# 42C BLC upgrade

# Manual

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# 1. INTRODUCTION

## 1.1 THEORY

The AQD photolytic $NO_2$ converter uses an array of ultraviolet light emitting diodes (UV-LED's) to photolyzed $NO_2$ to NO and ozone per Reaction 1, which may be subsequently measured by chemiluminescence or another suitable method.

Reaction 1: $NO_2 + h\nu \rightarrow NO + O_3$ (for $h\nu$ = 350-400 nm)

Reaction 2: $NO + O_3 \rightarrow NO_2$

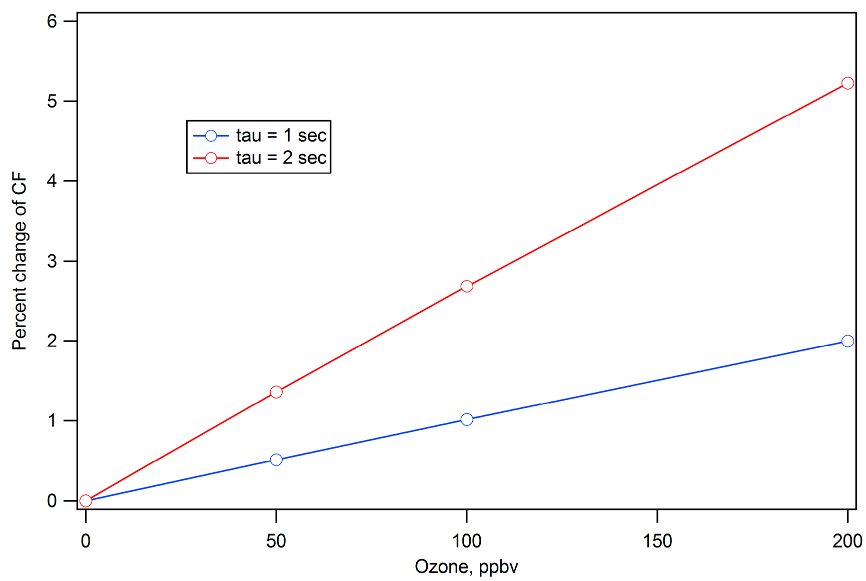
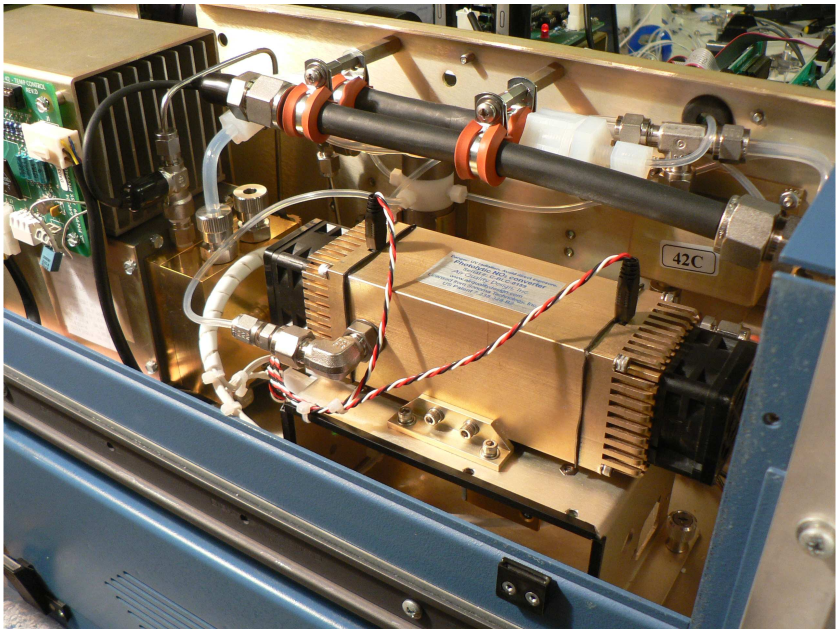



Figure 1-1. Percent change of the $NO_2$ conversion efficiency as a function of the ambient and produced ozone in the sample. For a residence time of 1 second the error introduced is less than 2%.

Since the reverse reaction (Reaction 2) occurs fairly quickly it is important that reaction 1 takes place in 1-2 seconds, followed shortly by measurement of the resulting product. Figure 1-1 shows the effect of the back titration of the produced NO on conversion efficiency as a function of the concentration of ambient and produced ozone.

## 1.2 CONVERTER OVERVIEW




The physical and performance characteristics of the AQD $NO_2$ converter include:

- High efficiency ($\geq$50% $NO_2$ conversion/second)
- Highly specific for $NO_2$
- Negligible radiant heating of the sample gas
- 1 second residence time for 1 SLPM at low pressure (200 Torr)
- Long light-source life (estimated >5,000 hours)
- Lamp control integrated into Thermo circuitry
- Power supply with cables and connectors included to integrate into Thermo circuitry
- Converter weight: 0.8 kg
- Converter size: 75 mm (w) x 55 mm (h) x 215 mm (l)
- Patented technology

**Danger: UV radiation. Avoid direct exposure.**

**Photolytic $NO_2$ converter**

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US Patent 7,238,328 B2

## 2. INSTALLATION AND USE

### 2.1 ELECTRICAL CONNECTIONS

The kit comes with cables and connectors for integrating with the Thermo 42 series circuitry. Figure 2-1 shows a picture of what connections need to be made, with the connectors labeled. Before connecting or disconnecting any cables, please disconnect power from the analyzer since there is high voltage present on the Thermo power supply board and the AC-DC converter for the BLC which presents a shock hazard.. The two pin connector labeled NO-NOx should be plugged into the connector labeled J11 (NO-NOx) on the Thermo power supply board. The three pin connector labeled pump should be plugged into the connector labeled J1 (pump) on the Thermo power supply board. The supplied splitter can be used on J1 if an internal pump is being used to power both the pump and BLC on J1.

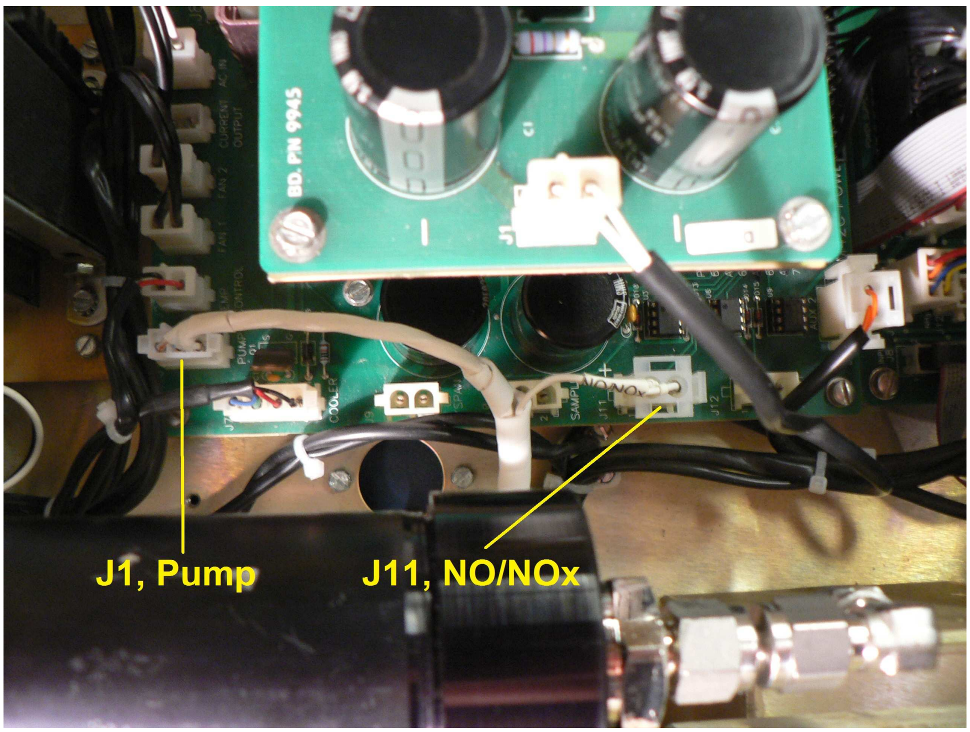


Figure 2-1, Photo of Pump and NO/NOx connections on the Thermo power supply board

### 2.2 PLUMBING CONNECTIONS

The plumbing connections for the converter are simply in and out with the two sides equivalent. The BLC converter should simply go in-line where the molybdenum converter was.

## 3. CONVERSION EFFICIENCY CALCULATIONS

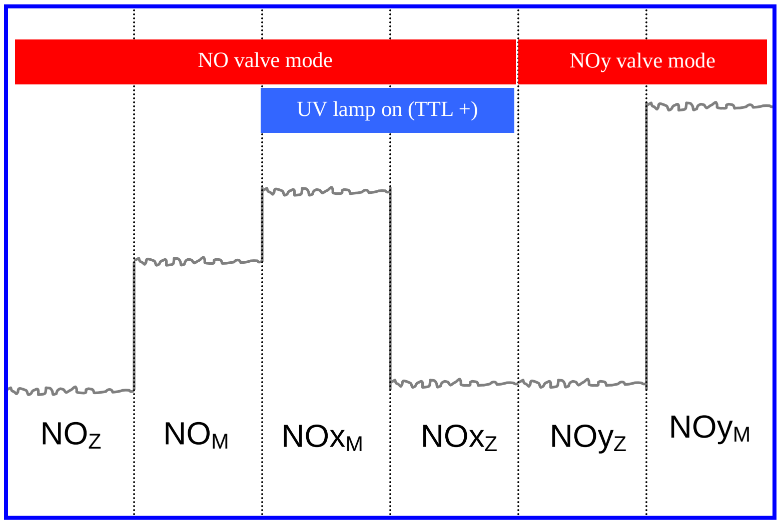


Figure 3-1. Example diagram of the sampling modes for a $NO$-$NO_2$-$NO_y$ system.

1. $[NO] = (NO_M - NO_Z) / NO_{SENS}$

   Where: $NO_M$ = NO concentration in measure mode
   $NO_Z$ = NO concentration in zero mode
   $NO_{SENS}$ = NO response factor

2. $[NO_2] = ((NOx_M - NOx_Z) - (NO_M - NO_Z)) / NO_{2SENS}$

   Where: $NOx_M$ = NOx concentration in measure mode
   $NOx_Z$ = NOx concentration in zero mode
   $NO_{2SENS}$ = $NO_2$ response factor

3. $[NOy] = (NOy_M - NOy_Z) / NOy_{SENS}$

   Where: $NOy_M$ = NOy concentration in measure mode
   $NOy_Z$ = NOy concentration in zero mode
   $NOy_{SENS}$ = NOy response factor

[1] For systems using photon counting the response factors are calculated in units of counts per second per ppb (cps/ppb) in the form:

$NO_{SENS}$ = (cal_counts – measure_counts) / cal_concentration.

In the TEI way of calibrating $NO_{SENS}$ would be 1.0 +/- and would be multiplied instead of divided.

[1] Similar to the $NO_{sens}$ calculation, the NO2SENS calc is presented in terms of cps/ppb as:

$NO2_{SENS} = NO_{SENS} * NO_2CE$

Where: $NO_2CE = ((NOx_T\text{-}NOx_{TZ})\text{-}(NO_T\text{-}NO_{TZ})) / ((NOx_C - NOx_{CZ}) - (NO_T\text{-}NO_{TZ}))$

[1] For systems using photon counting the response factors are calculated in units of cps/ppb of NOx) in the form:

$NOy_{SENS}$ = (cal_counts – measure_counts) / cal_concentration