Application Note AN-110

May 2016

SPEC Sensor™ End of Lifetime Test

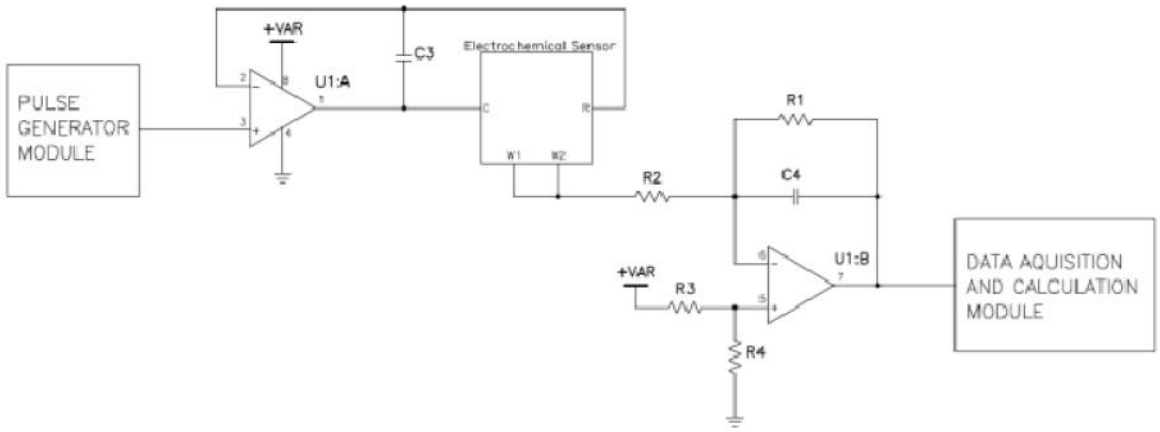
Scope

There are several possible modes of failure which may cause loss of sensitivity of the CO sensor. These include: Broken sensor connection, short circuit, or electrolyte loss due to dryout or leak. By using the following test circuit and protocol, such a malfunction can be detected.

CAUTION: This technique will not detect loss of response caused by blockage of the gas diffusion port by dust or condensed water. This test also does not measure the relative performance or response of the sensor to any CO concentration. F*or use in potentially life-threatening applications, there is no substitute for checking the sensor's response with a known CO concentration.*

NOTE: while this Application Note is written specifically to guide designers of home CO detectors in developing a "supervisory circuit" per UL 2034: Standard for Safety for Single and Multiple Station Carbon Monoxide Alarms, the information is applicable to all other SPEC sensors as well):

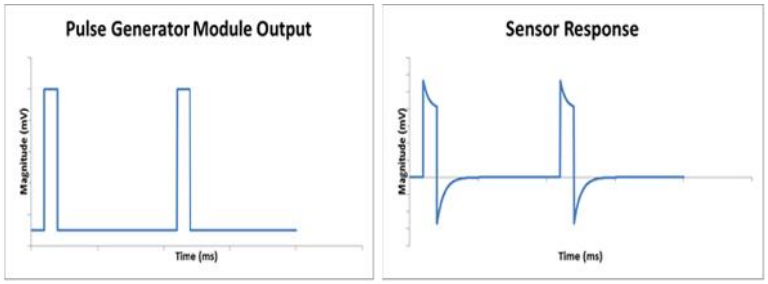
NOTE: electronic self-test methods cannot detect loss of response to CO caused by lack of gas diffusion when dust or water droplets cover the pin holes for gas diffusion. In addition, slight loss of CO sensitivity cannot be detected by self-diagnosis.



General Self-Test Procedure

1. Temporarily isolate the sensor output from the alarm circuit so that the self-test may be conducted without activating an alarm.
2. *Apply a -10 to -50 mV square-wave pulse to the reference electrode (or C-R in case of 2-electrode mode of operation), for 10 – 50 msec duration.* This causes an effective bias shift of +10 to +50 mv to the working electrode (figure on left).

3. *Measure the shift in the output voltage.* The figure on the right gives a generalized output for a sensor during this pulse. The pulse should be designed to generate a "signal" which simulates exposure to 500 – 1000 ppm CO. If the sensor is normal, sensor current will peak and plateau, and then quickly recover to its baseline level when the pulse is removed.



4. Reconnect the sensor output to the alarm circuit after the self-test has terminated. Any residual current from the applied pulse will be discharged.

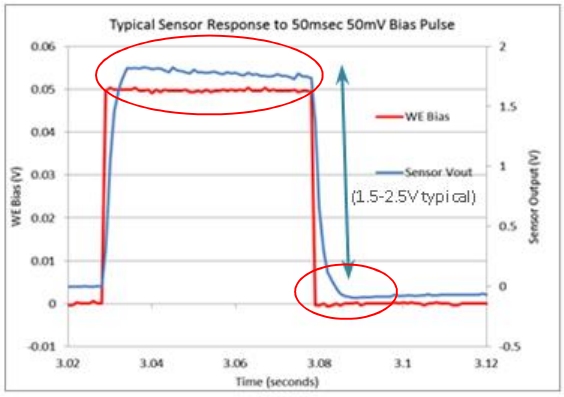
Typical Data "Operational" vs. "Not Operational" Sensor

The examples below present the response to a 50 msec pulse for a functioning sensor and a sensor which has been exposed to severe dryout (CO sensitivity was < 50% of the original sensitivity).

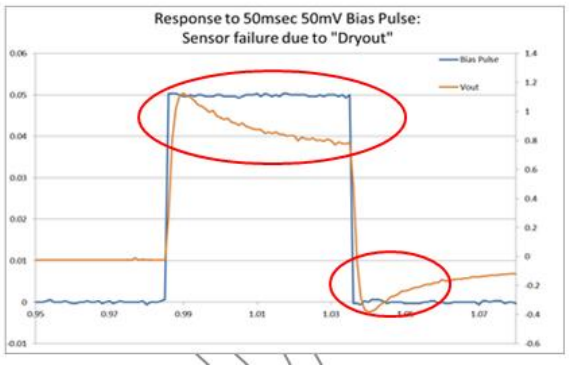
NOTE: the values and criteria given here are exemplary, data is being collected on a large number of sensors to provide statistically sound guidelines.

Operational Sensor

The V(out) increases to 1.5 – 2 V within 10 msec, and is relatively stable. When the bias is returned to zero, there is a slight overshoot of zero – a result of capacitive "charging" due to the imposed voltage during the bias pulse. The magnitude of this depends on the mV and duration of the pulse.



Not Operational Sensor – Low Sensitivity:
The V(out) shift has dropped to ~1 V (10 uA) and is also unstable, with strong overshoot past the BL when bias is returned to zero. In this example, an output shift of < 1 V with a 50 mV pulse indicates a failed sensor.



Self-Test Criteria

PASS ("Normal") approximately 1 - 2 seconds after the pulse is removed from the sensor, the sensor output should fall within the range of 2 - 7.5 µA (the normal output expected in 1000 ppm of CO). If the signal is in this window, the sensor can be judged to have normal CO sensitivity. *(Please refer to the above Figure for the Vout pattern corresponding to a functioning sensor).*

FAIL (low or no output) if the sensor output is less than 2 µA at the measurement time, the sensor has failed; either due to extreme dryout (due to prolonged operation at high T and low RH, or leakage of electrolyte), or bad connection to one of the sensor electrodes.

FAIL *(high output)* If the signal is at positive V(limit) and does not drop toward baseline, the sensor has been short-circuited, or there is a bad connection to one of the sensor electrodes.

NOTE: Depending on the user's circuit design, factors for the self-test such as pulse voltage, period, measurement timing, and acceptable output voltage range for at the determined measurement time may vary. Therefore, it is recommended that experimentation with the user's circuit be conducted for fine tuning these factors in self-test.