

# Tech-niques!

by Ron C. Johnson

As most of you already know, there are lots of interesting integrated circuits available that will help you do specific tasks with a minimum of external circuitry. The trick is to be familiar enough with them to know when they can be helpful to you. Sometimes you have seen a device used in one application but may not know that it can be applied slightly differently to something you want to build. This month let's look at a fairly new chip to see how it works and to get an idea of how it can be applied.

The integrated circuit we will discuss is one that I got a sample of not long ago — an optocoupler, part number IL300G and it comes in an eight pin DIP package. Optocouplers have been around for a long time now, of course, but the interesting thing about this unit is that it is a linear optocoupler.

Most optocouplers are used to couple a switched signal from one point to the other while keeping the two sections of the circuit electrically isolated. One application is in the input circuitry of programmable logic controllers where you are sensing the condition of field contacts. Switched AC or DC voltage can be sensed and coupled through the device to a transistor, TTL logic level or other type of output. By controlling the current and voltage applied to the input side various input levels can be accommodated. An ordinary optocoupler

handles this switched type of operation with no problem; when the signal causes current to flow through the input LED, light (usually infrared) travels between the LED and an optical sensor (photodiode or phototransistor) inside the chip. This causes the output device to turn on. The problem comes in when you try to modulate, or control the analog level of the current through the input diode, hoping to get a linear varia-

used in the actual output of the device. By feeding back the output of the feedback photodiode to the input amplifier the overall response will be linearized.

An excellent application for the device is in switching power supplies where sensing the output voltage is important in controlling the switch mode regulator. In a regulator circuit the output voltage is monitored to sense if load current fluctuations are causing the out-

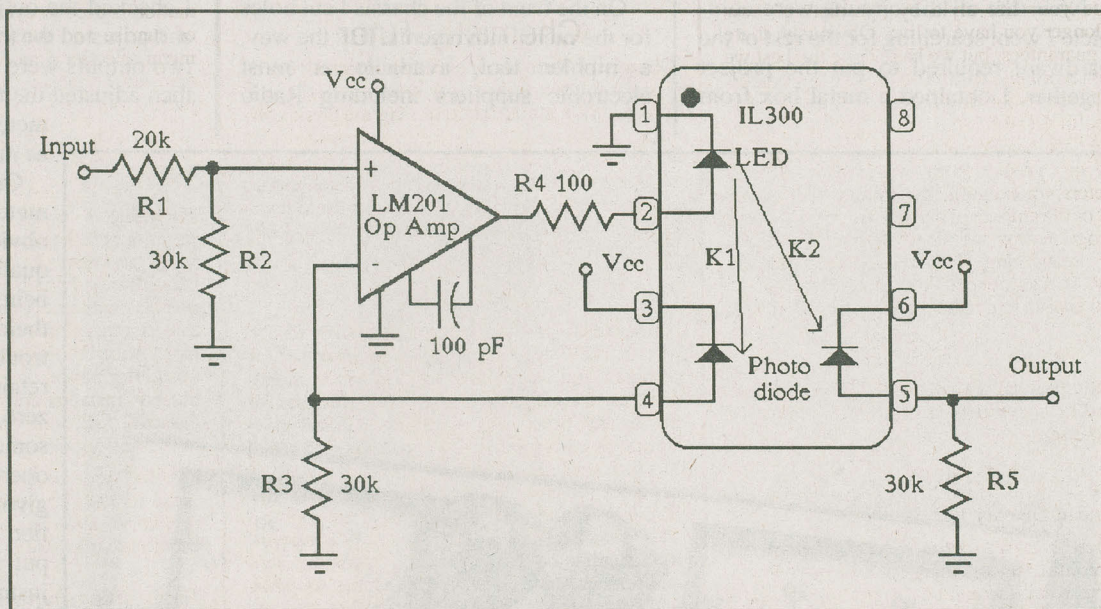


Figure 1. A Typical IL300 Circuit

tion at the output. It doesn't work very well due to the non-linearities of the devices in the chip.

The IL300G is designed specifically to couple analog signals while retaining a linear relationship between the input and output and, at the same time, to maintain electrical isolation. It does this by including an extra photodiode in the chip which can be used in the feedback loop of the op amp driving the optocoupler. (See Figure 1) This photodiode has the same transfer and temperature characteristics as the one

put voltage to change. The output level is sensed, compared to a reference, and the difference is used to tell the regulator to adjust the output accordingly. Due to the fact that, in a switching regulator, these two parts of the circuit are isolated by a transformer, isolating the feedback signal is helpful in maintaining separation between them.

Another application that comes to mind is in the field of industrial in-

see *Tech-niques*, page 38

## Tech-niques *cont'd* from page 29

strumentation where analog signals are often sent over relatively long distances and from various pieces of equipment which may have differing ground potentials. Electrically isolating the two pieces of equipment could avoid ground loop problems.

Figure 1 shows a circuit set up to be used in the first application, where the input is the 5 volt output of a switching power supply. The 5 volts is scaled using the voltage divider consisting of the 20k and 30k resistors, giving an input voltage of 3 volts to the non-inverting input of the LM201 op amp. The output of the op amp drives the input LED of the IL300 through a 100  $\Omega$  resistor. Linearization of the signal occurs because the photodiode connected to pins 3 and 4 of the IL300 is connected back to the inverting input of the LM201. The infrared radiation from the LED shines on both photodiodes in the chip. As the output of the LED rises, the current through the feedback photodiode increases dropping more voltage across R3, the 30k resistor connected to the inverting input. This

reduces the differential between the inputs, reducing the op amp output.

But how does this control for non-linearity and temperature, you ask?

If the input voltage increases by 10% there should be an equivalent 10% increase at the output of the optocoupler, and if it increases by a further 10% the output should again increase by 10% to be linear. But if the light-to-current characteristics of the photodiodes in the chip are non-linear (and they are, by nature) the first 10% may yield a 10% change in output while the second 10% yields 12%. But the feedback photodiode will also yield the same response which will reduce the gain of the op amp bringing down the LED current. The same will happen if the output changes because of temperature variations. The gain of the amp will change to compensate.

Choosing values for the resistors in this circuit becomes a bit complex because there are two transfer characteristics (specifications of the chip), called K1 and K2 which indicate how much photodiode current should be expected for a given LED current. Once the LED current is determined, the feedback photodiode current can be found and this can be used to determine

the value for the resistor, R3, which develops the feedback voltage to the amplifier. Application notes which come with the chip show how this should be done as well as how to determine the current limiting resistor, R4, in the output of the op amp. The value of the resistor, R5, used in the output of the IL300 is determined from a chart and depends on the production run of the chip you have. (The overall transfer characteristic of each chip is determined and marked on the chip before it leaves the factory.)

All of this last stuff makes the use of this chip a bit difficult but, on the other hand, if you have an application for it you can probably wade through the math to get what you want. A bit of experimentation should clear up any ambiguity that remains.

Ideally, of course, design of a circuit using a chip like this should be completely done on paper and then a breadboarded version is used to test it. Those of us who have worked in the practical world of electronics know that some experimentation often is required even after careful design. So give this chip a try. And if you come up with an interesting application for it, let me know...

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