Safer Security System

I presently have a simple security system utilizing loops with a load resistance between 1000 and 2000 ohms. Can you help me design a sensing circuit that will give logic.-level outputs for "open, " "shorted, " and "correct resistance" conditions? — R. E. F., Lakewood, CA

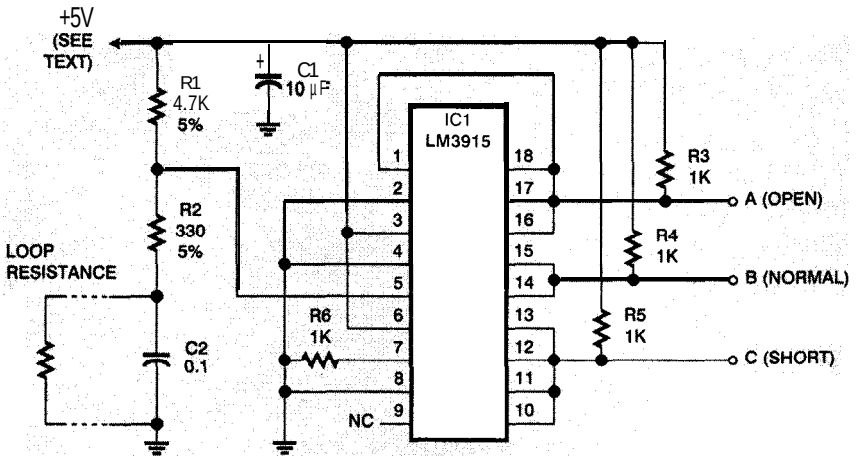

FIG. I-ONE OF THREE OUTPUTS goes low depending on whether loop resistance is too high, too low, or just right.

A Many security systems use a closed loop of wires and switches arranged so that whenever a door or window is opened, the loop will be broken and the alarm will sound. An obvious problem is that someone can tamper with the system, short out the loop, and later on, come back and burglarize the premises without sounding the alarm.

Hiding a known resistance in the loop, as you propose, is a very good idea. That way, the alarm can distinguish a short circuit from a correctly functioning closed loop.

Figure 1 shows a circuit that does the job. It's a somewhat unusual application of a National Semiconductor LM3915 IC, normally used to drive LED' bargraph displays. That chip happens to contain the right combination of comparators and logic circuits to do what you need.

Step 1 is to translate the loop resistance into a voltage; that's done by putting it into a voltage divider with resistors R1 and R2. Capacitor C2 protects the circuit against electromagnetic noise-important because burglar alarms use long wires, often running near heavy electrical equipment.

Step 2 is to translate the voltage into a logic signal indicating whether it's in the correct range. That's where the LM3915 comes in. Normally, the LM3 9 15 would drive ten LEDs, one for each of ten small ranges of voltage. To obtain logic-level outputs, we have it driving 1K resistors instead of LEDs. Since we only need to distinguish three situations, not ten, we tie some of the outputs together. The LM3915 has open-collector outputs that can be paralleled in that way.

LOOP RESISTANCE	OUTPUTS		
	A	B	C
OPEN OR >2K	0V	+5V	+5V
1K–2K	+5V	0V	+5V
SHORT OR <1K	+5V	+5V	0V

FIG. P-THIS TRUTH TABLE shows the states of outputs A, B, and C under different loop-resistance conditions.

The truth table in Fig. 2 shows how the outputs work. Note that they use negative logic (OV for "yes", +5V for "no"), the opposite of ordinary logic circuits. You can use inverters such as the 74HC04 to produce positive logic signals if that's what you need.

Finally, note that the circuit will actually work with any supply voltage from 3 to 25 volts. Of course, if the supply isn't 5 volts, the outputs will not be compatible with j-volt logic circuits.