

Engineer's notebook

Optical isolator circuit shows phone-line status

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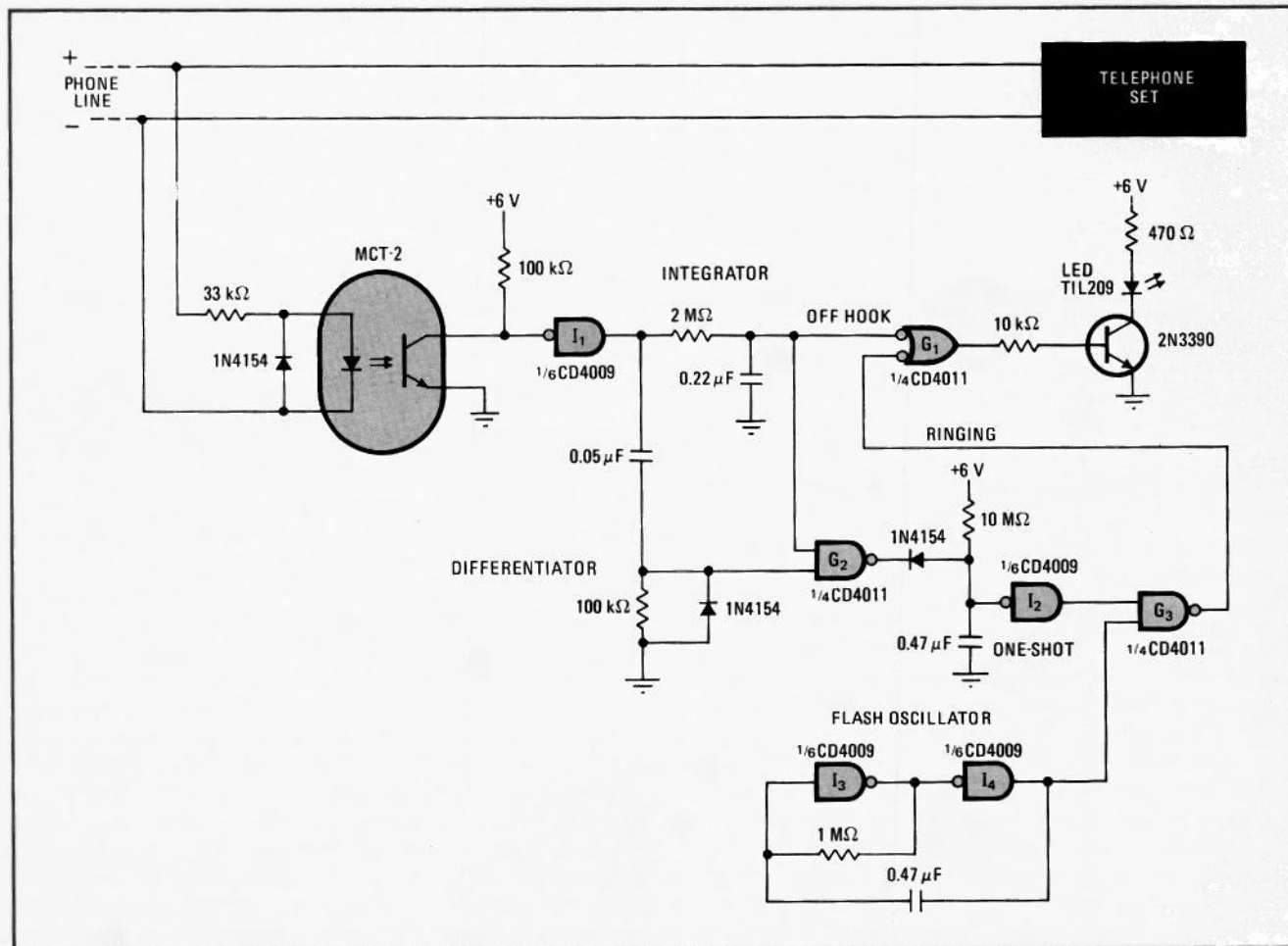
The status of a telephone line can be indicated at a remote location, such as the key unit on a secretary's desk, by a light-emitting diode connected in the circuit shown here. The LED is dark if the phone line is not in use, flashes on and off once every second if the phone is ringing, and stays on if the phone is off the hook.

The circuit includes an oscillator that operates continuously, some logic elements, and an optical coupler that senses the voltage on the phone line. If this voltage is ac, the logic circuit connects the oscillator to the LED, producing the flashing light. Low dc voltages, either steady

OPERATION OF PHONE-STATUS-DISPLAY CIRCUIT			
Phone condition	Line voltage (V)	Isolator output level	LED condition
On hook	50 dc	Low	Off
Ringing	100 ac	Pulses	Flashing
Off hook	6 - 8 dc	High	On
Dialing	6 - 50 dc	Pulses	On

or pulsed, hold the LED on, and high dc voltages leave it off. The table summarizes circuit performance.

As can be seen from the schematic diagram, the isolator output signal is applied to two RC networks—an integrator and a differentiator. The integrator filters out the ring and dial pulses, giving an output dependent on the steady state of the phone line. The differentiator extracts the pulses.



Secretary's helper. LED indicates status of a remote telephone. Light is off if phone is hung up, shines steadily if phone is off hook, and flashes on and off while phone rings and for 5 seconds after ringing stops. The flashing oscillator operates continuously, but can drive LED only when a ringing signal discharges the one-shot capacitor to enable NAND gate G_3 . Thus, one oscillator handles several phone lines.

When the phone is on the hook, so that inverter I_1 has low input and high output, G_1 is deactivated and cannot turn the transistor or LED on.

When the phone rings, the high dc from I_1 and the high output from the differentiator combine to activate G_2 , allowing the one-shot capacitor to discharge and enable G_3 . Thus the output from the flash oscillator is applied to G_1 , flashing the LED. Flashing continues during the slow charge-up of the 0.47-microfarad one-shot capacitor between rings and after ringing stops.

When the phone is off the hook, I_1 has high input and low output, so G_1 is able to turn on the transistor and let the LED light. The momentary high-voltage pulses that occur during dialing are suppressed by the integrator, so G_2 is not enabled.

The 100-v ac ringing signal might apply excessive reverse voltage to the light-emitting diode in the optical coupler. Therefore, the coupler input is shunted by a protecting 1N4154 diode.

Because the flash oscillator operates continuously, it can be connected to the NAND gates G_3 associated with a number of different phone lines and LEDs. In the author's office, one oscillator is used for 10 phones.

This circuit uses ordinary C-MOS ICs and operates from a noncritical supply voltage between 5 and 10 volts. The ac adapter from a pocket calculator is a convenient source. A single power supply can handle all of the phone lines.

The signals that are developed at the integrator and differentiator outputs can be used for other purposes than lighting a LED. Other areas of application include playing a recorded message when a phone rings, or running a timer while a phone is in use.

This circuit does not draw appreciable current from the phone line, feed back to the line, or reference any voltages to the line because the coupling is optical. Nonetheless, the telephone company should be consulted before the circuit is installed. \square