 can achieve high linearity and stable gain characteristics. The advantage of using HCNR201/200 lies in its flexibility of operating in a wide variety of different modes, such as in unipolar/bipolar, ac/dc and inverting/non-inverting configurations. Both HCNR201 and HCNR200 are housed in 400mil DIP8 widebody package.



The key features and characteristics of HCNR201/200 High Linearity Analog Optocoupler are as follow:

- Low Cost Analog Isolation, High Linearity, Flexible design with ease of accessing the two photodiodes
- Tighter K3 (IPD2/IPD1) Transfer Gain - Current flowing in output photodiode PD2 vs current flowing in the input photodiode PD1, this indicate how closely match are the two photodiodes
- Low Nonlinearity – Maximum deviation (in %) of the full scale output of a "best fit" straight line drawn from the plot Ipd2 vs Ipd1 from 5nA to 50µA. Straight line drawn is based on 11 point equally spaced from 5nA to 50µA. IPD2 error to best fit line is the deviation above and below the best fit line.
- Low Transfer Gain Temperature Coefficient - Gradient of K3 vs temperature plot. This indicate the transfer gain to temperature variations
- Wide Bandwidth : DC to > 1MHz
- IEC60747-5-5 certification for reinforced insulation with continuous working voltages at 1414 Vpeak and transient voltages of 8kVpeak for HCNR201/200

Table 1. Key technical specifications of HCNR201/200

Parameter	HCNR201	HCNR200
Transfer Gain, K3	0.95 to 1.05 (±5%)	0.85 to 1.15 (±15%)
Non Linearity, NL_{BF}	0.05% max	0.25% max
Temperature Coefficient, ΔK1/ΔTA	-0.3%/°C typ	-0.3%/°C typ
Temperature Coefficient, ΔK3/ΔTA	-65ppm/°C typ	-65ppm/°C typ
Bandwidth (LED)	9MHz typ	9MHz typ
Common Mode Noise Rejection, IMRR	95dB typ	95dB typ
Operating Temperature	-40°C to 85°C	-40°C to 85°C
Continuous Working Voltage, V_{IORM}	1414 V peak	1414 V peak
Isolation Voltage, V_{ISO}	5000 V	5000 V

High Speed, Low Cost Implementation Using HCNR201/200

Avago had various circuitries that are designed to be used together with the HCNR201/200 to provide isolation and using them in a number of industrial applications, such as motor drives, switched mode power supplies, transducer, current loop, etc.

HCNR201/200 are used in different circuit configurations. Figure 1 illustrates a high speed, low cost implementation using HCNR201/200, achieving a high bandwidth of 1.5MHz with stable gain characteristics. For applications looking for high bandwidth, high speed and low cost solutions, this will be a suitable implementation as the circuitry consists of only discrete transistors (No op-amps). But it will have to tradeoff accuracy to achieve the high bandwidth and speed. This configuration is typically used in the feedback path of the switched mode power supplies. The transfer function is governed by:

$$V_{OUT}/V_{IN} = R2/R1$$

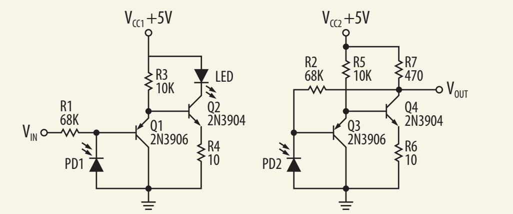


Figure 1: Low Cost, High Speed analog isolation using HCNR201/200

Voltage Monitoring in Servo Motor, Inverter and Power Supplies

HCNR201/200 are used for voltage monitoring in the feedback loop in the servo motor, inverter and power supplies applications.

The advantage of using HCNR201/200 is the compensation for LED characteristics drift due to temperature, aging or other non-linearities effect. They are used in servo motor drives whereby the input photodiode is placed in the feedback path to control the LED current using external components, such as op-amps. This is shown in the figure 2 for a positive input voltage, VIN. Bipolar input circuit will use either two HCNR201 or two HCNR200. The capacitor C1 is compensating capacitor for stability. The two op-amps LM158 are two separate packages and not two channels in a single dual channel package, otherwise galvanic insulation will not be present.

Input photodiode current, $I_{PD1} = V_{IN}/R1$. To achieve linearity, with R1 at 80kΩ, the input voltage, V_{IN} will need to be maximum of 4V and keeping the maximum photodiode current at 50µA (as specified in the datasheet).

The linear transfer function for this application circuit is governed by :

$$V_{OUT}/V_{IN} = K3 * R2/R1$$

The relationship between V_{IN} and V_{OUT} is linearly related as the above equation is independent of the light output of the LED. Gain of the amplifier circuit can be adjusted by ratio of R2 to R1.

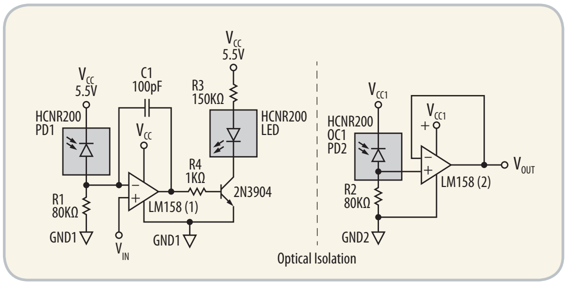


Figure 2: Positive Polarity Input Voltage using HCNR201/200

Current Loop

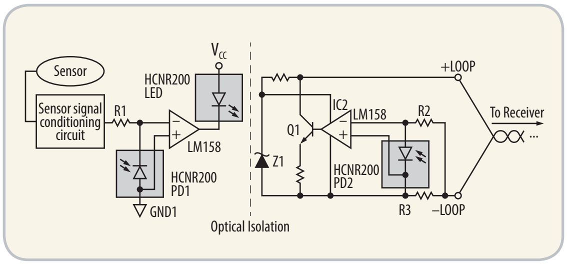
Current loop had become the standard method for sensor signal transmission. Current loop is suitable in industrial environments whereby long cable lengths are required or high electromagnetic interference are present. The distance from the sensor stage to the controller (PLCs, PC) can be a long distances. High voltage insulation or galvanic isolation is needed to protect the equipment. There are a couple of types of current loops: analog (a linear current represents the analog signal), logic (high and low logic levels represent MARK and SPACE states respectively), and a combined analog and digital current loop that uses the HART® (Highway Addressable Remote Transducer) communication protocol. Compared to voltage signals, current loops have the benefits of insensitive to noise and errors from line impedance, long distance transmission without loss, and lower EMI sensitivity.

Transmitter Circuit

From Figure 3, zener Z1 establishes the voltage required by the loop side op-amp, IC2. The loop side of the circuit is powered by the loop current, thus eliminating the need for an isolated power supply.

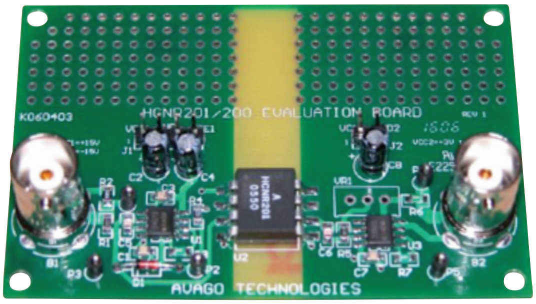
$$ILOOP/V_{IN} = K3 * (R2 + R3) / (R2 * R1)$$

For a 4-20mA current loop transmitter, with chosen R2 = 25Ω, R3 = 10kΩ, R1 = 80kΩ, the resistor values are selected such that when input voltage is 0.8V, loop current will be 4mA. And when input voltage is 4V, the loop current will be 20mA. (Assume transfer function, $K3 = I_{PD2}/I_{PD1} = 1$).



Note: Isolated 4-20mA current loop Receiver not shown here

Figure 3: Isolated 4-20mA Current Loop Transmitter using HCNR201/200



Evaluation Boards

Evaluation board allows designers to implement the HCNR201/200 analog optocouplers in their applications in the fastest possible way. HCNR201/200 analog optocoupler is versatile and suitable for many other industrial applications, such as voltage/current sensing, current loops, etc. Evaluation boards are available upon request from Avago. The Evaluation Board User manual is available for download at www.avagotech.com/docs/AV02-1134EN.

Spice Models

Spice models accurately predict circuit performances in accordance to HCNR201/200 AC and DC datasheet specifications as close as possible. The HCNR200 spice model is available and can be downloaded from the internet. The spice circuit simulations of various Avago circuit configurations is available for download at www.avagotech.com/docs/AV02-3334EN.

Contact us for your design needs at: **www.avagotech.com/hcnr201**

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