

# **ECO Field Investigation – Underground Bus Station (Brisbane AU)**

Application Note

July 2010

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## Preface

This Application Note describes the field investigation and performance results for the Xtralis ECO detector (incorporating CO sensor) installed at the Queens Street underground bus station (Brisbane, AU).

## Related Products

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## Background

In enclosed or underground bus terminals, toxic gases (Carbon Monoxide (CO), Nitric Oxides (NO<sub>x</sub>), etc.) from bus vehicle exhaust emissions present a health risk to the general public and employees.

The risk of toxic gas poisoning in these enclosures is reduced or removed by natural or mechanical ventilation normally through the continuous introduction of an adequate number of air changes per hour. Whilst this approach is effective, the associated running costs are high. An acceptable alternative is to employ gas detectors throughout these enclosures to monitor toxic gas levels to activate / regulate mechanical ventilation ensuring toxic gases are within acceptable limits. This *demand-control* ventilation reduces the running costs.

The Queen Street underground bus station is the Brisbane CBD's primary bus terminus situated underneath The Myer Centre and Queen Street Mall.

The bus station incorporates a network of underground tunnels with 17 bus platforms servicing a total of 38 different bus routes. Point type CO detectors are fitted throughout the tunnel areas to continuously monitor gas levels for *demand-control* ventilation.

In addition to gas monitoring, the platforms comprise a number of VESDA Aspirating Smoke Detection systems. The VESDA systems are interfaced to the Fire Panel for Fire Brigade call out in the event of a fire.

The point type gas detectors and the VESDA systems are interfaced to a Zitton Fire Alarm Control Panel.



Figure 1 Queen Street Bus Station - Queen Street Mall Entrance

## Scope

The tunnel servicing platforms A5 to A10 (Figure 2) of the Queen Street Bus Station was selected for the field investigation as the existing VESDA system provided the platform for the installation and testing of the ECO detector.

The scope of the field investigation was to ascertain and compare the application performance of the ECO detector against point type gas detector. In particular:

- Compare ECO performance (configured for *area* gas monitoring) to a point type gas detector (*localised* monitoring)
- Correlate soot particle concentration (provided by VESDA system) to gas concentration (provided by ECO detector). The intention is to establish correlation between airborne particulates (ambient particles, soot particles from bus vehicle emissions) and toxic gas levels.

The ECO detector configured for *area* gas monitoring is installed downstream the VESDA unit to allow sampling from all holes of the VESDA pipe network (Figure 3).

A scientific CO data logger was used as point type gas detectors for the present investigation.

## Site Information

### VESDA System

A VESDA LaserPlus (S/N: 109154) is installed in the tunnel section servicing platforms A5 to A10 (Figure 2).

The VESDA pipe network consists of two pipes installed under the ceiling that cover approximately 2000m<sup>2</sup>. Pipe 1 comprises 9 x Ø3.5mm sampling holes spaced 10m. Pipe 2 comprises 12 x Ø3.5mm sampling holes spaced 8m. The ASPIRE2 design is included in Appendix A.

The VESDA *Fire 1* relay (0.278 Obs%/m) is interfaced to the Fire Panel for Fire Brigade call out in the event of fire.

The tunnel has a ceiling height of 3 meters and the frequency of bus arrivals at each platform is approximately 3 minutes.

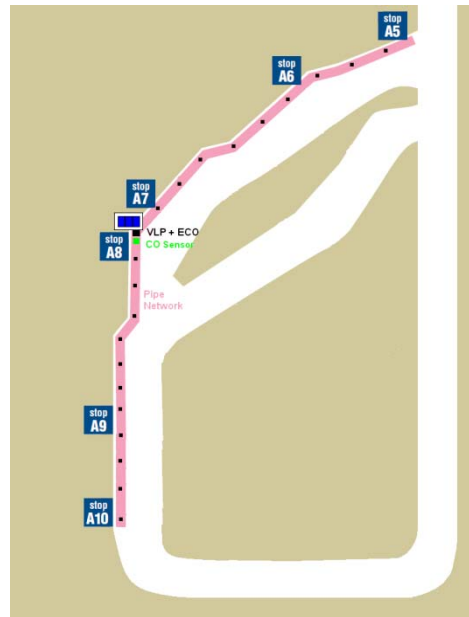


Figure 2 VESDA pipe network - Platforms A5- A10

## Installation

The measured gas was carbon monoxide (CO) which has approximately the same density as ambient air (relative density: 0.967).

The sampling location for the ECO and point type detector was decided to be under the ceiling of platform A7 rather than breathing height (0.9 - 2.5m – AS1668.2-2002). The reason for this being the temperature of the CO gas from vehicle emissions is higher than the ambient air therefore thermal movement will dominate over forces of diffusion and the gas will rise upwards to the ceiling.

### ECO

One ECO detector was fitted to the exhaust of the VESDA system (Figure 3).

- Model: ECO-D-B-41 CO
- Mfg. Date: 21-05-2010
- Main Module F/W: 1.2.20
- Sensor Module H/W: 17388.05.01
- Sensor Module S/W: 1.1.14

The inclusion of the ECO detector onto the VESDA pipe network had minimal impact to the performance of the VESDA system in terms of volumetric flow delivery as shown below from the measured flow rates before and after installation.

*Table 1. VESDA System – Smoke Transport Time*

VESDA System	Normalised Flow rate %
No ECO	99
ECO Installed	95



*Figure 3 ECO Installation – VESDA Exhaust*

#### **Point Type Carbon Monoxide (CO) Data Logger**

A Carbon Monoxide (CO) data logger (Model: EL-USB-CO1) was installed to record CO levels at the ceiling of the tunnel at platform A7. The CO data logger was mounted under the tunnel ceiling at the center of the VESDA pipe network.

The specification of the Carbon Monoxide (CO) data logger is included in Appendix B.

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<sup>1</sup> Lascar electronics: [www.lascarelectronics.com](http://www.lascarelectronics.com)

# Results

## Area Monitoring (ECO) / Localised Monitoring (Point Type)

The CO gas profiles recorded from the ECO (area monitoring) and point type (localized monitoring) detectors is shown in Charts 1 & 2.

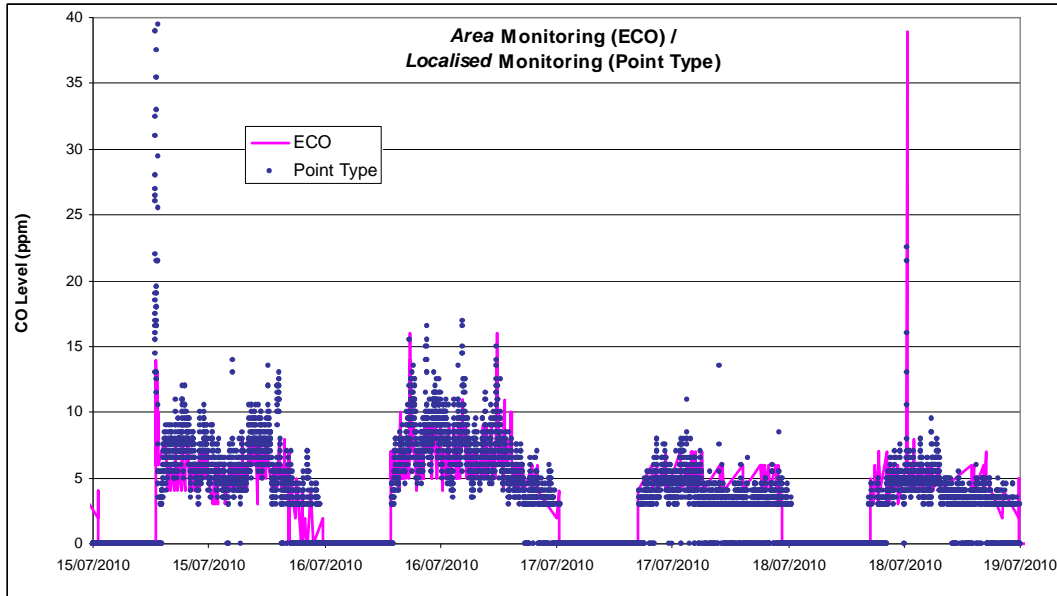


Chart 1 Area Monitoring (ECO) / Localised Monitoring (Point Type) - 1 wk period (15/07/10 - 19/07/10)

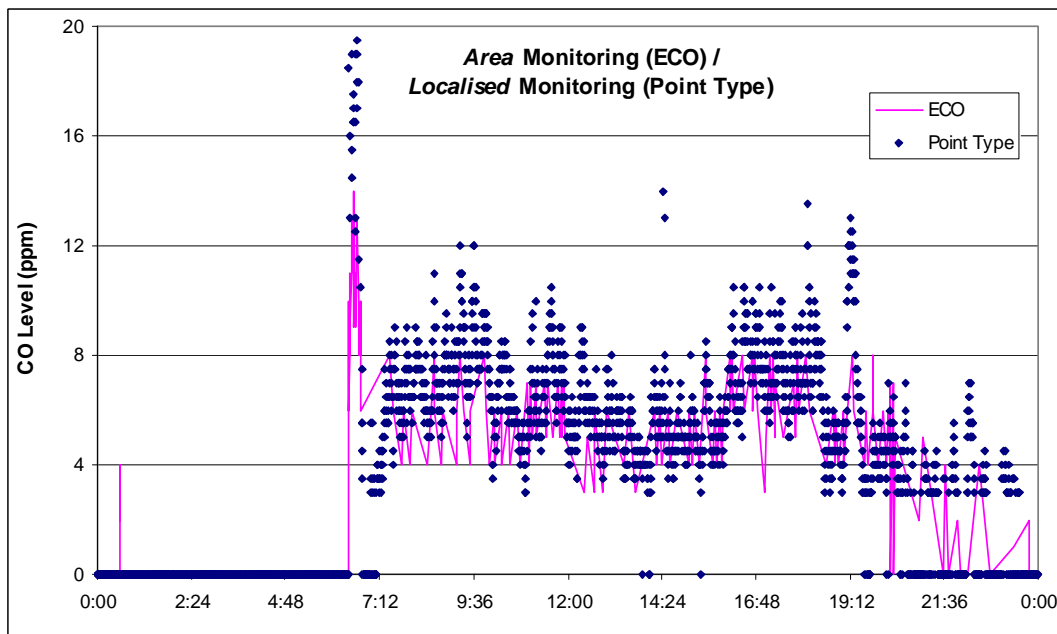


Chart 2 Area Monitoring (ECO) / Localised Monitoring (Point Type) - 24 hr period (15/07/10)

Chart 3 correlates the ambient contaminants level (recorded by the VESDA system) to CO levels (recorded by the ECO – area monitoring configuration). It can be seen that high levels of ambient contaminants is associated to bus emissions as they are accompanied by a high CO signature. There are occasions, however, where elevated CO levels were not accompanied by any ambient contaminants.

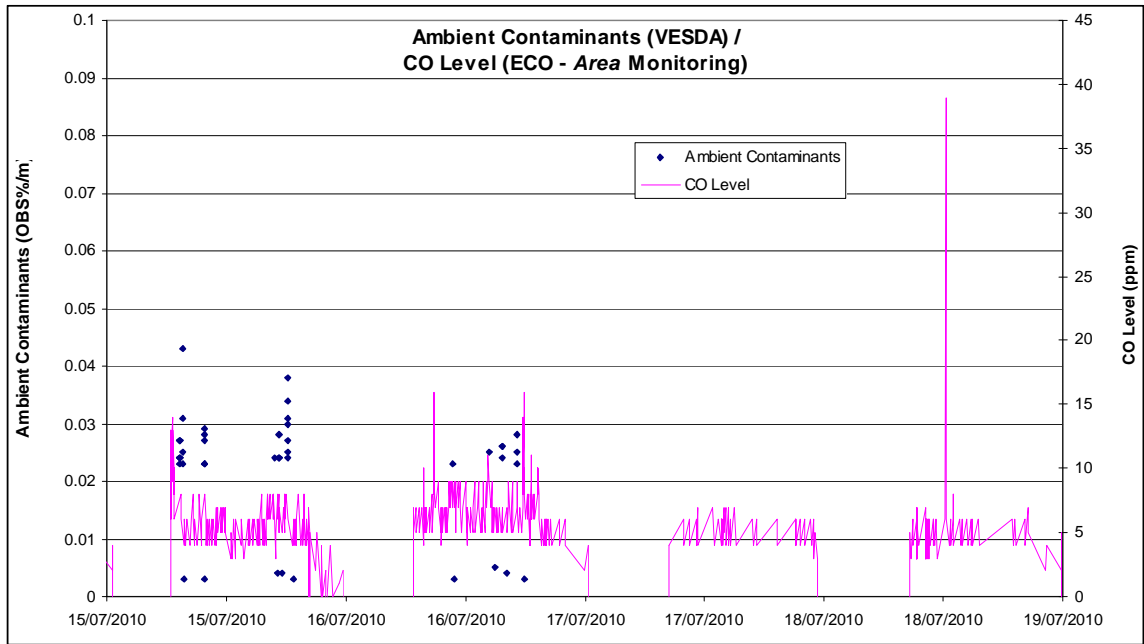


Chart 3 Ambient Contaminates (VESDA) / CO Level (ECO) – 1 wk period (15/07/10 - 19/07/10)

Chart 4 shows ambient contaminants and CO levels recorded over a 24 hour period.

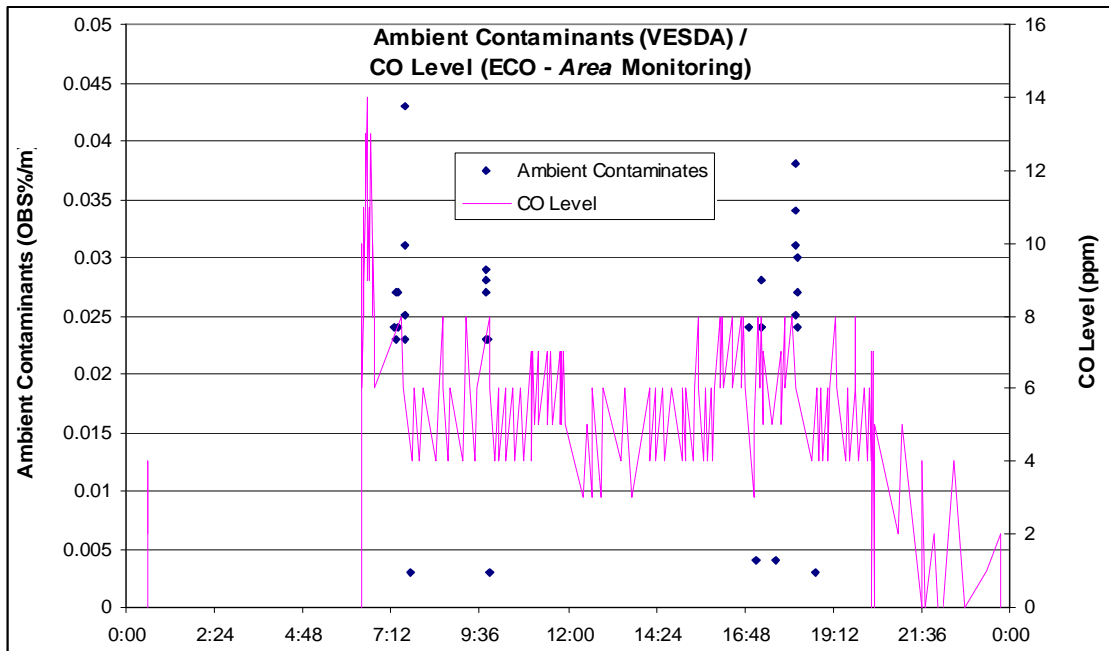


Chart 4 Ambient Contaminates (VESDA) / CO Level (ECO) - 24 hr period (15/07/10)

## Summary

An ECO detector fitted to a VESDA pipe network system was investigated with field tests undertaken at the Queen Street underground bus station. The investigation showed:

- The ECO detector configured for Area monitoring (fitted to the exhaust of the VESDA system) exhibited similar response to CO levels to a point type gas detector located at the center of the VESDA pipe network.
- The VESDA + ECO concept provides a holistic approach in terms of monitoring ambient particulates and gaseous contaminants for added protection to the health of people.

The *Area* monitoring configuration could be extended to apply for *Fence* monitoring used when potential gas emission sources cannot be pinpointed so the outer limits of the zone need to be monitored to check whether gas concentrations are crossing into neighboring zones.

# Appendix A – VESDA ASPIRE2

## Installation Data Pack for Queen St Bus Terminal Brisbane

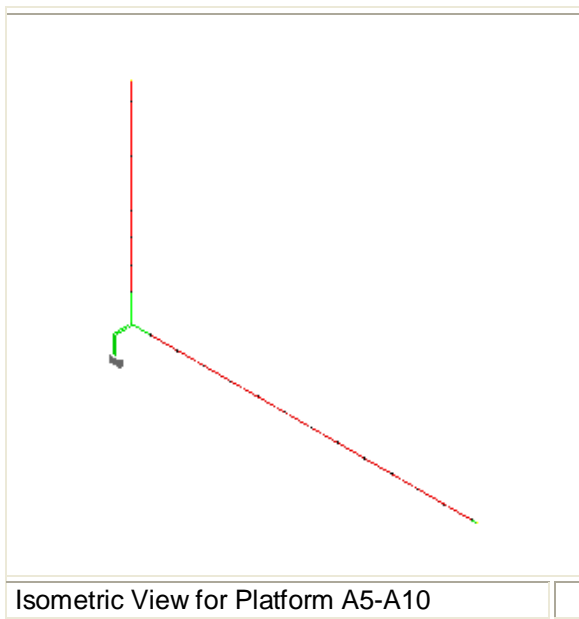
Pipe Type Asiapac  
 Date 17/06/10  
 Units Metric  
 Altitude 0.0m  
 Designed with Hole Sizes 0.0;3.5mm

### Detector : Platform A5-A10

Type VESDA LaserPLUS  
 Endcap Usage Create a Balanced Design  
 Application Default  
 Aspirator Speed 4200rpm  
 Temperature 20.0°C  
 Absolute Pressure 1013.5hPa  
 System Flowrate 97.4l/min  
 Manifold Pressure 209Pa  
 Total Pipe Length 190.00m  
 Number Of Sample Points 22  
 Maximum Transport Time 136  
 Minimum Hole Flow Rate 2.0l/min  
 Inverted Detector No  
 Fire Threshold 0.278%/m

### Balance Data

Group name	Aggregate Sensitivity	Balance	Suction pressure (least)	Endcap Sensitivity Factor
[Default Group]	0.278%/m	! ? 36%	! ? 22Pa	0.0



### Pipe:A5-A7

Total Pipe Length 85.00m  
 Ambient Pressure 0Pa

Sector Pressure 209Pa  
 Number Of Sample Points 9  
 Pipe Flowrate 44.3l/min

## Section1

#		Distance m	Relative m	Direction	Hole Diameter mm	Transport Time sec	Pressure Pa	Flow l/min	Flow %	Hole Sensitivity %/m	Diameter mm
-	Bend	2.67	2.67	F	-	-	-	-	-	-	-
-	Elbow	5.34	2.67	FL	-	-	-	-	-	-	-
1	Hole	11.00	5.66	-	3.5	6	169	6.6	6.8	4.110	21.0
2	Hole	21.00	10.00	-	3.5	11	142	6.0	6.2	4.482	21.0
3	Hole	31.00	10.00	-	3.5	16	119	5.5	5.7	4.895	21.0
4	Hole	41.00	10.00	-	3.5	21	101	5.1	5.2	!? 5.328	21.0
5	Hole	51.00	10.00	-	3.5	28	85	4.7	4.8	!? 5.785	21.0
6	Hole	61.00	10.00	-	3.5	36	73	4.3	4.5	!? 6.234	21.0
7	Hole	71.00	10.00	-	3.5	47	64	4.1	4.2	!? 6.654	21.0
8	Hole	81.00	10.00	-	3.5	64	58	3.9	4.0	!? 7.000	21.0
9	Endcap	85.00	4.00	-	3.5	78	56	4.1	4.2	!? 6.652	21.0

## Pipe:A8-A10

Total Pipe Length 105.00m  
 Ambient Pressure 0Pa  
 Sector Pressure 209Pa  
 Number Of Sample Points 13  
 Pipe Flowrate 53.1l/min

## Section1

#		Distance m	Relative m	Direction	Hole Diameter mm	Transport Time sec	Pressure Pa	Flow l/min	Flow %	Hole Sensitivity %/m	Diameter mm
-	Bend	2.67	2.67	F	-	-	-	-	-	-	-
-	Bend	5.34	2.67	R	-	-	-	-	-	-	-
1	Hole	8.00	2.66	-	3.5	5	172	6.6	6.8	4.080	21.0
2	Hole	16.00	8.00	-	3.5	8	145	6.1	6.2	4.449	21.0
3	Hole	24.00	8.00	-	3.5	12	121	5.6	5.7	4.864	21.0
4	Hole	32.00	8.00	-	3.5	15	101	5.1	5.2	!? 5.330	21.0
5	Hole	40.00	8.00	-	3.5	19	83	4.6	4.7	!? 5.855	21.0
6	Hole	48.00	8.00	-	3.5	24	69	4.2	4.3	!? 6.442	21.0
7	Hole	56.00	8.00	-	3.5	29	57	3.8	3.9	!? 7.096	21.0
8	Hole	64.00	8.00	-	3.5	35	47	3.5	3.6	!? 7.812	21.0
9	Hole	72.00	8.00	-	3.5	43	39	3.2	3.2	!? 8.579	21.0
10	Hole	80.00	8.00	-	3.5	54	32	2.9	3.0	!? 9.368	21.0
11	Hole	88.00	8.00	-	3.5	68	28	2.7	2.7	!? 10.125	21.0
12	Hole	96.00	8.00	-	3.5	!? 90	!? 24	2.5	2.6	!? 10.776	21.0
13	Hole	104.00	8.00	-	3.5	!? 136	!? 22	2.4	2.5	!? 11.231	21.0
14	Endcap	105.00	1.00	-	0.0	-	-	-	-	-	21.0

# Appendix B – CO Data Loggers

## EL-USB-CO Carbon Monoxide (CO) Data Logger with USB Interface

This data logger measures and stores up to 32,510 Carbon Monoxide (CO) readings over a 0 to 1000 ppm measurement range and -10 to +40°C (14 to +104°F) operating temperature range. The user can easily set up the logging rate and start time, and download the stored data by plugging the module straight into a PC's USB port and running the purpose designed software under Windows 98, 2000, XP and Vista (32-bit). The data can then be graphed, printed and exported to other applications. The data logger is supplied complete with a long-life lithium battery. Data is stored in non-volatile memory and is not lost when the battery is empty. A bright red LED will flash and a buzzer can sound when a preset warning level has been exceeded.

### FEATURES

- 0 to 1000 ppm CO measurement range
- Stores up to 32,510 Measurements
- User-Programmable Warning Threshold with Bright Visual and Audible Warning
- USB Interface for Set-up and Data Download
- Expected sensor life: 4 years
- Replaceable Internal Lithium Battery



### WINDOWS CONTROL SOFTWARE

Easy to install and use, the control software runs under Windows 98, 2000, XP (Home and Professional Editions) and Vista (32-bit). It allows the user to set up and download any EL-USB-CO. The latest version of the control software may be downloaded from [www.lascarelectronics.com](http://www.lascarelectronics.com).

### DATA LOGGER SET-UPS

- Logger Name
- Logging Rate (10s, 30s, 1m, 5m)
- Warning Threshold
- Start Date and Start Time

### ORDERING INFORMATION

Standard Data Logger (Data Logger, Software on CD, Battery)	Stock Number EL-USB-CO
Replacement Battery	BAT 3V6

### IMPORTANT SAFETY WARNING:

**DO NOT ATTEMPT TO USE THE EL-USB-CO WITHOUT READING AND UNDERSTANDING THE DOCUMENTATION. CARBON MONOXIDE MONITORING IS A COMPLEX PROCEDURE. IF THERE IS ANY DOUBT AS TO THE SAFETY OR APPLICATION - STOP! CONSULT A QUALIFIED EXPERT.**

**The EL-USB-CO is a professional measuring instrument, designed to record Carbon Monoxide (CO) gas levels for later analysis. It is not an alarm/safety/warning device and should not be used in this capacity for the following reasons:**

- 1. The lights and sound emitted by the EL-USB-CO to indicate a high level of CO do not provide adequate warning to those in the surrounding area that a high level of CO has been recorded.**
- 2. The battery life of the EL-USB-CO during audible and visual indication of a high level of CO will rapidly diminish and will therefore only be active for a short period of time.**
- 3. The EL-USB-CO takes a sample reading at intervals as set by the user for recording/monitoring/analysis purposes. Dangerous levels of CO will not register with the device until a sample reading is taken.**
- 4. Due to the limitations of the device as a professional instrument, it is left to the user to set the light and sound alarms indicating the presence of company. Therefore the instrument can be set up to provide NO form of warning.**

**Carbon Monoxide is poisonous. It is clear, colorless gas that has no smell or taste and can be lethal even in very low concentrations. It can injure or kill people and animals who are not adequately warned of its presence.**

**In areas where the safety of humans and animals is a concern we insist that a domestic or industrial CO detector/alarm, designed to a nationally approved quality standard, with features such as a high decibel alarm or siren and a clear visual warning, specifically designed to provide adequate warning of dangerous CO levels, be installed, used and maintained.**

Specifications liable to change without prior warning

EL-USB-CO

Issue 6

04/2007

PP.

Applies to EL-USB-CO/2



No: 0754 - Page 1 of 3

# EL-USB-CO Carbon Monoxide (CO) Data Logger with USB Interface

## SPECIFICATIONS

Specification	Min.	Typ.	Max.	Unit
Measurement range	0		1000	ppm CO
Internal resolution		0.5		ppm CO
Accuracy (error)		+6		% of reading
Repeatability		+2		% of reading
Decay of reading over time			5	% of reading / year
Response time (to reach 90%)		1		minute
Logging rate	every 10s		every 12hr	-
Operating temperature range (15-90 %RH, non-condensing)	-10 (14)		+40 (104)	°C (°F)
Operating pressure range	900		1100	mbar
1/2AA 3.6V Lithium Battery Life*			3	month

\* with battery supplied, 10 minute logging rate, 25°C ambient temperature, audible warning disabled, reading <10 ppm CO

### LED FLASHING MODES

EL-USB-CO features a red and a green LED.

The LEDs on an EL-USB-CO will flash in one of the following ways, assuming hold of the warning threshold has been turned off in the EL-WIN-USB control software.

- Green single flash, every 30 seconds      Logger primed and ready to start.
- Green single flash, every 10 seconds      Logging in progress, last stored value OK
- Red single flash, every 10 seconds      Logging in progress, the last stored reading is equal to or exceeds the warning threshold (If hold is turned on, then a stored value is equal to or exceeds the warning threshold) (will flash once every second when audible warning is enabled)
- Green single flash, every 20 seconds      Low battery, logging in progress, the last stored value OK
- Green double flash, every 20 seconds      Logger is full, last stored value OK
- Red/Green single flash, every 20 seconds, alarm hold turned on      Logger is full, last stored value is equal to or exceeds the warning threshold (will flash once every second when audible warning is enabled)
- No LEDs flash      Battery inserted, but no logging exercise started or Battery dead.

By default hold is disabled. In this mode the red LED will no longer continue to flash after the logged temperature has returned to normal from an alarm condition.

Hold can be turned on via the control software. In this mode the red LED that indicates an alarm condition will continue to flash, even after the logged temperature has returned to normal. The red LED will effectively have latched into its alarm condition. This feature ensures that the user is notified that an alarm level has been exceeded, without the need to download the data from the logger.

### AUDIBLE WARNING

The audible warning will sound once per second when the warning threshold has been exceeded. To disable the warning, remove the cap from the front of the data logger.

The audible warning will sound once every 60 seconds when there is a low battery condition. This indicates that the battery must be replaced.

Specifications liable to change without prior warning      EL-USB-CO      Issue 6      04/2007      PP.      Applies to EL-USB-CO/2



## EL-USB-CO Carbon Monoxide (CO) Data Logger with USB Interface

### BATTERY REPLACEMENT

- We recommend that you replace the battery every 3 months, or prior to logging critical data.
- The EL-USB-CO does not lose its stored readings when the battery is discharged or when the battery is replaced; the data logging process will however be stopped and cannot be re-started until the battery has been replaced and the logged data has been downloaded to PC.
- Only use 3.6V 1/2AA lithium batteries. Check with your supplier that the battery you are ordering is 'press fit' and is not fitted with solder tags. Before replacing the battery, remove the EL-USB-CO from the PC.

Note:

Leaving the EL-USB-CO plugged into the USB port for longer than necessary will cause some of the battery capacity to be lost.



**WARNING:** Handle lithium batteries carefully, observe warnings on battery casing.  
Dispose of in accordance with local regulations.



### Authorized Distributor:



Optimum Energy Products Ltd.  
1-877-766-5412  
[www.DataLoggerStore.com](http://www.DataLoggerStore.com)

LASCAR ELECTRONICS LTD.  
MODULE HOUSE,  
WHITEPARISH,  
WILTSHIRE SP5 2SJ,  
UK  
TEL: +44 (1794) 884567  
FAX: +44 (1794) 884616  
E-mail: [sales@lascar.co.uk](mailto:sales@lascar.co.uk)

LASCAR ELECTRONICS INC.  
3750 WEST 26th STREET,  
ERIE,  
PA 16506,  
USA

LASCAR ELECTRONICS (HK) LIMITED  
UNIT NOS. 6-8, 19/F FUTURA PLAZA,  
111-113 HOW MING STREET,  
KWUN TONG, KOWLOON,  
HONG KONG  
TEL: +852 2389 6502  
FAX: +852 2389 6535  
E-mail: [purchasing@lascar.com.hk](mailto:purchasing@lascar.com.hk)

*Specifications liable to change without prior warning*      EL-USB-CO      Issue 6      04/2007      P.P.      Applies to EL-USB-CO/2



No: 0754 - Page 3 of 3

## Further Support

Contact an Xtralis office or distributor for further information.

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**www.xtralis.com**

**The Americas** +1 781 740 2223

**Asia** +852 2916 8894

**Australia and New Zealand** +61 3 9936 7000

**Continental Europe** +32 56 24 19 51

**UK and the Middle East** +44 1442 242 330

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