Application Note AN-110

September 2015

SPEC Sensor™ End of Lifetime Test

Scope

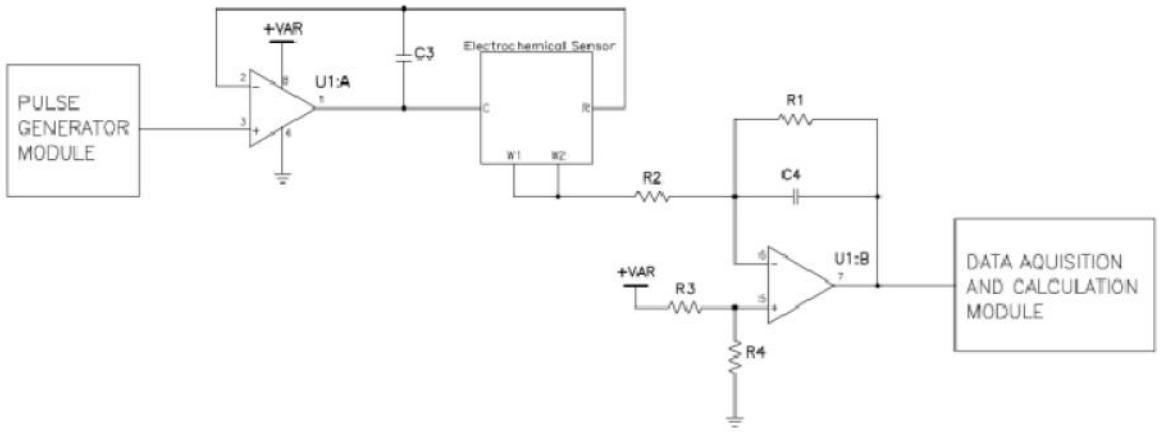
There are several possible modes of failure which may cause loss of sensitivity of the CO sensor. These include: Broken sensor connection, short circuit, or electrolyte loss due to dryout or leak. By using the following test circuit and protocol, such a malfunction can be detected.

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.*

不同的失效模式会导致灵敏度丢失。连接断开,短路,电解液丢失,由于枯竭或者泄漏.但是使用下面的测试电路和协议就可以知道这样的一个失效.注意:这个技术不能检测由于堵孔导致的响应丢失,比如凝结的水,灰尘.这个测试也不能测量相关的性能或者响应。对于生命威胁的使用场合,没有替换的方法,用已知的CO浓度来检查传感器的响应

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 -50mV square-wave pulse to the reference electrode (or C-R in case of 2-electrode mode of operation), for 10-50msec duration.* This causes an effective bias shift of +10 to+50mv to the working electrode (figure on left).

通用的自测步骤

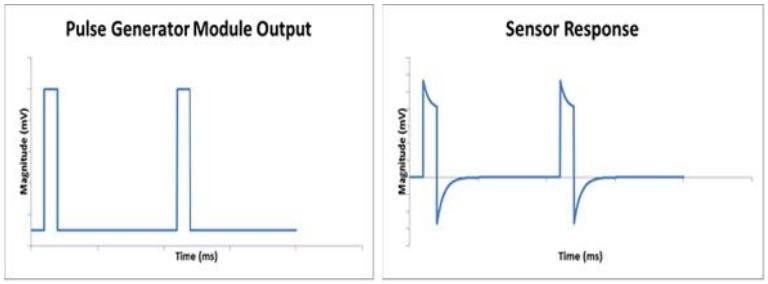
1, 从报警电路暂时隔离传感器,自测才能进行,而不会触发报警

2, 施加一个负10到-50mV的方波脉冲给参考电极(或者C-R电极,如果使用两电极模式的话),大概持续10-50毫秒.这个产生一个效果偏置偏移到+10到50mV到工作电极,如左边的图.

3,测量输出电压的偏移.图右边给出了这个脉冲下通用的输出.脉冲应该设计成产生一个"信号"仿真暴露在500-1000PPM的CO.假如传感器正常的话,传感器电流会尖峰和平地,然后当脉冲拿走之后,迅速恢复到基准

4, 自测完成之后,重新连接传感器输出到报警电路.任何脉冲施加了的残余电流都会释放掉

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 500-1000ppm 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.

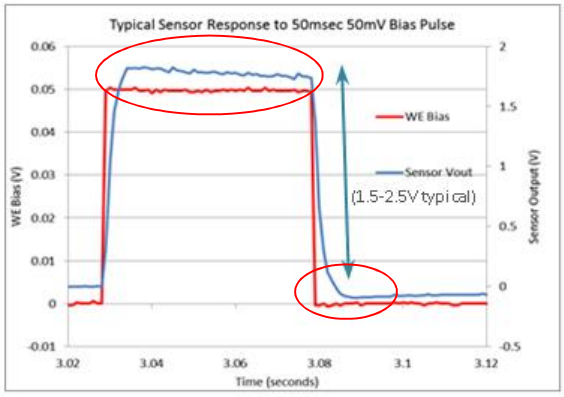
Typical Data "Operational" vs. "Not Operational" Sensor

The examples below present the response to a 50msec 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 1.5-2V with 10msec, and is relatively stable. When the bias is returned to zero, there is a slight overshoot of zero – due to capacitive "charging" due to the imposed voltage during the bias pulse. The magnitude of this depends on the mV and duration of the pulse.



"合格"和"不合格"传感器的数据

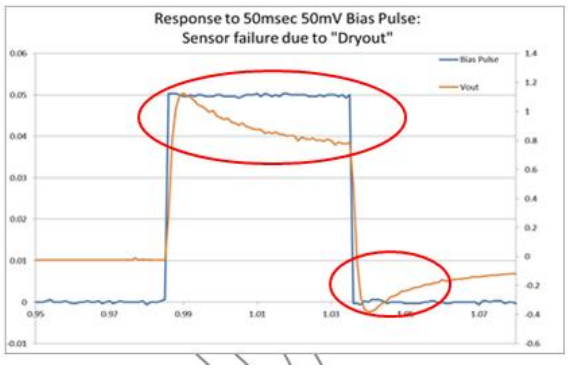
下面显示了50ms的脉冲给一个合格的传感器和干枯的传感器(CO灵敏度降低50%以上)注意:此值和标准在这里只是举例而已,采集的数据,更多的传感器数量,可以提供统计上更好的指导

合格传感器: 10ms以内,电压增加至1.5-2V,而且相当稳定.当偏置回到0的时候,由于电容"充电", 会有少许的过激,由于施加的电压.幅度取决于mV和脉冲持续的时间

Not Operational Sensor – Low Sensitivity:

The V(out) shift has dropped to ~1V (10uA) and is also unstable, with strong overshoot past the BL when bias is returned to zero. In this example, an output shift of <1V with a 50mV pulse indicates a failed sensor.

不合格的传感器-低灵敏度
v输出下跌到1V(10uA),且不稳定,很强的过冲,当偏置回到0的时候,超过基准线.在这个例子中,输出偏移小于1V,50mV脉冲表示传感器坏了.自测标准:通过:大约脉冲移走后1-2秒,传感器应该掉下至2-7.5uA（CO在1000PPM的常规输出).假如信号在这个窗口,就可以判定传感器的灵敏度正常(请参考上图对于电压输出的样子对应于一个合格的传感器).不合格:(低或没有输出):假如输出是小于2uA,传感器就坏了;要么是干枯(长期在高温工作和低湿工作,或者漏液了);或者电极的连接效果不好.不良(高输出):假如信号是正的电压,没有下跌到基准以下,传感器就短路了,或者传感器的电极连接不好。注意:取决于用户的电路设计,自测的因子比如脉冲电压,周期,测量时间,可以接受的电压范围都会变化.那么,就建议用用户的电路做实验用于微调这些自测的因子.



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 1000ppm 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 2µA 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.

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Revision History

Rev Date	Description of Rev	Approved by:
2015-03-24	Working Draft	M. Findlay
2015-04-17	Rev 0.01 with Title change and Brian K comments	M Findlay