Two diodes protect logic-level translator

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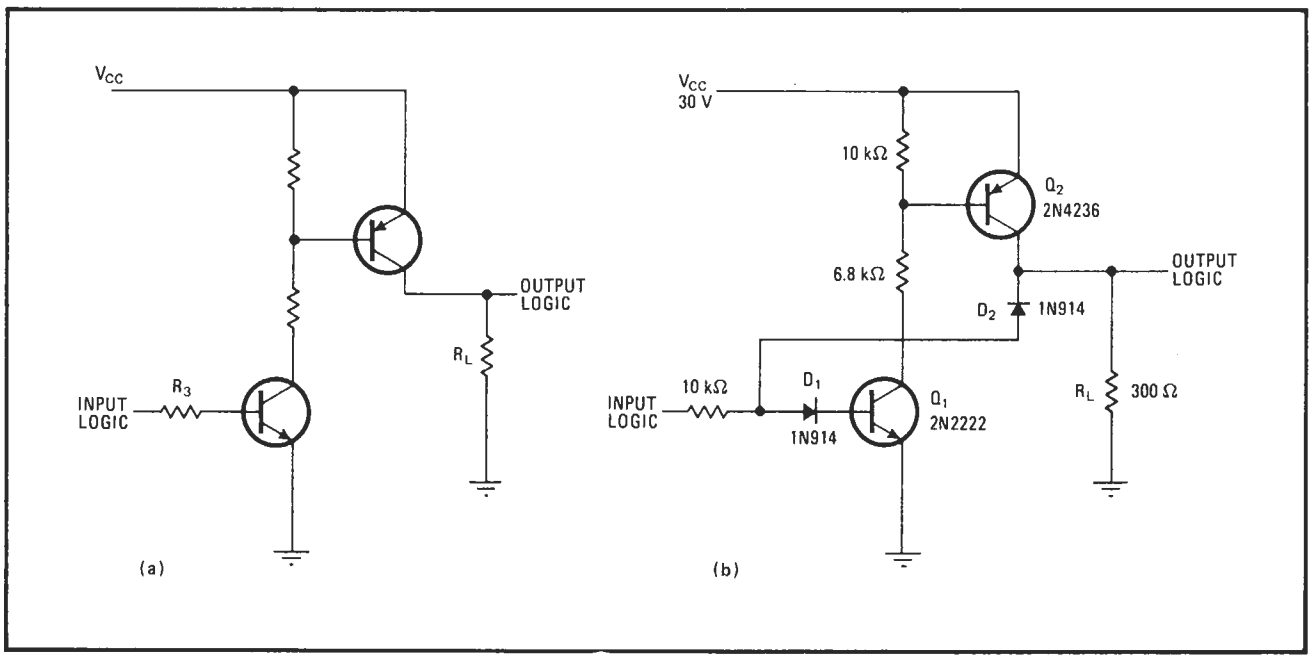
A level translator is used to interface between two circuits that operate at different logic levels. But the translating transistor (or level-up transistor) is often burned out when its load is accidentally short-circuited to ground. The addition of two diodes to the conventional level-up circuit can protect the transistor. Even a transistor that operates at 30 volts (as well as those meeting lower voltage requirements) can be safeguarded by the circuit modification described here.

The conventional translation circuit (or logic level-up circuit) is shown in Fig. 1(a), and a modified version with two protection diodes added is shown in Fig. 1(b). The component values shown are chosen to provide a normal load current of about 100 milliamperes. In normal operation, when the input logic is high (logic 1), diode D_1 is forward-biased; Q_1 is turned on, and therefore Q_2 is turned on. Diode D_2 is reverse-biased, so the output-logic voltage across the load is nearly V_{CC}. When the input logic is low (logic 0), the transistors are turned off, and the output logic is zero.

If the output load is shorted to ground when the input is a logic 1, the anode of D_1 is above ground only by the amount of the forward-voltage drop through D_2. This voltage is not great enough to let Q_1 conduct because a voltage of at least two diode drops, V_{D1} and V_{BE}, would be required to turn on Q_1. Therefore Q_1 is turned off, and, as a result, transistor Q_2 is turned off too, which prevents it from conducting a destructive current straight to ground. The circuit remains shut down as



1. Protection. Conventional logic-level translator shown in (a) is modified by addition of two diodes in (b). Diodes protect translation transistor Q_2 from destructive current that would otherwise flow if load resistor were short-circuited. Diodes turn off both transistors, so no current is drawn from supply while load is shorted. In normal operation, load current of about 100 milliamperes is unaffected by diodes.