rather than providing multiple choices. The sensor modules used may only be suitable for use with the matching controller so it is wise to read the specifications to make sure the unit suits your application. Among the most common multichannel controllers are 4- and 8-channel versions. These units sometimes incorporate a single display which either displays each channel sequentially, displays a designated channel, or displays the channel with the highest reading.

Other designs incorporate an individual display for each channel providing the obvious advantage of allowing you to view the readings of all channels simultaneously. Displays can be either LCD or LED. LED displays are generally easier to read but also consume more power than LCD displays. However, LED displays can be designed to pulse at a high frequency, which is not perceptible to the human eye and which allows it to consume considerably less power. LCD displays have narrower tolerance in operating temperature and are damaged by long-term exposure to the sun's ultraviolet rays.

Alarm Relay Contacts

Controllers typically provide two- or three-relay contacts, which are used to activate alarm lights, horns, or other devices when gas concentrations exceed preset alarm thresholds. As shown in Figure 7, relay contacts work much the same way as a light switch.

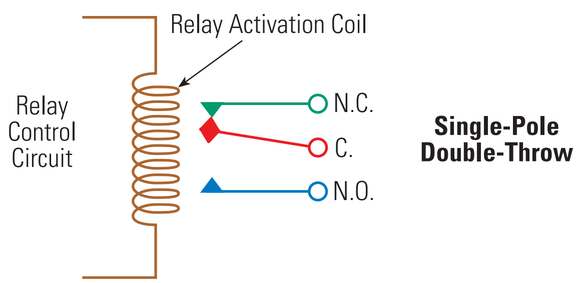


Fig. 7 A Form C Relay Contact. N.C. stands for normally closed; C stands for common, which switches between the two contacts; and N.O. stands for normally open.

CONTACT FORMS

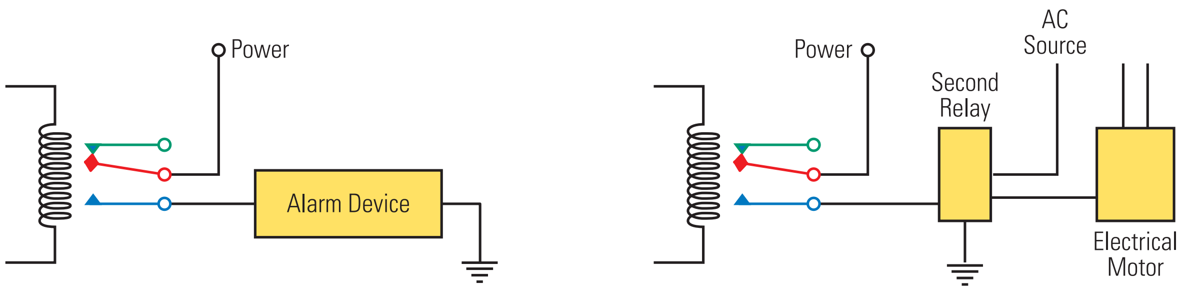
There are several ways the relay contacts are expressed.

Form A Contacts: a single-pole, single-throw, normally open contact. This is the same as a simple switch.

Form B Contacts: a single-pole, single-throw, normally closed contact.

Form C Contacts: a single-pole, double-throw, changeover from normally open to normally closed or vice versa.

Relays can be either single-pole, double-throw (SPDT) or double-pole, double-throw (DPDT). The difference is that SPDT relays have only one contact set while DPDT relays have two contact sets. Relay contacts are normally rated from 3 to 5 amperes resistive at 240 VAC. Generally, this is sufficient to handle most audible and visual alarm devices. However, in cases where the current requirements are higher than the relay contact rating, a second relay with a higher contact rating can be employed. The first relay can be used to drive the second relay, enabling machinery such as exhaust fans to be powered. It is important to check contact ratings prior to use. Solid-state relays have lower contact ratings and a smaller physical size. The power required to activate these relays is also lower. Figure 8 shows the contact arrangement for a visual or an audible alarm (A) and connection to a second relay for a higher power application (B).



A. Connecting an Alarm Device ***B. Connecting to a Second Relay***

Fig. 8 Relay Connections

In most cases, relay contacts are deactivated or open under normal conditions. However, this condition can be reversed and the relay can be activated under normal conditions. This arrangement is called a *fail-safe configuration* and it enables alarms to be tripped in case of a power failure.

Alarm Settings

Alarm level set points can be implemented in various ways. A simple way is to have the alarm levels preset at the factory, leaving no option for the user to adjust the alarm set points. However, in most designs, two or three alarm levels are provided which are, in fact, user adjustable. These alarm levels are provided in a variety of ways, as discussed next.

(A) DIP switch

By employing an 8-segment DIP switch, for example, alarm levels from 0-100% can be divided into 256 increments, providing the ability to set precise alarm levels. It is necessary to have a separate DIP switch for each alarm setpoint.

(B) Preset Button

A zero-to-full scale signal is produced using a momentary pushbutton that can be activated during the alarm setup process. An alarm level is simulated and a potentiometer is used to set the actual alarm level. Each alarm requires a separate potentiometer. This procedure is simple and requires only the use of a small screwdriver.

(C) Microprocessor

With controllers that are microprocessor-based, alarm levels can be set by pushbuttons or by magnetically operated switches on the front panel according to the instructions provided with the unit.

Alarm Processing

A small gas monitoring system with a few sensors monitoring a relatively small area typically has a simple alarm system. Controllers often provide at least two sets of alarm contacts: one to activate a low alarm device such as a beacon and one to activate a high alarm device such as a horn. The controller has indicators such as LEDs that illuminate when relay contacts are activated. In some cases, controllers have audible alarms built into them. With monitoring systems that have multiple sensors, relay contacts are often common to all sensors. Thus, if any of the sensors exceed a preset alarm threshold, the corresponding alarm relay will be activated.

Acknowledgment of alarms is accomplished via a momentary switch which is used to silence audible alarm devices while leaving the visual alarm active until the alarm condition disappears. Relays can be either latching or nonlatching, depending on how the relay tripping circuitry is designed. Typically, a simple jumper wire connector is used to make the relay either latching or nonlatching. A *nonlatching relay* will turn off the alarm device once the alarm condition is gone. A *latching relay*, on the other hand, will stay activated until the acknowledge button is pressed, thus resetting the relay.

The use of a time-delay relay can be quite useful for some applications. For example, in a parking garage, it is typical to activate a low alarm if the concentration of CO reaches 50 ppm and a high alarm if the concentration exceeds 100 ppm. Parking garages present a relatively small, confined area for monitoring. They often contain high density parking and low ceilings. Thus, alarm levels can be easily exceeded. Even a car driving by the sensor can possibly activate an alarm. This can create frequent false alarms which can become a nuisance.

By employing a time-delay relay, alarms are not activated unless alarm levels are continuous for a predetermined length of time, such as 3 minutes. For example, if 50 ppm of CO is still present after 3 minutes, the warning relay is activated and a low speed exhaust fan is turned on. When the CO concentration drops below 50 ppm, the warning relay is then deactivated and the fan is shut off. If the CO concentration exceeds 100 ppm, a high speed ventilation fan is activated and a 15-minute timer is started. If the CO level is still over 100 ppm after 15 minutes, the timer will activate a relay to turn on an audible or visual alarm advising of the situation. The time delay relay is used to prevent frequent activation and deactivation of fans due to momentary traffic or other causes. This conserves energy, reduces maintenance, and increases the life expectancy of the fans.

In computer-controlled systems, alarm processing is greatly simplified. The monitoring software can provide time delays for the relays, voting from multiple sensors (which determines the alarm to be activated based on the number of sensors at alarm), and many other alarm options that can be useful for many applications.

Calibration

The most important function performed by the controller is calibration. It is a routine maintenance procedure that the user must perform in order to ensure the proper operation of the sensor. A simple conventional technique is to use potentiometers to set the zero and span adjustments. However, this does require access to the calibration potentiometers and use of a screwdriver. With a microprocessor-based controller, this same function can be accomplished via a keypad with “up” and “down” functions. This allows for minimum operator interaction. The procedure is as follows:

1. Select the calibration gas concentration, which is the concentration of the gas you intend to apply to the sensor.

2. Next, apply the calibration gas. An indicator will come on to notify you to apply the gas. When the reading reaches a stable point, another indicator will display “done.” At this time, the calibration gas is removed and the calibration is complete.

As discussed earlier, magnetic keypads can be employed in hazardous areas where access to keypads is difficult. Additionally, some designs incorporate remote controls similar to those used on TV sets but they must be designed to meet the demands of hazardous area electronics. This allows the adjustments to be made with-