

# DART SENSORS

## BREATH ALCOHOL SENSORS

These sensors are of the two-electrode electrochemical type, requiring a pumped sample of air to be delivered into either tube. In the presence of ethanol vapour a small direct current is produced; the sensor requires no power supply of its own but this current requires amplification to make it readable using external data collection equipment.



### SENSOR PACKAGES AND VARIANTS

Sensor Variant	Application
11mm Economy Sensor	Infrequent use/not intended to meet approval standards
11mm Premium Sensor	Frequent use
16mm Sensor	Professional use

### ELECTROLYTES

Type	Application
Type 3A	Can withstand wider range of temperature. Has been successfully used in interlock applications.
Type 4A	"Normal" applications
Types 3, 4, 5	Replacement for legacy devices only

### SENSOR CHARACTERISTICS AND CONDITIONS

Parameter	Value			Units
	Type 3/3A	Type 4/4A	Type 5	
Maximum Ethanol Concentration	300	300	300	µg/100ml air
Storage Temperature Range	-40 to 60	-20 to 40	No data	°C
Humidity Range	Avoid dry or condensing conditions			n/a
Recommended Usage Temperature	15 to 40	15 to 40	15 to 40	°C
Service Life	3-5	3-5	3-5	years
Typical response time (clear to 5% of peak @ 23°C)	~ 10	~ 6	15-20	seconds
Sensitivity	Depends on sample volume			n/a



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## GETTING STARTED

Obtain an accurate electric pump such as the one we supply, and attach to one inlet of the sensor. Another inlet of the sensor goes into your breath flow pipe/mouthpiece. Distance must be kept short to avoid condensation. You will also need a connection to a pressure switch/other means of detecting a breath flow.

Wait until the baseline is level or very nearly level before taking a sample. When the flow detector senses a breath flow, wait for at least 2 seconds before actuating the pump. Either hold the pump until the peak has passed, or you can reset it within about 200mS to avoid a reinjection spike.

Any alcohol present will generate an electric potential. Feed output into an I/V amp. A good quality low noise op-amp is needed, and a dual supply (+ and -) is essential: if the sensor baseline drifts negative, as sometimes happens after repeated tests, a single rail amp cannot see the output until it passes above zero and a zero result is given.

Take measurements from the actual baseline (NOT FROM ZERO). Integrate the entire current output of the amplifier until the net output has fallen to a fixed value, typically between 5% and 10% of the peak value (a near-level baseline is necessary before sampling, but you do not need to wait to return to actual zero).

Pass output from amplifier through A/D to microprocessor and compare with calibration data to obtain result.

The measured output rises with increase in temperature until somewhere in the region 20C to 40C, then gently falls. For the most accurate set-up (for police/professional use) you should calibrate each unit individually at least at three temperatures – 5°C, 20°C, 40°C are commonly chosen – generating a compensation algorithm. You do not need to calibrate for zero.

Output is linear throughout the normal range of ethanol values. It is usual to set a mask (reading up to 0.005 BAC as zero).

## OVERLOAD

Overload concentration is unknown. In practical terms the test subject would be unconscious beyond the maximum rating of the sensor. A risk of overload from mouth alcohol is a possibility; this would need to be detected by your instrument.

## HUMIDITY

Exposure to extremes of humidity may damage the sensor or cause electrolyte leakage.

## HEATING THE SENSOR

Sensors are heated in the following applications.

- Operation in a cold climate (police hand-helds).
- Interlocks, where they must operate from a start at very low temperatures.
- Fixed installations (e.g. coin-ops) where there is no power penalty and the system can benefit from greater speed of operation, needs no temperature compensation, and also not be potentially subject to condensation from breath.

The usual way to heat the sensor is with a heated metal (usually aluminium) block. The sensor is attached to the block. The heat is supplied by a power transistor and controlled by means of a thermistor next to it – it needs to be as close as possible to avoid hysteresis swings of temperature. Watch out for the thermal offset which occurs during the heating-up stage.

## CALIBRATION

In units using the integration method, the calibration should be very stable. Calibration checks are carried out at 6



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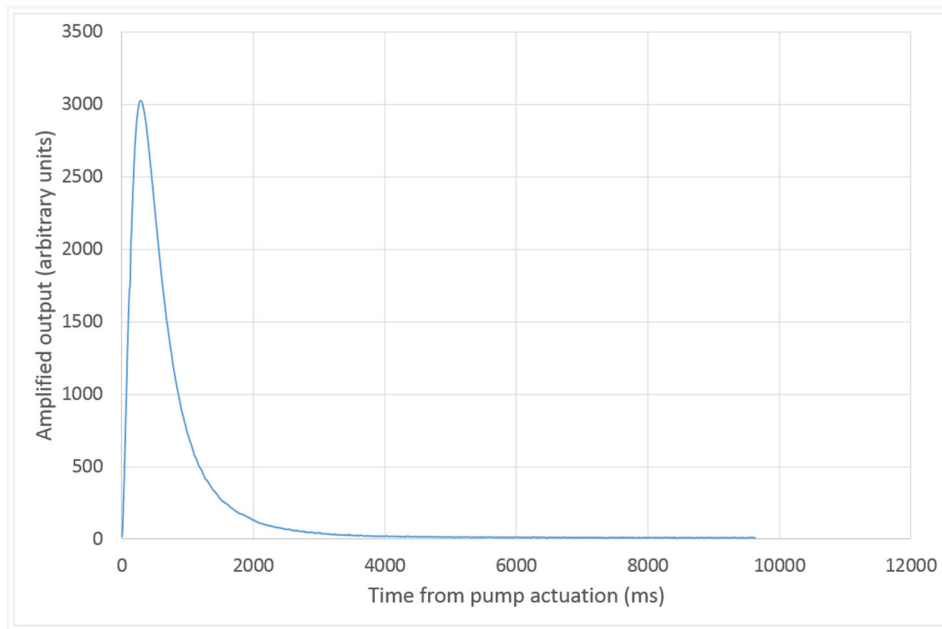
monthly intervals in the case of the UK police evidential equipment, but that is a statutory requirement, and few would need a recalibration at this interval. There are instances known of hand-held units containing our sensors which have held calibration (35 +/- 2) for up to six years. The best advice is to check as often as you think necessary.

Some guidelines on performance expectations:

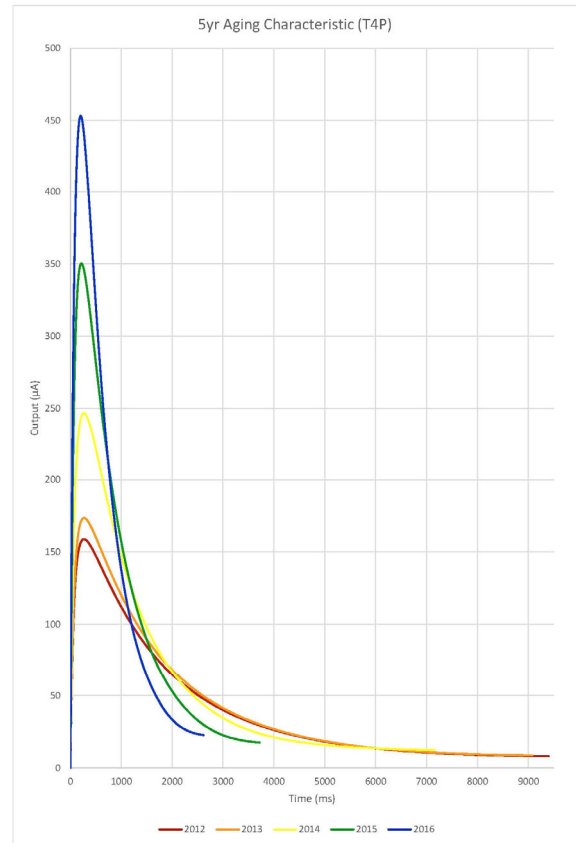
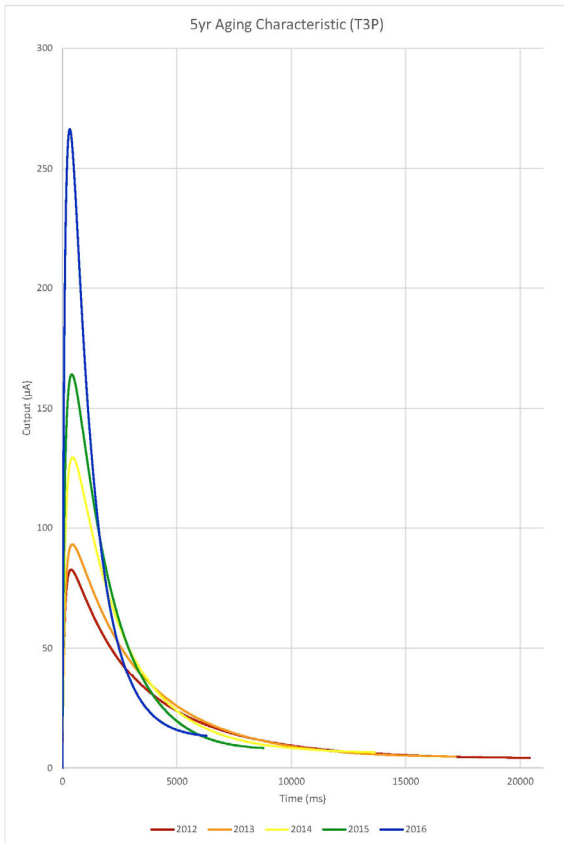
- Evidential (prosecution equipment) expected to hold within +/- 5% or better, 6 or 12 months.
- Police screeners, high end consumer, +/- 10%, 6 or 12 months.
- Low cost consumer units (bulk price \$30 or so), +/- 16% is reasonable.
- Toys without a proper sampling system – it would be pointless to give any figures for such equipment.

## TYPICAL OUTPUT

As alcohol sensors age, their peak output declines and response time lengthens. This is a fundamental property of this type of sensor that can be worked around by using the integral of the signal to obtain a result. The figure below shows the typical output of a new type 4 sensor.



The following page shows the effect of age on the signal over 5 years, obtained from extensive testing of our sensor archive.



5 year aging data for 11mm type 3 premium sensors (2-BAT3P)

5 year aging data for 11mm type 4 premium sensors (2-BAT4P)

## SAMPLE VOLUME

Breath alcohol sensors are almost always operated with a snap sample taken near the end of an exhalation. The course of breath expiration is generally detected with the aid of a pressure switch, a heated thermistor, or a microphone.

A precise sample volume in the range 0.25 cm<sup>3</sup> to 0.50 cm<sup>3</sup> works well for 11mm and 16mm sensors. The smaller the better, as long as the volume is precise and the electronics can cope with the lower signals.



## INTERFERENTS

There is sensitivity to the following within the limits specified by the UK Home Office: methyl alcohol, isopropanol, carbon monoxide, diethyl ether.

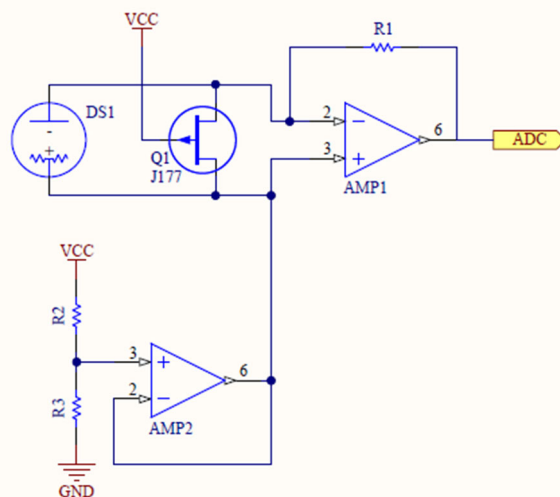
It is also sensitive in varying degrees to: hydrogen sulphide, sulphur dioxide, aldehydes including formaldehyde, phenol, hydrogen, alkenes. NO<sub>x</sub> and ozone give a negative response.

Thankfully the “interfering” substances are unlikely, except in very extreme circumstances, to cause a problem. One of the reasons why the fuel cell sensor is ousting the semiconductor type is its greater specificity – it is, for example, not sensitive to acetone, which can occur in substantial quantities in the breath of diabetics.

The fuel cell sensor routinely passes the specificity requirement for breath alcohol equipment approvals – for example, all the tests required by the authorities in USA and the UK for evidential use. But to give actual examples:

It has no sensitivity to the following substances: acetone and other ketones; toluene, benzene and other aromatic hydrocarbons; ethyl acetate and similar esters; methane, ethane and other saturated hydrocarbons; carbon dioxide; water vapour (brief transients may occur).

## APPLICATION CIRCUIT



The reference circuit above is available pre-built from Dart Sensors for development purposes. It incorporates a JFET to short the sensor, preventing offsets from building up when not in use. It also generates a virtual ground, a requirement when operating in single-supply environments.

## TROUBLESHOOTING

Given the complexity of an alcohol sensing system, there is a lot of scope for the problem to arise in other places than the sensor (which, if not abused, should not develop sudden faults, and will have been confirmed as working correctly before dispatch). It is worth checking the following:

- Is your baseline steady and low in noise?
- Are you getting a build-up of condensation near the sensor inlet (keep gas pathway short and heat if necessary to 35°C minimum)?
- Noise spike from solenoid operation?
- Sensor wired up backwards?
- Did you use a dual rail, low noise amplifier ?

When new, the sensor (particularly type 4) has a very sharp spike response followed by a quick clean-up, and even quite indifferent electronics will not hamper accurate determination of the integration cut-off point. But the fuel cell profile changes shape with age, the sharp spike drops away and the tail grows longer. If the output is noisy, the software grabs at the first dip to find the cut-off point, and takes it too early. It will be more of a problem at low alcohol levels, results will be low. Linearity is therefore affected.

Here are five remedies you can explore.

- Change the fuel cell (not really a cure but a short term fix).
- Put more smoothing (averaging) or other signal processing into the software.
- Attend to the electronic noise, use lower noise amp.
- Cut off the integration at 10, 15 or even 20% of peak value.
- Increase the sample volume to gain signal.

Incidentally, you can anticipate the ageing of the peak spike by allowing the sensor output to hit the rail on high values when new: integration carries on just the same (but the cut-off point is slightly altered).



# RoHS Declaration of Conformity

## Identification

Dart Sensors 11mm Breath Alcohol Sensors  
Dart Sensors 16mm Breath Alcohol Sensors

## Manufacturer

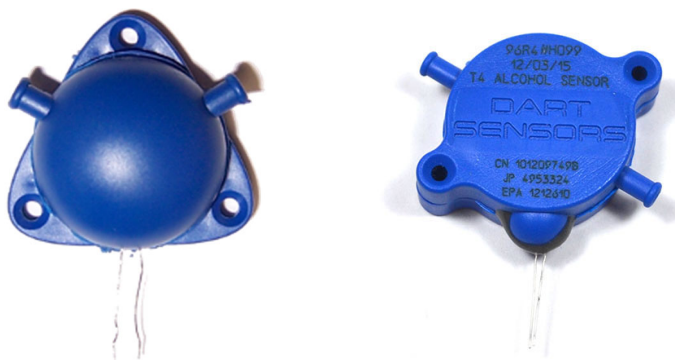
Dart Sensors Ltd  
Elm House  
54 Mary Arches Street  
Exeter EX4 3BA  
UK

This declaration of conformity is issued under the sole responsibility of the manufacturer.

## Object of the declaration

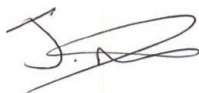
- 11mm breath alcohol sensor, premium, all types (2-BAT\*P\*)
- 11mm breath alcohol sensor, economy, all types (2-BAT\*E\*)
- 16mm breath alcohol sensor, all type (2-R\*)

Images are included for reference:



The object of the declaration described above is in conformity with Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

Signed for and on behalf of Dart Sensors Ltd:



Jake Miles, General Manager  
Exeter, 15th May 2019



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