COZIR™ Application Note
Response Time (SprintIR and COZIR-W)

1 Overview

One of the benefits of the COZIR-W and SprintIR family of sensors is the ability to high speed measurements with short response times. This document describes the factors which affect the speed of response and show what to do to get the fastest response.

1.1 Sensor Types

COZIR-W

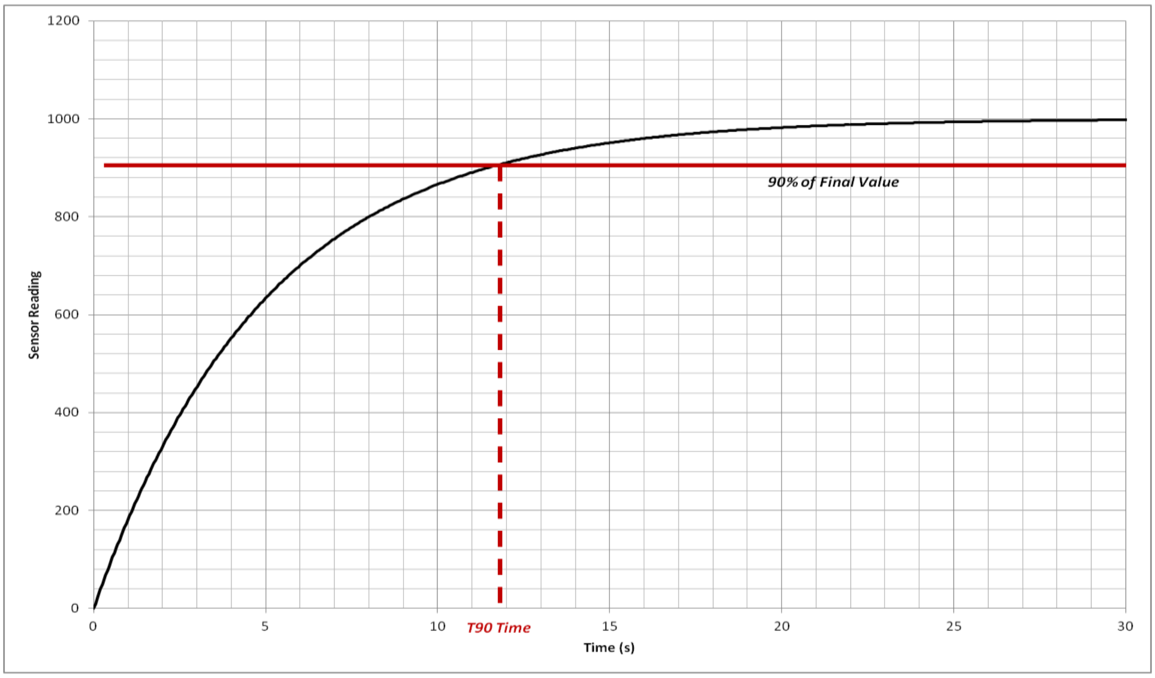
COZIR-W sensors provide two readings per second in ranges from 0-5% up to 0-100%. It features low power (3.5mW when running at full speed) from a 3.3V supply.

SprintIR

SprintIR sensors are designed for environments in which CO_2 levels change very quickly, and provides a continuous stream of 20 readings per second with a 35mW power level. The SprintIR is also available with a flow through adaptor to allow gas to be pumped through the sensor.

1.2 Definitions – T90 Response Time

Gas sensor response times are typically expressed as T90 time expressed in seconds. The T90 time defines the sensor response to a step change in gas concentration; more specifically it is the time taken for the sensor to reach 90% of the new value after a step change. For example, if the gas concentration changes from 0ppm to 10000ppm, the T90 time is the time taken for the sensor reading to reach 90% of 10000ppm ie 9000ppm.



In a similar way, other times can be defined (eg T63, T60) however GSS response times are always quoted as T90 times.

2 Factors which affect response time

The response time of the sensor is primarily determined by two factors, the gas change time, and the signal processing. In most situations, the response is determined mainly by the time taken to change the gas inside the gas measurement cell. This can either be a passive change, by gradual diffusion of the gas environment through the filter membrane, or can be forced by pumping gas into the gas measurement cell.

2.1 Diffusion Time (non pumped)

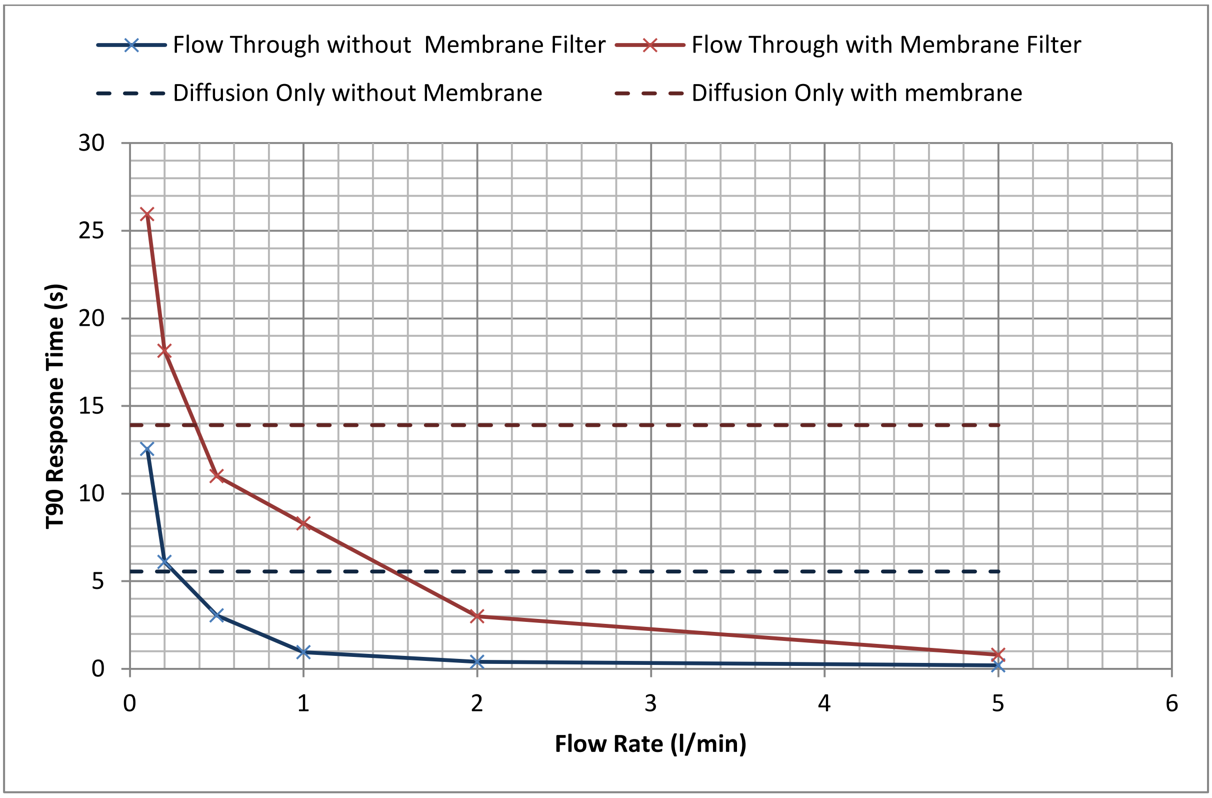
COZIR and SprintIR sensors are protected by a membrane filter to protect the sensor optical surfaces from dust and dirt. When there is no forced circulation of gas, the diffusion time is largely limited by this filter membrane.

The membrane filter can be removed, or the sensors supplied without the membrane filter. However this leaves the optical assembly unprotected from dust and contamination, so GSS do not offer a warranty for sensors supplied without the filter. Please contact GSS engineering if you want to use the sensor in this way. The chart below (see under *Gas Flow Rate* shows the effect of the membrane filter on the response time).

2.2 Gas Flow Rate (flow through adaptor)

In a flow through configuration, the response time reduces sharply with the gas flow rate.

SprintIR sensors are usually fitted with membrane filters which interfere with the gas flow and cause some mixing of the inlet and outlet gasses outside the gas cell.



2.3 Reading Frequency

In many applications, the COZIR measurement rate (2 readings per second) is fast enough, and has little practical impact on the response time of the sensor.

If gas is pumped through the sensor at a high rate, the reading frequency will eventually become the limiting factor, and the SprintIR sensors should be used. It measures at 50ms intervals.

2.4 Digital Filter

Digital filtering may be accessed by utilizing the "Z\r\n" data from the sensor; this takes the form of a low-pass damped recursive formula. This should be used where relative concentration changes are very small or where averaged absolute values are most critical. The amplitude of the damping can be altered using the "A ###\r\n" where ### is in the range 1 to 256, if 0 is inputted instead then a smart filtering mode is used. By using the "z\r\n" data digital filtering can be ignored and the raw value utilized instead.

3 Optimizing Speed of Response

The GSS COZIR-W and SPRINTIR owe their high speed response to several factors: including fast electronics with practical but flexible digital filtering; and short optical path-lengths minimizing gas stagnation volumes. In order to incorporate this sensor in optimized response configurations it is therefore key to continue to ensure that overall gas volume is kept to a minimum without restricting gas flow. This can be achieved in practice with short sample lines and matched pumping for fast throughput applications; and careful consideration of the digital filtering requirements for your own purpose.

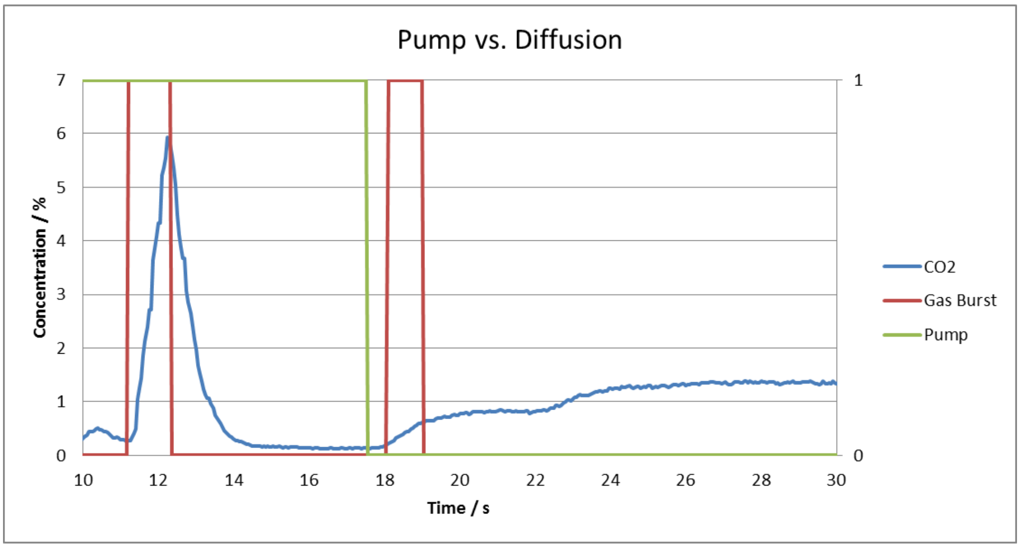
To achieve the fastest response:

- Minimise the overall gas volume in the sensor and connecting pipes
- Use the lowest digital filter value practical for your application (there is a tradeoff between response time and noise)
- Where possible, use a high flow rate and a flow through configuration
- Where the highest speed of response is essential, use a sensor without the membrane filter. **NB This voids the warranty because of the potential exposure to contaminants.**

4 Examples

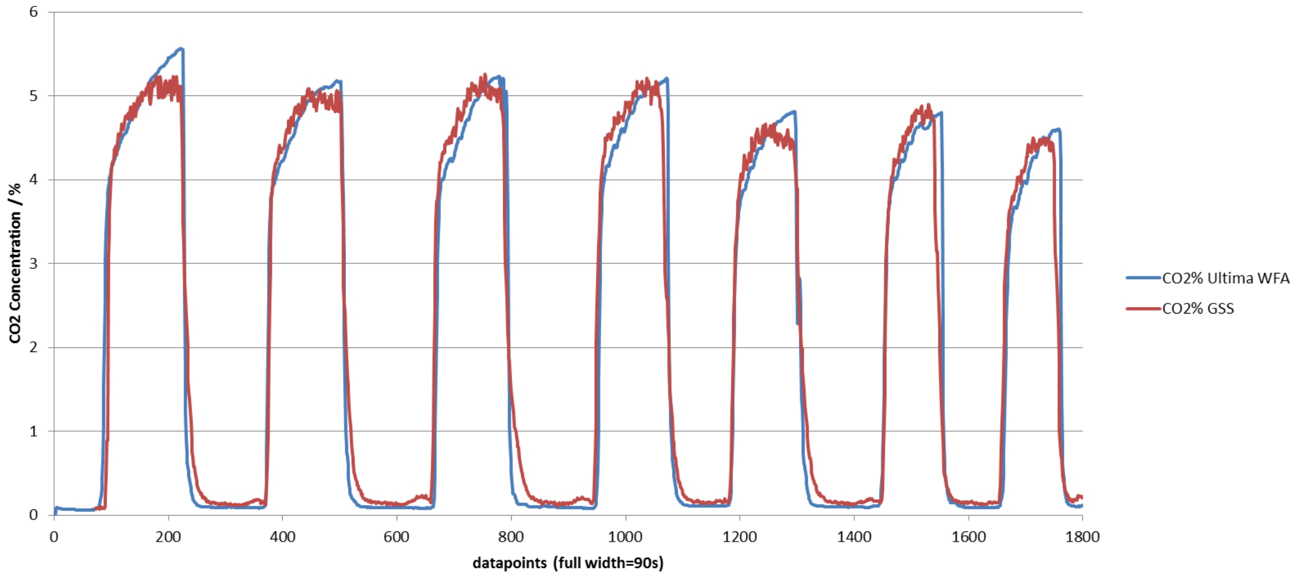
4.1 Flow Through (pumped)

The following chart shows the effect of pumping (with Boxer 1100 diaphragm pump at 3Vdc) on unfiltered CO2 concentration. Two gas bursts are compared with and without pumping.



4.2 – Breath Analysis in Sports Science

A real application requiring the portable analysis of breath by capnographic methods to resolve EtCO2 involved the integration of a GSS sensor into a mask. By using a short gas sampling tube and suitable pump the stagnation / residence time can be kept to a minimum. The following is a real comparison between a commercially available sports system and GSS sensor with no digital filtering.



Digital filtering in this case would smooth the "rough" crown in the capnogram but add an apparent temporal lag; more importantly the signal averaging due to the digital filter would decrease the gradient in rapidly changing transitions in concentration potentially yielding misleading test results.