

Applications of the LM3524 Pulse-Width-Modulator

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The LM3524 Regulating Pulse-Width-Modulator is commonly used as the control element in switching regulator power supplies. This is in keeping with its intended purpose. Engineers closely associate this part with switching power supplies. Nevertheless, the flexible combination of elements (see box) within the LM3524 also allows it to be used in a number of other applications outside the power supply area. Because the device is inexpensive and operates off a single-sided supply, it can considerably reduce component count and circuit complexity in almost any application. The constant light intensity servo of *Figure 1* furnishes a good example.

CONSTANT LIGHT INTENSITY SERVO

The circuit of *Figure 1* uses a photodiode's output to control the intensity of a small light bulb. The constant intensity output of the light bulb is useful in a number of areas, including opto-electronic component evaluation and quality control of photographic film during manufacture. In this circuit, the photodiode pulls a current out of the LF356 summing junction, which is directly related to the amount of light that falls on the photodiode's surface. The LF356 output swings positive to maintain the summing junction at zero and represents the photodiode current in amplified voltage form. This potential is compared at the LM3524 to the voltage coming from the 2.5k "intensity" potentiometer wiper. A stable voltage for the "intensity" control is taken from the LM3524's internal five-volt regulator. The difference between the LF356 output and the "intensity" potentiometer output is amplified at a gain of about 70 dB, which is set by the 1 MΩ value at pin 9. The

LM3524 output transistors are paralleled and provide drive to the 2N2219 switch transistor. The 5.6k and .01 μF values set the switching frequency at about 30 kHz. Because the LM3524 forms a switched mode feedback loop around the light bulb and photodiode, the average power delivered to the light bulb will be controlled by the photodiode output, which is directly proportional to the lamp's output. Frequency compensation for this feedback loop is provided by the .001 μF capacitor, which rolls off the loop gain at a 1 ms time constant. *Figure 2* shows the wave forms in the circuit. Trace A is the 2N2219 collector and trace B is the AC-coupled LF356 output. Each time the 2N2219 collector goes low, power is driven into the lamp. This is reflected in the positive going ramp at the LF356's output. When the 2N2219 goes off, the lamp cools. This is shown in the negative going relatively slow ramp in trace B. It is interesting to note that this indicates the bulb is willing to accept energy more quickly than it will give it up. *Figure 3* elaborates on this. Here, trace A is the output of a pulse generator applied to the "step test" input and trace B is the AC-coupled LF356 output. When the pulse generator is high, the diode blocks its output, but when it goes low, current is drawn away from the "intensity" control wiper through the 22k resistor. This forces the servo to control bulb intensity at a lower value. This photo shows that the bulb servos to a higher output almost three times as fast as it takes to go to the lower output state, because the bulb more readily accepts energy than it gives it up. Surprisingly, at high intensity levels, the situation reverses because the increased incandescent state of the bulb makes it a relatively efficient radiator (*Figure 4*).

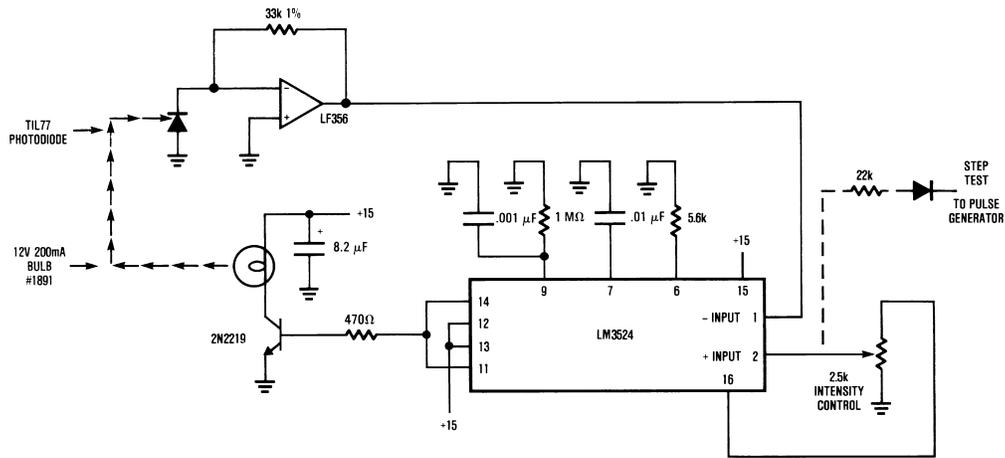


FIGURE 1.

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TEMPERATURE-TO-PULSE-WIDTH CONVERTER

The circuit in Figure 5 uses the LM3524 to convert the output of an LM135 temperature transducer into a pulse width which can be measured by a digital system, such as a microprocessor-controlled data acquisition system. Although this example uses the temperature transducer as the input, the circuit will convert any 0.1 to 5V input applied to the 100 k Ω resistor into a 0–500 ms output pulse width with 0.1% linearity. In this circuit, the LM135's temperature-dependent output (10 mV/ $^{\circ}$ K) is divided down and applied to A1's positive input. This moves A1's output high, driving the input to the LM3524's pulse-width modulation circuitry. The LM3524 pulse-width output is clipped by the LM185 reference and integrated by the 1 M Ω -0.1 μ F combination. The DC level across the 0.1 μ F capacitor is fed back to A1's negative input. This feedback path forces the LM3524's output pulse width to vary in a highly linear fashion according to the potential at A1's positive input. The overall temperature-to-pulse width scale factor is adjusted with the "gain trim" potentiometer. The 1000 pF capacitor is integrated by the LM358. The DC level across the 0.1 μ F capacitor is fed back to A1's negative input. This feedback path forces the LM3524's output pulse width to vary in a highly linear fashion according to the potential at A1's positive input. The overall temperature-to-pulse width scale factor is adjusted with the "gain trim" potentiometer. The 1000 pF capacitor provides stable loop compensation. A1, an LM358, allows voltages very close to ground to be sensed. This provides greater input range than the LM3524's input amplifier, which has a common mode range of 1.8–3.4V. The oscillator output pulse at pin 3 may be used to reset counters or other digital circuitry because it occurs just before the output pulse width begins.

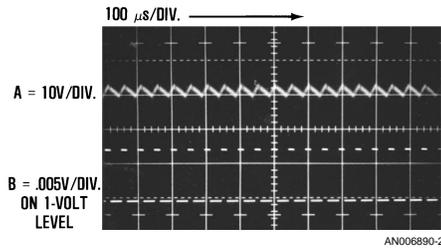


FIGURE 2.

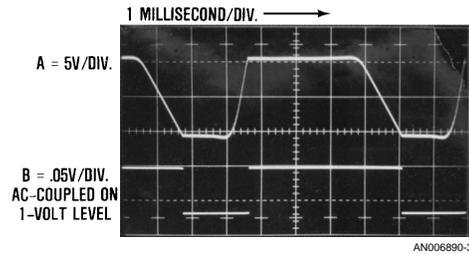


FIGURE 3.

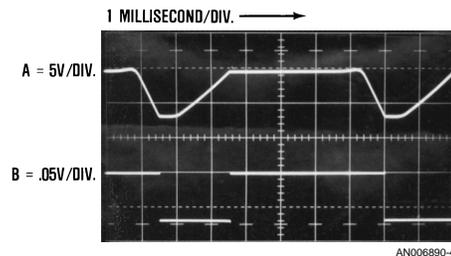
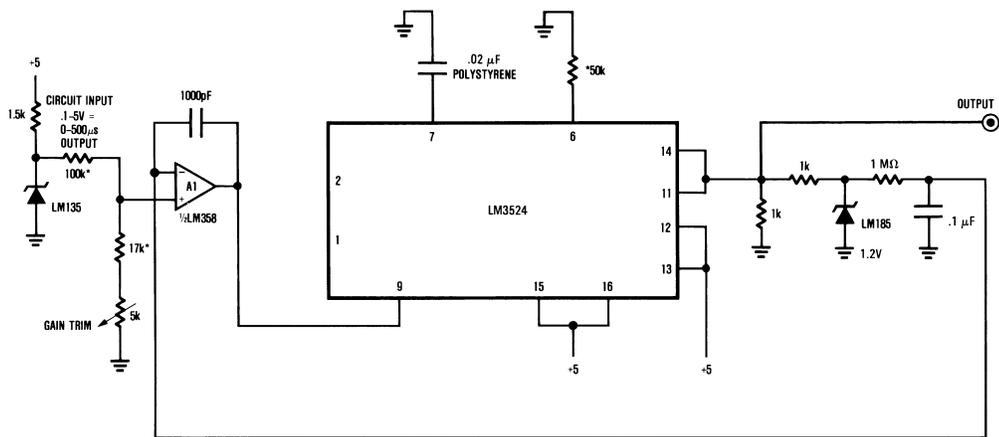


FIGURE 4.



*Metal Film Resistor

FIGURE 5.

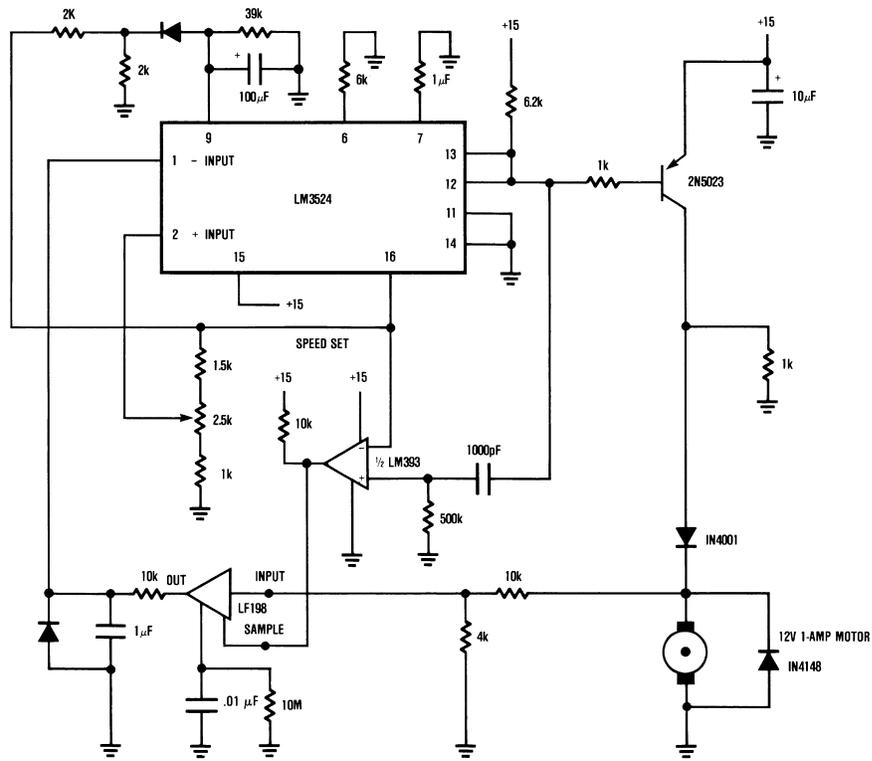


FIGURE 7.

AN006890-7

HORIZONTAL 3.μs/DIV.

- A 20V/DIV.
- B 10V/DIV.
- C 50V/DIV.
- D 20V/DIV.

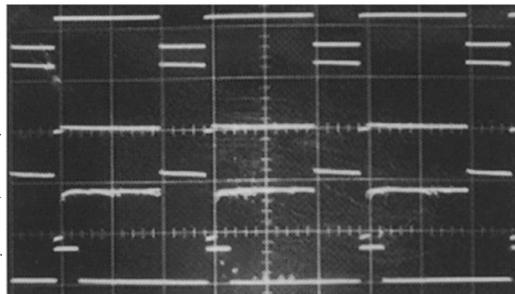
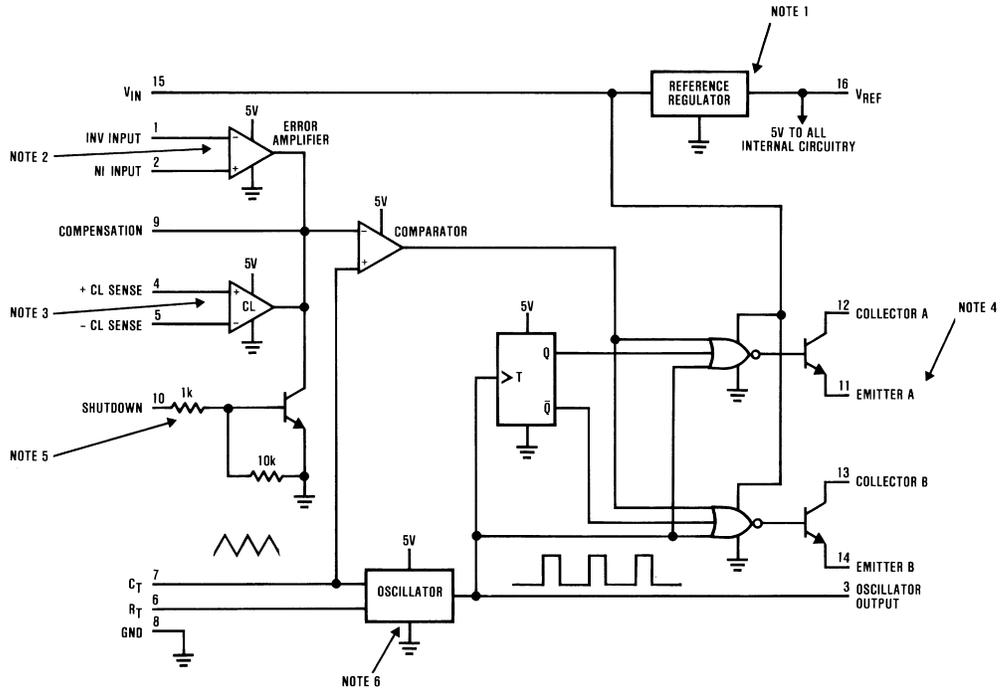


FIGURE 8.

AN006890-8

The LM3524 at a Glance



Note 1: 5V 50 mA regulator available to user.

Note 2: Transconductance diff. input amplifier. Gains from 40–80 dB available by resistor loading of output. 1.8–3.4V common mode input range.

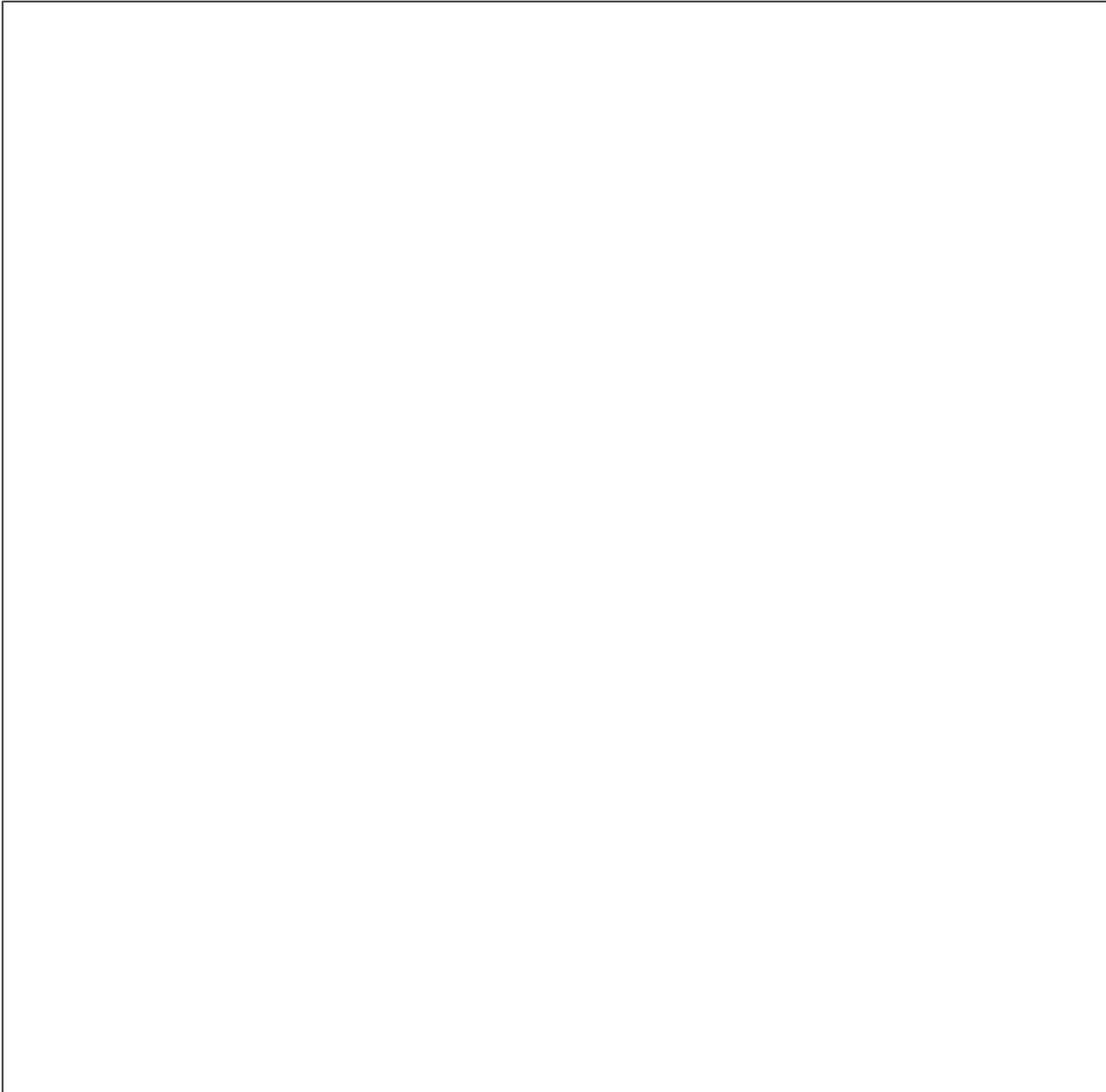
Note 3: Over current sense comparator –0.7 to 1V common mode input range.

Note 4: Output transistors switch out of phase and may be paralleled. Up to 100 mA maximum output current.

Note 5: Transistor may be used to strobe LM3524 into an off state at its outputs.

Note 6: Oscillator typically frequency programmable for up to 100 kHz.

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