

MODEL 650 NOXYGEN

OPERATORS MANUAL

gasanalyzers.com

California Analytical
Instruments, Inc.



This manual describes installation, calibration and operation of California Analytical Model 650 NO_x/O₂ analyzer. To assure correct operation and accurate results, it is recommended that the user carefully read this document.

650 Quick Start Guide

- 1) Plug in the analyzer and turn the power on.
- 2) Connect the appropriate gas lines and vents to the analyzer.
- 3) Allow the analyzer to stabilize for at least one (1) hour.
- 4) During the analyzer's stabilization period, setup the analyzer to the desired configuration.
 - a) Set the analyzer's output as desired.
 - i) From the Main Menu press F5 (Setup) then F7 (System Settings.)
 - ii) Press F3 (output assignments) to setup the output channels.
 - (1) Set to real time
 - (2) Set channel 2 to NO
 - (3) Set channel 3 to NO₂
 - (4) Set channel 4 to O₂
 - (5) Press back to return to the system settings menu.
 - iii) Press F4 (output range) to setup the output ranges
 - (1) Set the Min and Max to zero (0). This will cause the outputs to default to the analyzer ranges.
 - (2) Set the outputs for milliamps (mA) or voltage (V) as desired.
 - (a) The mA setting will give 4-20 mA or 2-10V (if 500 ohm resistors are installed).
 - (b) The V setting will give 0-20mA or 0-10V (if 500 ohm resistors are installed).
- 5) Connect all appropriate analog outputs.
 - a) Pin 1 is the output common (ground).
 - b) Pins 2, 3, 4, and 5 are output channels 1, 2, 3, and 4 as setup in step 4.a.ii.
 - c) If the output is set for voltages but there is no voltage output, you will need to install a 500 ohm resistor between pin 1 and the channel you are trying to measure. You will have to measure the voltage drop across this resistor.
- 6) Press F1 from the analyzer's main Menu to get to the measurement screen.
 - a) The individual NO, NO_x, and NO₂ channels only work while measuring in dual mode. (Real time and O₂ output continuously)
 - b) Press F2 while in the measurement screen to get to dual measurement mode.
- 7) Supply sample gas to the analyzer.
- 8) The measurement screen should indicate the concentration of the sample gas. If the concentration is incorrect, the analyzer will need to be Zeroed and Spanned using your calibration gases. Please reference the appropriate section of the manual for a description on how to zero and span the analyzer.

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1. Introduction

1.1. Overview

Congratulations and thank you! You have just purchased one of the most reliable gas analyzers in the world. Before using the analyzer, please familiarize yourself with its operation by reading this manual. If you have any questions, please do not hesitate to call California Analytical Instruments for assistance. We want you to be a member of our thousands of satisfied customers.

1.2. Unpacking Instructions

Open the shipping container and carefully remove the analyzer from the packing materials. Inspect the instrument for any sign of damage. Remove the Top Cover retaining screws. Visually check for loose parts or connectors that are not properly seated. Verify all circuit boards and circuit board connections are secure. If all internal components look normal, re-install the cover.

1.3. Reporting Damage

Should there be any apparent damage to either the inside or outside of the instrument due to shipping or handling, immediately notify the shipper. The shipping container or packing materials should be retained for inspection by the shipper.

1.4. Contact Information

California Analytical Instruments, Inc.
1312 West Grove Avenue
Orange, CA 92865
714 974-5560
Fax 714 921-2531
Website: www.gasanalyzers.com

1.5. Warranty Certificate

Subject to the exceptions and upon the conditions stated below, California Analytical Instruments (CAI) warrants that the products sold under this sales order shall be free from defects in workmanship and materials for one year after delivery of the product to the original Buyer by CAI and if any such product should prove to be defective within such one year period, CAI agrees, at its option, either (i) to correct by repair or, at CAI's election, by replacement with equivalent product any such defective product, provided that investigation and factory inspection discloses that such defect developed under normal and proper uses, or (ii) to refund the purchase price. The exceptions and conditions mentioned above are as follows:

- a. components or accessories manufactured by CAI which by their nature are not intended to and will not function for one year are warranted only to give reasonable service for a reasonable time; which constitutes reasonable time and reasonable services shall be determined solely by CAI. A complete list of such components and accessories is maintained at the factory;
- b. CAI makes no warranty with respect to components or accessories not manufactured by it; in the event of defect in any such component or accessory CAI will give reasonable assistance to Buyer in obtaining from the respective manufacturer whatever adjustment is authorized by the manufacturer's warranty;
- c. any product claimed to be defective must be returned to the factory transportation charges prepaid and CAI will return the repaired or replaced product freight collect;
- d. if the product claimed to be defective requires on-site repair, such warranty labor will be provided at no charge; however, transportation and living expenses will be charged to Buyer;
- e. if the product is a consumable or the like, it is warranted only to conform to the quantity and content and for the period (but not in excess of one year) stated on the label at the time of delivery or 90 days;
- f. CAI may from time to time provide a special printed warranty with respect to a certain product, and where applicable, such warranty shall be deemed incorporated herein by reference;
- g. CAI shall be released from all obligations under all warranties, either expressed or implied, if any product covered hereby is repaired or modified by persons other than its own authorized service personnel unless such repair by others is made with the written consent of CAI.

IT IS EXPRESSLY AGREED THAT THE ABOVE WARRANTY SHALL BE IN LIEU OF ALL WARRANTIES OF FITNESS AND OF THE WARRANTY OF MERCHANTABILITY AND THAT CAI SHALL HAVE NO LIABILITY FOR SPECIAL OR CONSEQUENTIAL DAMAGES OF ANY KIND OR FROM ANY CAUSE WHATSOEVER ARISING OUT OF THE MANUFACTURE USE, SALE, HANDLING, REPAIR, MAINTENANCE OR REPLACEMENT OF ANY OF THE PRODUCTS SOLD UNDER THIS SALES ORDER. SOME STATES DO NOT ALLOW THE EXCLUSION OR LIMITATION OF INCIDENTAL OR CONSEQUENTIAL DAMAGES, SO THAT THE ABOVE LIMITATIONS OR EXCLUSIONS MAY NOT APPLY. THIS WARRANTY GIVES YOU SPECIFIC LEGAL RIGHTS, AND YOU MAY ALSO HAVE OTHER RIGHTS, WHICH VARY FROM STATE TO STATE.

Representations and warranties made by any person, including dealers and representatives of CAI, which are inconsistent, or in conflict with the terms of this warranty, shall not be binding upon CAI unless reduced to writing and approved by an expressly authorized officer of CAI.

2. Features

2.1. Description

The CAI Model 650 NO_x/O₂ Analyzer is a highly sensitive chemiluminescent (CLD) gas analyzer and a reliable paramagnetic oxygen analyzer. It measures oxides of nitrogen gas and dry basis oxygen concentrations in industrial and vehicle emission applications.

2.2. Features-General

The Model 650 NO_x/O₂ analyzer has a 3 by 5 inch liquid crystal display and a 20 key data/operation input keyboard. The 16 bit microprocessor control board consists of the MSR-Card with 16 digital inputs, 16 digital outputs, 16 analog inputs and 4 analog outputs. The analyzer can be manually operated from the keypad or remotely via TCP/IP or RS-232C communications. After turning on the analyzer, it needs at least 30 seconds for initialization. During this time, the screen is illuminated. The analyzer is available with an optional internal heated sample pump and internal zero and span solenoids.

IMPORTANT TIP: When the analyzer is powered up, it defaults to access level 1 (User). To operate ALL parameters, check the access level. See Section 7.5.13.

The contents of this operator's manual include:

- 9) Specifications
- 10) Installation Requirements, Mechanical & Electrical
- 11) Operation & Calibration Instructions
- 12) Reaction Chamber Description with Procedures for Disassembly of its Component Parts
- 13) Function Explanation of the Electronic Circuitry
- 14) Electrical Block Diagram

2.3. Model 650 CLD/Paramagnetic Specifications

DETECTORS	Chemiluminescence (CLD) Photodiode /Paramagnetic (O ₂)
NO/NO_x RANGES	0-1 to 3,000 ppm NO or NO _x (Four user-definable ranges) (Higher Ranges Available upon Request)
OXYGEN RANGE	0-25%
RESPONSE TIME	T90 < 3 Seconds to 60 Seconds Adjustable
RESOLUTION – DETECTION LIMIT	0.03 ppM NO/NO _x (Displays 5 significant digits)
REPEATABILITY	Better than 0.5% of Full Scale
LINEARITY	Better than 1.0% of Full Scale
NOISE	Less than 0.5% of Full Scale
ZERO & SPAN DRIFT	Less than 1% of Full Scale per 24 Hours
ZERO & SPAN ADJUSTMENT	Via front panel, TCP/IP or RS-232
CO₂ EFFECT	Less than 0.5% with 10% CO ₂
ADDITIONAL INTERFERENCE DATA	CO 1000 ppm – NA, HCN 28 ppm – N/A, SO₂ 500 ppm – N/A, NH₃ 10 ppm – N/A, N₂O 201 ppm – N/A
FLOW CONTROL	Electronic Proportional Pressure Controller
SAMPLE FLOW RATE	3.0 LPM ± 1 LPM
CONVERTER	Carbon Material @ 205°C > 98% to 100% Efficiency
OZONATOR	Ultraviolet Lamp
AIR OR O₂ REQUIREMENTS	Dry air less than 0.01 ppm NO _x at 250 cc/Min. @ 25 psig
NO/NO_x Control	Manual/Remote/Auto Cycle (Remote NO _x mode by dry contact closure)
OUTPUTS AVAILABLE	Scalable to 0-10 V or 4-20 mADC, RS232 and TCP/IP
DISCRETE ALARMS	General Fault/ TTL Logic (Ground True) Calibration Failure/ TTL Logic (Ground True) High Concentration (2 each)/ TTL Logic (Ground True)
DIGITAL DIAGNOSTICS	<ul style="list-style-type: none"> • Converter Temperatures • Cell Temperatures • Photodiode Temperatures • Air Pressures, Flow Rate and EPC Control Voltage • Sample Pressure, Flow Rate and EPC Control Voltage
KEYPAD DISPLAYS	<ul style="list-style-type: none"> • Factory Settings • TCP/IP Address • Scalable Analog Output Voltages • Passwords (4)Full • Scale Range Select • Auto Cal Times
SPECIAL FEATURES	<ul style="list-style-type: none"> • Calculated NO₂ values from empirically derived NO_x converter efficiencies • Auto Ranging • Auto Calibration (adjustable through internal clock)
DISPLAY	Back lit LCD
SAMPLE TEMPERATURE	50°C Non-condensing
CHAMBER TEMPERATURE	66°C
AMBIENT TEMPERATURE	5 to 40°C
AMBIENT HUMIDITY	Less than 90% RH Non-condensing
WARM-UP TIME	1 Hour
FITTINGS	1/4 Inch Tube
POWER REQUIREMENTS	115/230 (±10%) VAC; 50/60 Hz; 560 Watts
DIMENSIONS	5¼ H x 19 W x 23 D (Inches)
WEIGHT	48 Pounds

SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE

3. Installation

3.1. General

The instrument is designed for industrial applications. These installation instructions are for a typical site. Any questions regarding specific installation situations should be directed to Technical Service of California Analytical Instruments, Inc.

3.2. Site and Mounting

NOTE: The following precautions must be carefully observed:

- 1) Select a site free from direct sunlight, radiation from a high temperature surface, or abrupt temperature variations.
- 2) This analyzer is not suitable for installation outdoors.
- 3) Select a site where the air is clean. Avoid exposing the instrument to corrosive or combustible gases.
- 4) The instrument must not be subject to severe vibration. If severe vibration is present, use isolation mounts.
- 5) The instrument is designed for rack-mounting. Optional rack mount slides are available.
- 6) Do not install near equipment emitting electromagnetic interference (EMI).

NOTE: A rear supporting brace or equivalent is required if the optional rack mount slides were not purchased.

3.3. Electrical

All wiring is connected at the rear of the instrument. The AC power is connected to the power/fuse/switch as shown below:

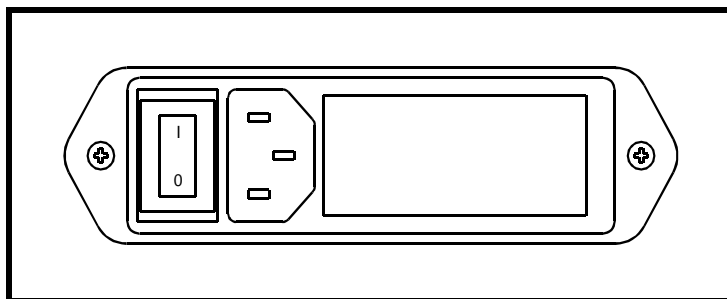


Figure 3-1 AC Power Switch, Connector, and Fuse

NOTE: A defective ground may affect the operation of the instrument. The output voltages are connected per Table 8.1.1. Shielded wiring is recommended for output signals.

CAUTION: Electromagnetic interference (EMI) may affect the operation of the instrument. Do not install the instrument in the vicinity of electrical noise (such as high frequency furnaces, electric welding machines, etc.). If the instrument must be installed at such locations, a separate power line must be used. Noise from a relay or solenoid valve should be controlled by the use of an EMI suppressor (RC circuit) across the power wiring close to the noise-generating component.

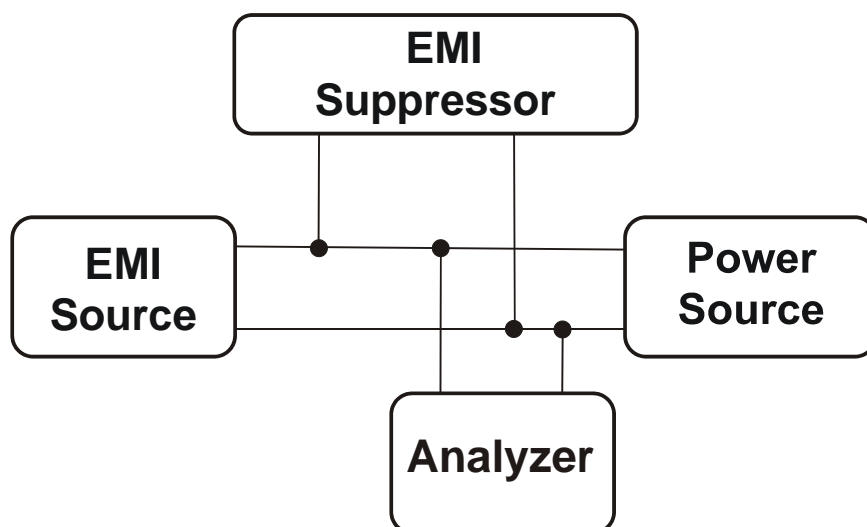


Figure 3-2 EMI Suppressor.

NOTE: The EMI Suppressor must be located close to the noise source.

3.4. Analog Output Connections (Appendix)

See Appendix for connector pinouts located on the analyzer rear panel. Remote range identification and range selection are obtained via the rear panel connections. When a range is selected, the corresponding control line is pulled low to zero VDC. Ranges not selected will remain at approximately 5 VDC. When remote range control is selected on the front panel switch, a contact closure is provided at the rear panel connector. Remote range selection is made by connection of the control line for the desired range to the analyzers zero VDC line provided in the connector. Five VDC is also provided. Remote NO_x On is selected by connection to the common line. This contact closure turns on the NO_x function by flowing the sample first through the NO/NO_x converter.

3.5. Gases

- 1) Air or O₂ (Ozone Air, < 1 ppm C) in pressurized cylinder.
- 2) Nitrogen or (zero air) in pressurized cylinder.
- 3) Standard span gas(es) near full scale concentration with a nitrogen balance, in a pressurized, certified cylinder.

3.6. Gas Handling Equipment

- 1) Pressure regulators for zero gas (Air or N₂), ozone supply (air or O₂) and span gas cylinders.
- 2) Corrosive resistant gas tubing.

NOTE: High levels of NH₃ (greater than 10 PPM NH₃) may reduce the NO₂ to NO Converter's conversion efficiency to a level that is unacceptable. It is therefore recommended that the customer purchase a commercially available NH₃ scrubber and install it in the path of the sample gas prior to its introduction into the analyzer.

3.7. Gas Connections

The tubing from the sampling system to the gas analyzer should be made from corrosive-resistant material such as Teflon or stainless steel. Even when the gases being sampled are corrosive themselves, rubber or soft vinyl tubing should not be used since readings may be inaccurate due to gas absorption into the piping material. To obtain fast response, the tube should be as short as possible. Optimum tube internal diameter is 0.16 inch (4 mm). Couplings to the instrument are ¼ Inch tube.

NOTE: Be sure tubing and joints are clean. Dust entering the instrument may cause it to malfunction.

3.8. Sampling Requirements

3.8.1. Filtration

Dust must be eliminated completely. Use filters as necessary. The final filter must be capable of removing particles larger than 4 microns.

3.8.2. Condensation

Dew point of the sample gases must be lower than the instrument temperature to prevent accidental condensation within the instrument. Bypass the sample through a dehumidifier to reduce the dew point to about 2 to 4°C or less. If the sample contains an acid mist, use an acid mist filter, cooler or similar device to remove all traces of the mist.

3.8.3. Presence of Corrosive Gases

Useful service life of the instrument will be shortened if high concentrations of corrosive gases such as Cl₂, SO₂, F₂, HCl, etc., are present in the sampled gas.

3.8.4. Gas Temperature

When measuring high temperature gases, take care that the maximum rating of the instrument 104 °F (50 °C) is not exceeded.

3.8.5. Pressure and Flow Rates

The air or oxygen supply entering the instrument is controlled by an electronically controlled proportional flow (EPC) controller. The regulator is factory adjusted for optimum analyzer performance. The ozone supply (Air or O₂) air cylinder pressure should be set at approximately 25 PSIG. The sample entering the instrument is controlled by a factory set precision electronically controlled proportional flow (EPC) controller. The EPC is factory set for optimum analyzer performance as indicated by the sample pressure. If the analyzer does not contain the optional internal sample pump, the sample gas entering the instrument should be at a pressure between 10 and 25 PSIG with a flow capacity at a minimum of 3 liters/min. If the analyzer contains the optional sample pump, do not apply a pressurized sample. The optional pump is capable of drawing a sample through a ¼ inch heated sample line of approximately 75 feet. The calibration/span gas cylinder pressures should be set at 25 PSIG for delivery into the optional zero and span inlets located on the rear panel.

NOTE: If the analyzer contains an optional internal sample pump, the introduction of a pressurized sample gas in excess of 1.5 PSIG will damage the pump.

3.8.6. Sample Gas Bypass Outlet (Vent)

A sample gas bypass outlet connector is located on the rear panel (¼ Inch Tube). Pressure at this outlet should be kept at atmospheric level. **ANY** backpressure will cause an error in reading. The vent outlet is located on the rear panel and may contain high levels of ozone which should be vented away from the instrument.

4. Basic Operation

The operation of the digital microprocessor conforms to the guidelines of the AK committee, originally developed in the German automotive industry. Via the serial port of the MSR-Card, the analyzer can be remote-controlled by a master computer. The serial communication fully corresponds to the specifications of the AK protocol. TCP/IP communication is also available.

4.1. Display

The analyzer's LCD display includes 16 lines with 30 characters each. The display also has background lighting that can be switched on and off via the Display key on the keyboard. The following example shows the measurement screen which is formatted into 4 information areas.

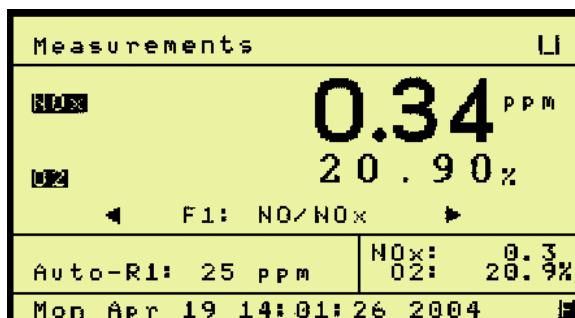


Figure 4-1 Measurement Screen

THE TOP INFORMATION AREA CONTAINS:

The AK Protocol Information. This capability is for advanced uses and may be toggled on and off in the setup screen, F5. Next to the symbol for the active operating mode, the device status is indicated. The status field is also displayed on all other screens.

SARE Aurorance enabled
SMGA Measuring gas is flowing
SMAN Device is in manual operation status
SWET What?

The level of Password Entry is shown on the right with 1 to 4 horizontal lines.

THE LARGE INFORMATION AREA CONTAINS:

The date portion of the screen.

THE THIRD INFORMATION AREA CONTAINS:

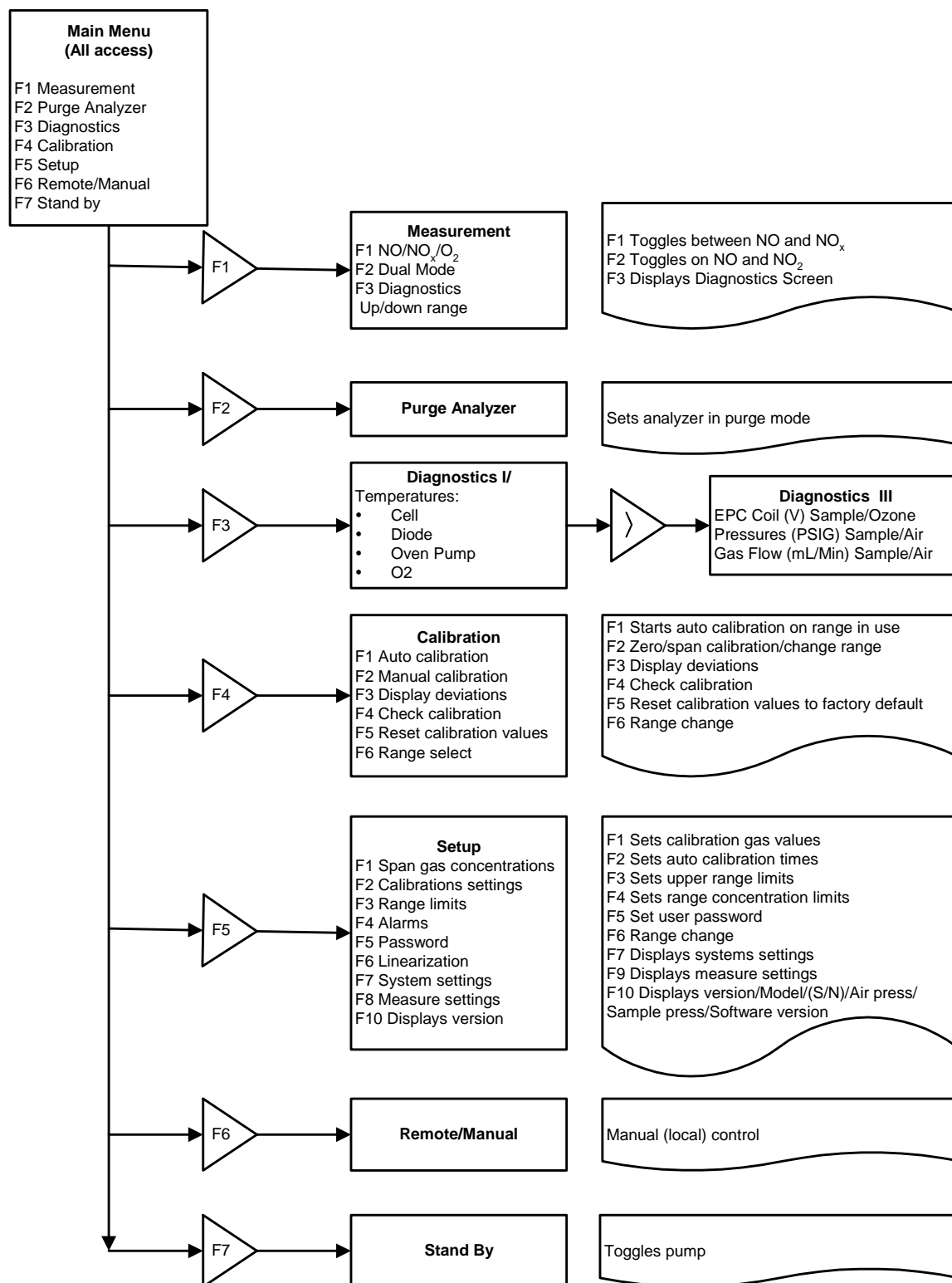
The help information for the parameter selected, ranges, etc.

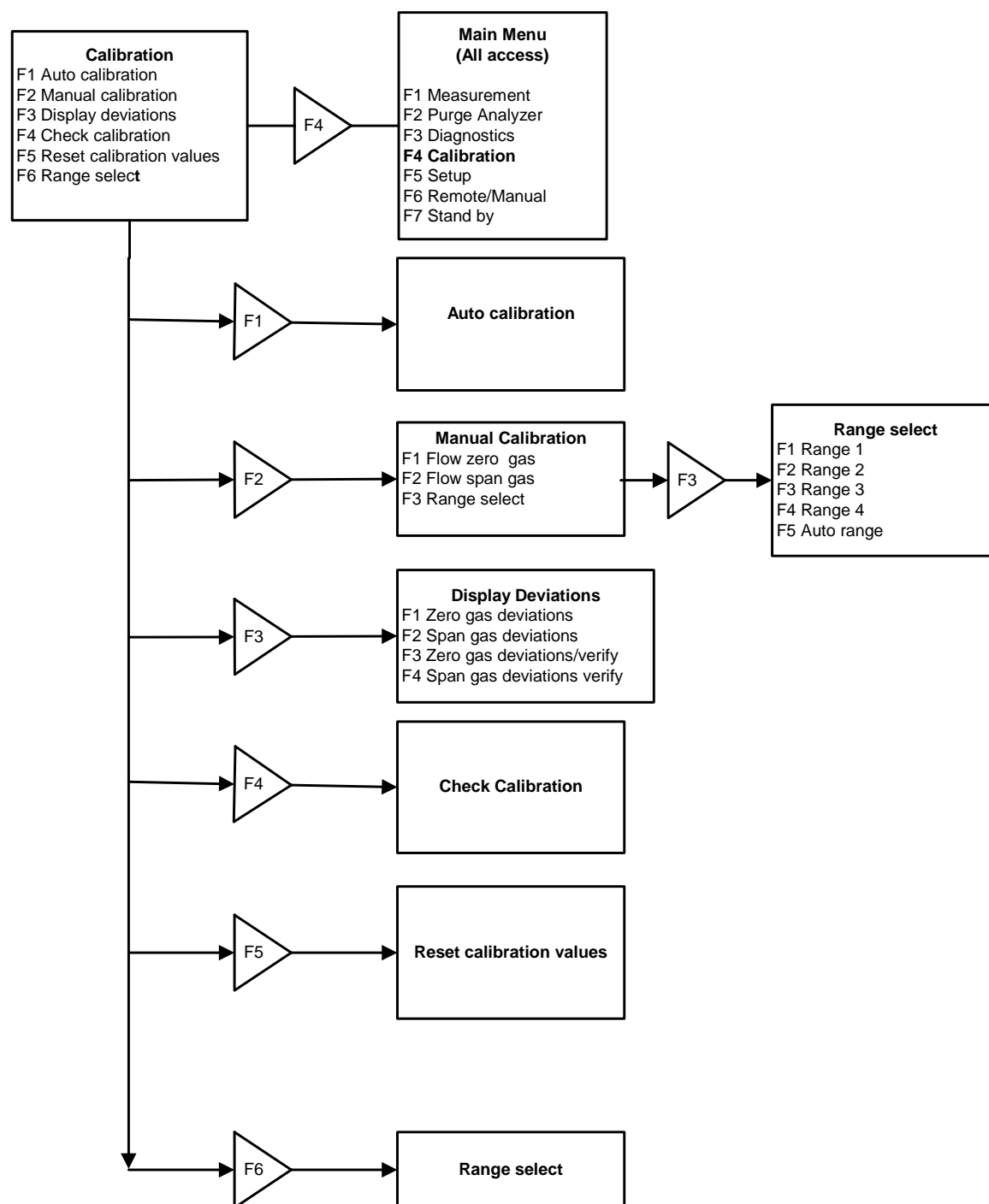
THE LOWER INFORMATION AREA CONTAINS:

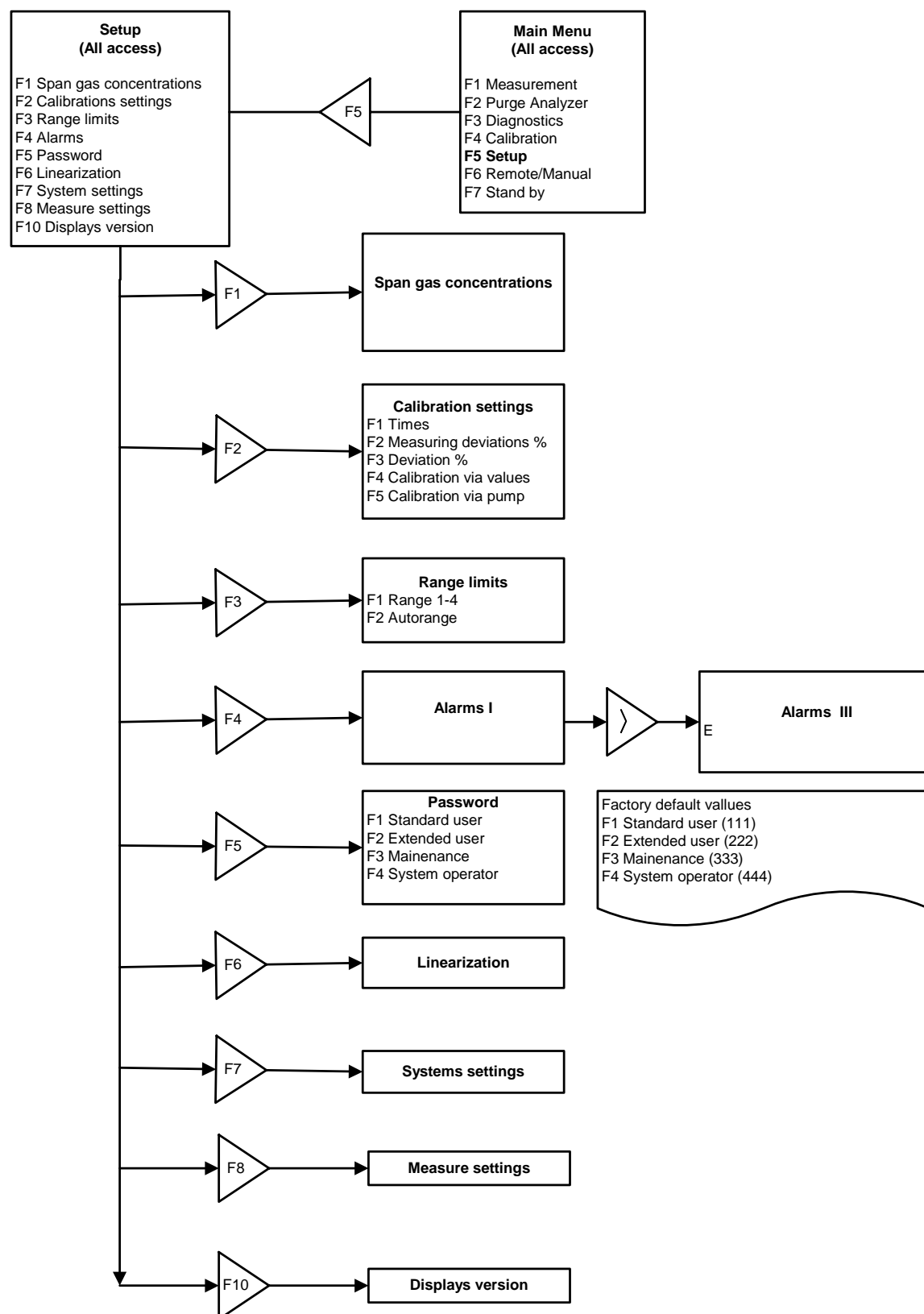
The time and date and any error condition.

The symbol in the bottom right corner indicates the keyboard mode. In the example shown, the keyboard is in the function key mode. For input fields, the mode is usually switched to numerical input. Then, an N appears in the lower right of the screen. This symbol is displayed on all screens.

4.2. Menu Tree







4.3. Keyboard

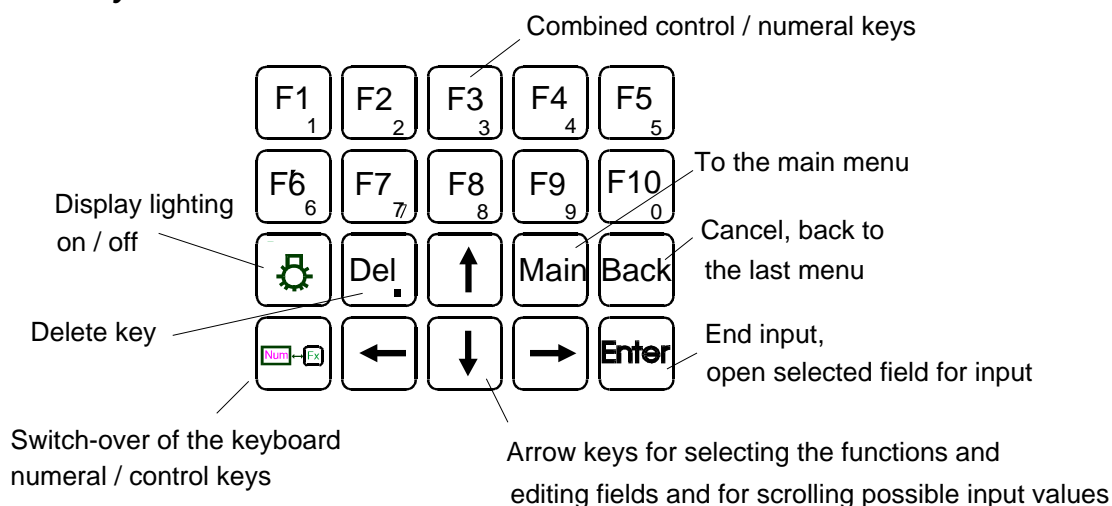


Figure 4-2 Keyboard

4.3.1. Operation with the Cursor Keys and the Enter Key

When operating the unit with the cursor keys, you select the various functions with the up/down cursor keys and start them with the Enter key. This method is particularly suitable for less proficient users since the system displays a short on-line help for nearly every function selected. The actual cursor position is shown as a black horizontal bar.

TIP: If you are not yet familiar with the screens and their fields, just press any cursor key after a screen appears. This moves the cursor from field to field and displays the corresponding online help.

4.3.2. Operation with the Function Keys

When using the function keys (F1 through F10), functions are directly accessed by pressing their corresponding function keys. This method is suitable for the advanced user since it is faster than the operation with the cursor keys.

4.3.3. Read/Change Parameters

To read and/or change parameters, you must switch to the parameter input mode by pressing the Enter key after calling the corresponding parameter screen. The input cursor (horizontal bar under the first character) then appears in the active edit field (black background). The cursor can be positioned with the right and left cursor keys, and the value displayed (number or letter) can be changed with the up and down cursor keys or entered directly. Every input has to be concluded by pressing the Enter key again, which causes the cursor to disappear.

5. Operating Structure

The analyzer's operation can be divided into four operating levels. The current level is always displayed as a stack of 1 to 4 horizontal bars in the top right corner of the screen. In the access level menu, you can choose between the following operating levels:

F1	User	(operating level 1)
F2	Advanced user	(operating level 2)
F3	Maintenance	(operating level 3)
F4	System user	(operating level 4)

A password can be assigned to each operating level. Only the system user, who normally has the highest operating priority, can assign the password. At the factory, the default passwords for the CAI analyzers are set as follows:

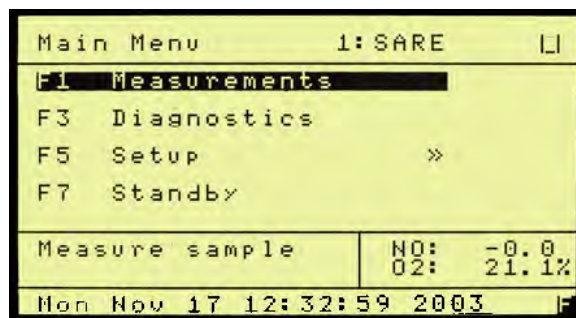
User:	111
Advanced user:	222
Maintenance:	333
System:	444

The default setting can be changed only by the system user. This manual is written to include all information for the advanced system user.

TIP: Because of the user settings, some of the parameters shown in this manual may not appear on your analyzer. Check the access level.

5.1. The Main Menu

Upon power up, the CAI logo is first displayed and then the main menu appears as below:



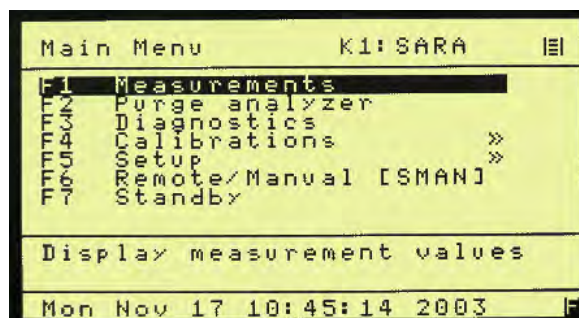
NOTE: Access Level Indication

Figure 5-1 Main Menu on Power Up Screen

NOTE: F6 is not available because, on initial start up, the analyzer reverts to ONLY Level 1 access. See Section 7.5.12 for setting Password information.

All functions can be selected with the cursor keys and activated by pressing the Enter key, or directly with the function keys F1 through F7. A ">" to the right of a function means that one or more sub-menus are available. If this sign is missing, the function starts immediately after the activation.

NOTE: Access level is 4.



NOTE: Access Level Indication

Figure 5-2 Main User Menu (Level 4)

6. Menu Structure

There are 4 operating levels based on the level of your password. This section shows the access rights of the single levels.

6.1. User Functions (Level 1)

Main Menu		Setup Menu		Password Menu	
F1	Measurements	F5	Password	F1	Enter password
F2	Purge Analyzer	F10	Version		
F3	Diagnostics				
F4	Calibrations				
F5	Setup				
F7	Standby				

6.2. Advanced User Functions (Level 2)

Main Menu		Setup Menu		Password Menu	
F1	Measurements	F3	Range Limits	F1	Enter password
F2	Purge Analyzer	F5	Password		
F3	Diagnostics	F10	Version		
F4	Calibrations				
F5	Setup				
F7	Standby				

6.3. Maintenance Functions (Level 3)

Main Menu		Setup Menu		Password Menu		System Settings Menu	
F1	Measurements	F1	Span Gas Concentration	F1	Enter password	F1	Real Time Clock
F2	Purge Analyzer	F3	Range limits	F2	Reset password	F5	Status Line on/off
F3	Diagnostics	F5	Password	F7	Auto Startup		
F4	Calibrations	F7	System Settings				
F5	Setup	F8	Measure Settings				
F7	Standby	F10	Version				

6.4. System User Functions (Level 4)

All function described in this manual may be accessed from Level 4.

7. Main Menu Function Descriptions

7.1. F1 Measurements

The measurements screen is activated by pressing F1 on the Main Menu screen.

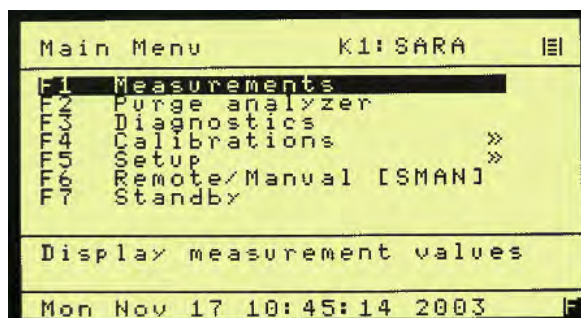


Figure 7-1 Main Menu Screen

7.1.1. F1 NO or NO_x Measurement

The NO/NO_x content is displayed in ppm. Pressing F1 switches between measuring the sample gas for NO_x or NO only. When the converter is off, only NO is measured. When the converter is on, NO_x is measured.

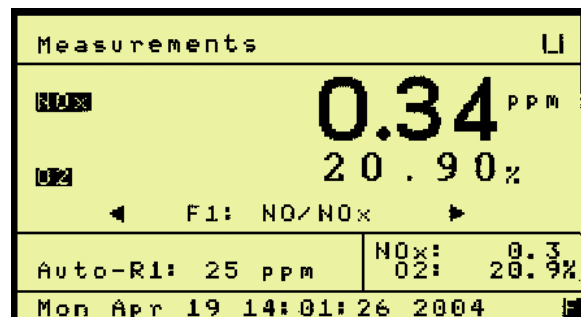


Figure 7-2 Measurements Screen

7.1.2. F2 NO + NO_x Measurement

The F2 function activates the “hold and sample” feature which allows the analyzer to automatically switch between NO and NO_x measurement. The time duration for the sample read is set up in the Setup Menu. The analyzer will read and display the NO (converter is bypassed) value. At the predetermined time, it will switch to the NO_x mode (through converter) and read and display the NO_x value, while the last 15 second NO average is displayed. The top value will be “real time” values and will change between NO and NO_x. The difference between the two average values is shown as NO₂. All three values are sent to the analog and digital outputs.

Measurements			[L]
NO	0.33	ppm	
NO	0.00	ppm	
NO ₂	0.00	ppm	
F1: NO/NO _x			
Auto-R1: 25 ppm		NO: 0.3	
		O ₂ : 20.9%	
Mon Apr 19 14:01:04 2004			

Figure 7-3 Measurement Screen

7.2. F3 Diagnostics

F3 activates the diagnostic screen where pressures, flow rates, temperatures and EPC control voltages are displayed in real time. The units are psig, degrees C, ml/min. and voltage. Use the arrow key to switch between diagnostic screens.

Diagnostics I			[L]
Temperatures: [°C]	Cell	: 65.97	
	Diode	: -5.00	
	Conv.	: 203.49	
	Oven	: 10.00	
	Pump	: 10.00	
	O ₂	: 40.33	
page 1/2		NO: -0.0	
next screen▶		O ₂ : 21.0%	
Mon Nov 17 12:32:59 2003			

Figure 7-4 First Diagnostics Screen

Diagnostics II			[L]
EPC Coil:	Sample:	6.92	
[V]	Ozone:	7.23	
Pressures: [PSIG]	Sample:	0.00	
	Air:	0.06	
Gas Flow: mL/Min	Sample:	1.57	
	Air:	24.56	
page 2/2		NO: -0.0	
◀previous page		O ₂ : 21.0%	
Mon Nov 17 12:32:59 2003			

Figure 7-5 Second Diagnostics Screen

7.3. Select Range

With the arrow keys, the ranges 1 to 4 can be selected and locked in which will disable the auto range capability. Continue pressing the arrow keys will recycle the analyzer back to auto range. The range and/or auto range is displayed on the measurement screen. If the limits are exceeded while not in the auto range mode, a warning "Over Range" appears on the screen.

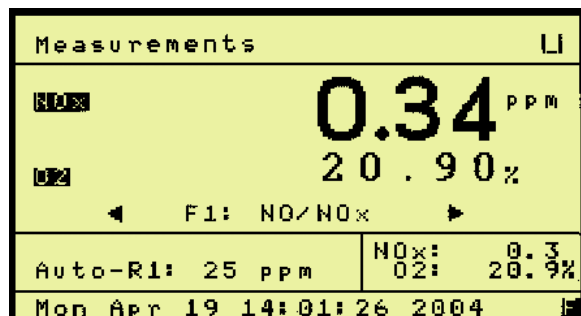


Figure 7-6 Set to Auto-Range

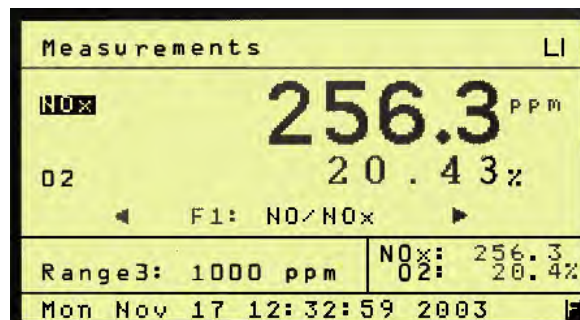


Figure 7-7 Analyzer set to Range 3

7.4. F2 Purge Analyzer

F2 from the Main Menu activates the Purge (analyzer) function if equipped.

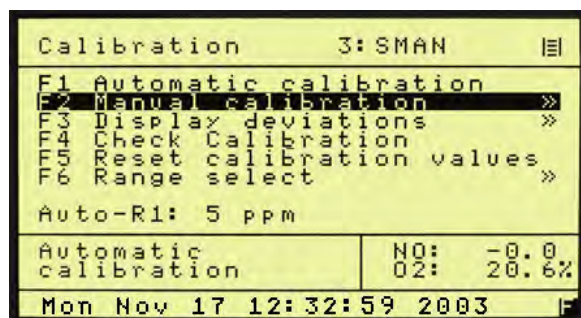


Figure 7-8 Main Menu (User Level 4)

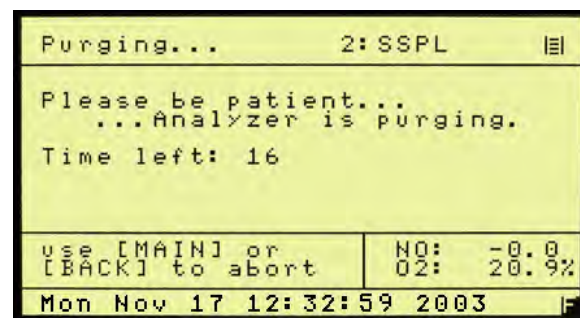


Figure 7-9 Purge Screen

Main Menu (User Level 4)

7.5. F3 Diagnostics

F3 from the Main Menu activates the Diagnostics function. As described in Section 7.1.3, F3 brings up the two diagnostics screens. The Diagnostics screens may be brought up from **EITHER** the Main Menu or the Measurements screen.

NOTE: Access level is 4.

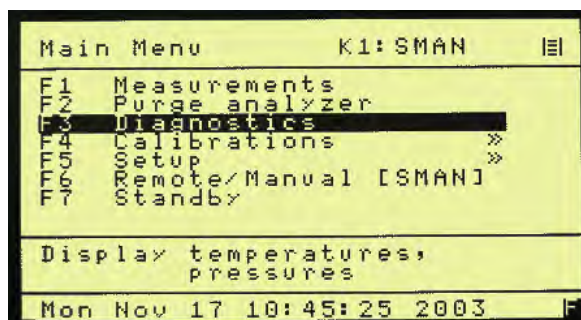


Figure 7-10 Main User Menu (Level 4)

7.6. F4 Calibrations

F4 from the Main Menu activates the Calibrations screen. Calibrations may be automatic or manual. Deviations can also be displayed. Calibration values can be reset to default values and the range to be calibrated can be changed.

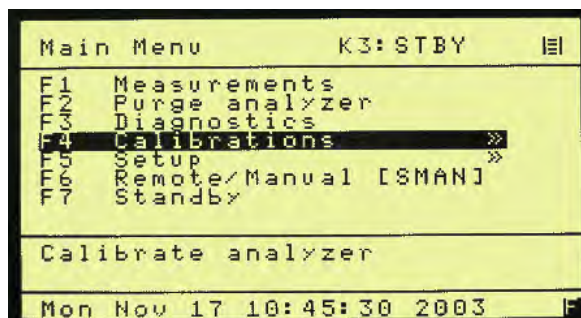


Figure 7-11 Main User Menu (Level 4)

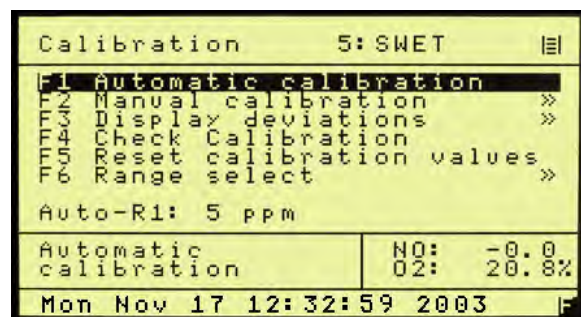


Figure 7-12 Calibration Screen (Level 4)

7.6.1. F1 Automatic Calibration

From the Calibrations screen, F1 starts automatic calibration. If auto range is selected, the actual range in use will be calibrated. Auto calibration works as follows: First zero gas is purged a certain time, called purge-time. Then the measurement begins. The measured value must be a minimum-time, called measuring-time and within an upper and a lower limit to be saved as new offset value. The maximum length of measuring time is 9 seconds. If the measured value was constant during calibration time, it is checked to determine if this value deviates from the preceding value. If the deviations are too large, a warning "Deviation error!" appears and the user can choose if the new value is saved or not. At last, the zero gas is flown a further time, verifying time, so it can be checked if the signal is still constant. All of these times can be changed. After zero gas calibration, the same happens with span gas. During auto calibration "Calibration in progress" is displayed. It also shows which gas is flowing and which time runs. When auto calibration has finished it is displayed. If the span value of the selected range is 0 (see section 5.6.1), then it will not be calibrated. If one range is calibrated and the span value for the lower ranges is zero, calibration parameters will be copied to this range. To calibrate all ranges with the same span gas, you must enter the gas concentration in the Span Gas Calibration screen for ALL RANGES. You must also calibrate each range. Offsets and scalars are NOT copied to other ranges.

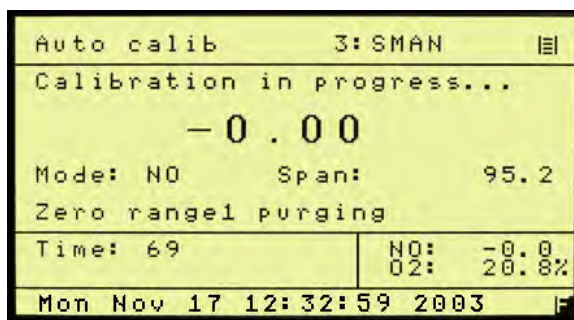


Figure 7-13 Auto Calibration Screen

7.6.2. F2 Manual Calibration

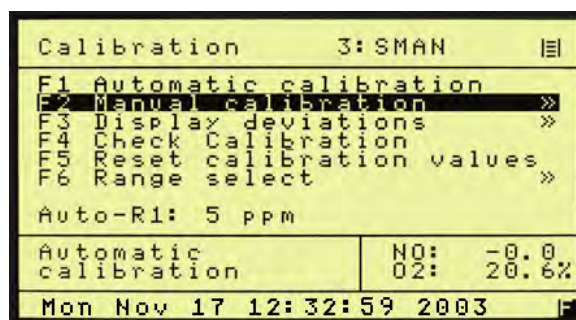


Figure 7-14 F2 Manual Calibration

From the Calibration screen, F2 starts manual calibration. If auto range is selected, calibration is not possible, and the appropriate range can be selected. In the manual calibrations menu, five options are possible:

- 1) F1 Flow zero gas
- 2) F2 Flow span gas
- 3) F3 Range select
- 4) F4 Flow zero O₂
- 5) F5 Flow span O₂



Figure 7-15 Manual Calibration Screen

When zero or span gas is flown, the measured value can be saved by pressing F1. If the screen is left by pressing the buttons "Main" or "Back", the measured value is not saved. Solenoids are closed by pressing F2.

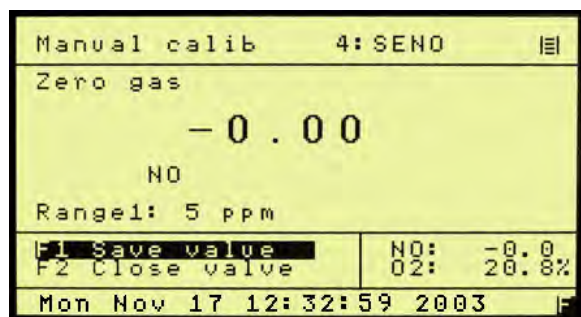


Figure 7-16 Manual zero gas calibration

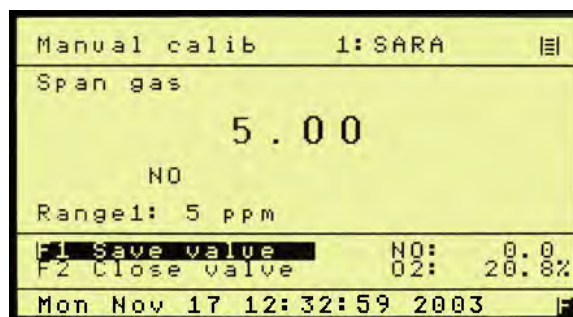


Figure 7-17 Manual Span gas calibration

From the manual calibration menu, the range to calibrate can be chosen by pressing F3.

Range select 3: SMAN	
F1 Range1	
F2 Range2	
F3 Range3	
F4 Range4	
F5 Auto Range	
Actual range:	
Range1: 5 ppm	N0: -0.0
	O2: 20.7%
Mon Nov 17 12:32:59 2003	

Figure 7-18 Range select

Range select 4: SEN0	
Selected range:	
Range1: 5 ppm	
F1 Measurements	
F2 Calibrations	N0: 0.0
	O2: 20.7%
Mon Nov 17 12:32:59 2003	

Figure 7-19 Selected range 1

Range select 3: SMAN	
Selected range:	
Range2: 300 ppm	
F1 Measurements	
F2 Calibrations	N0: -0.6
	O2: 20.7%
Mon Nov 17 12:32:59 2003	

Figure 7-20 Selected range 2

Range select 3: SMAN	
Selected range:	
Range3: 1000 ppm	
F1 Measurements	
F2 Calibrations	N0: -2.7
	O2: 20.7%
EPC Coil Sample Failure	

Figure 7-21 Selected range 3

Range select 2: SMGA	
Selected range:	
Range4: 3000 ppm	
F1 Measurements	
F2 Calibrations	N0: -2.1
	O2: 20.7%
Air Pressure Failure	

Figure 7-22 Selected range 4

Range select 1: SARE	
Selected range:	
Auto-R2: 300 ppm	
F1 Measurements	
F2 Calibrations	N0: -2.0
	O2: 20.7%
Mon Nov 17 12:32:59 2003	

Figure 7-23 Selected auto range

7.7. F3 Display Deviations

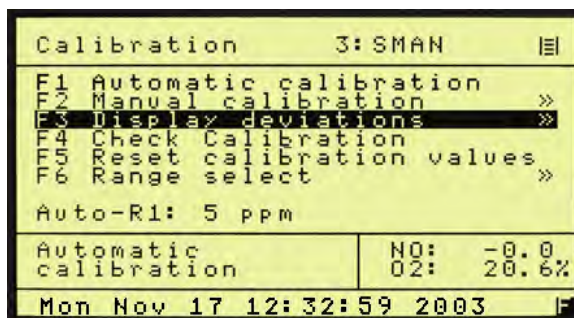


Figure 7-24 F3 Display deviations

After every calibration, the deviations are calculated for zero and for span gas.

- 1) F1 shows zero gas deviations
- 2) F2 shows span gas deviations
- 3) F3 Deviations of zero gas during verifying
- 4) F4 Deviations of span gas during verifying

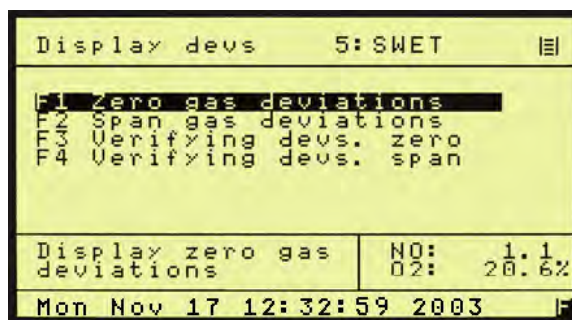


Figure 7-25 Display deviations screen

F1 and F2 deviations are displayed in percent.

During calibration there is verification for zero and span gas. With option F3 and F4 you can view the deviations during the verification time. Absolute deviation is the absolute average difference from the saved value in ppm. Relative deviation is the absolute average difference in percent, related to the range limit.

7.7.1. Absolute Zero Gas Deviation

Absolute zero gas deviation is zero gas content calculated by the factory polynomial related to the range limit of the calibrated range.

Zero gas devs 1: SARE		
Zero gas deviations [%]:		
	abs	rel
Range1:	-6.65	-2.52
Range2:	0.11	0.10
Range3:	0.25	0.02
Range4:	0.07	0.02
		N0: -0.0
		O2: 20.6%
Mon Nov 17 12:32:59 2003		

Figure 7-26 Zero gas deviations

Zero gas devs 2: SMGA		
Zero gas devs. verifying		
measured values	abs	rel
Range1:	0.00	0.00
Range2:	0.00	0.00
Range3:	0.00	0.00
Range4:	0.00	0.00
		N0: 0.0
		O2: 20.6%
Mon Nov 17 12:32:59 2003		

Figure 7-27 Zero gas deviations verifying

7.7.2. Relative Zero Gas Deviation

Relative zero gas deviation is the actual deviation minus the deviation of the previous calibration related to the range limit of the calibrated range.

7.7.3. Absolute Span Gas Deviation

Absolute span gas deviation is span gas bottle value minus span gas value calculated by the factory-polynomial related to the range limit of the calibrated range.

Zero gas devs 2: SMGA		
Zero gas devs. verifying		
measured values	abs	rel
Range1:	0.00	0.00
Range2:	0.00	0.00
Range3:	0.00	0.00
Range4:	0.00	0.00
		N0: 0.0
		O2: 20.6%
Mon Nov 17 12:32:59 2003		

Figure 7-28 Span gas deviations

Span gas devs 3: SMAN		
Span gas devs. verifying		
measured values	abs	rel
Range1:	0.00	0.00
Range2:	0.00	0.00
Range3:	0.00	0.00
Range4:	0.00	0.00
		N0: 0.0
		O2: 20.6%
Mon Nov 17 12:32:59 2003		

Figure 7-29 Span gas deviations verifying

7.7.4. Relative Span Gas Deviation

Relative span gas deviation is the actual deviation minus the deviation of the previous calibration related to the range limit of the calibrated range.

7.7.5. F4 Check Calibration

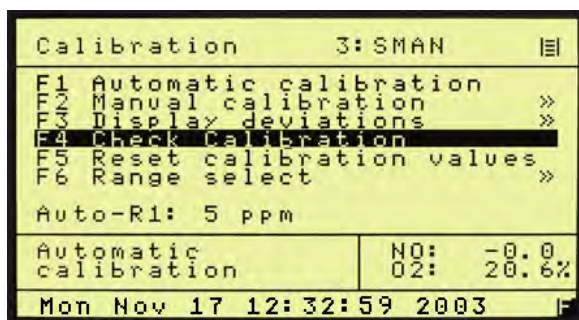


Figure 7-30 F4 Check calibration

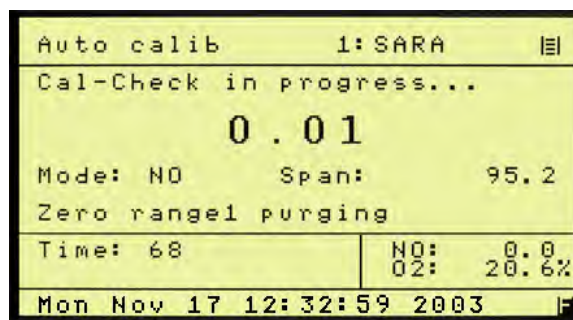


Figure 7-31 Check Calibration

There is a default calibration. Pressing F4, activates an automatic zero and span check for verification.

7.7.6. F5 Reset Calibration Values

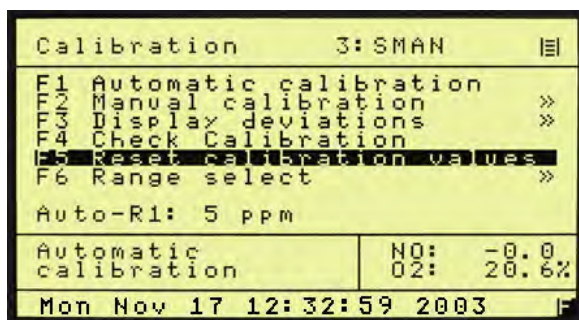


Figure 7-32 F5 Reset calibration values

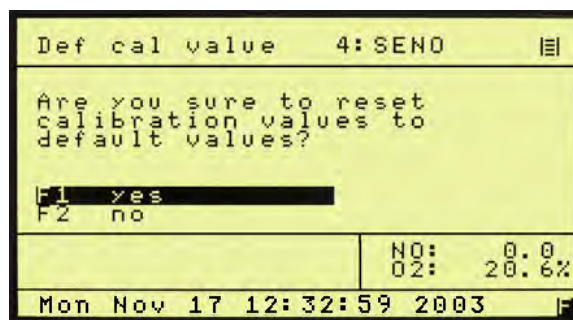


Figure 7-33 Reset calibration values

There is a default calibration. Pressing F5, a new screen appears and asks if the user is sure to reset calibration values to the default calibration values. F1 confirms and the calibration values are reset to default calibration values. F2 leaves this menu without resetting to default values. This function will overwrite all calibrations with factory values. Also the linearization polynom will be overwritten with the factory values.

7.7.7. F6 Range Select

This allows a range change to be activated from the calibration menu.

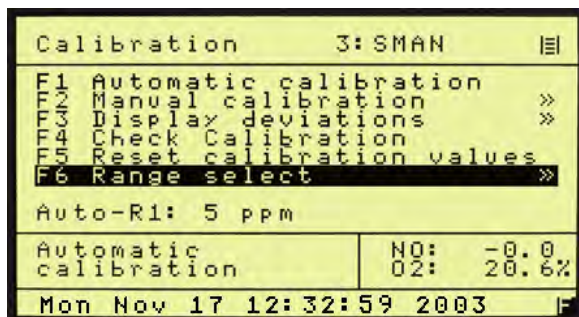


Figure 7-34 Range Select

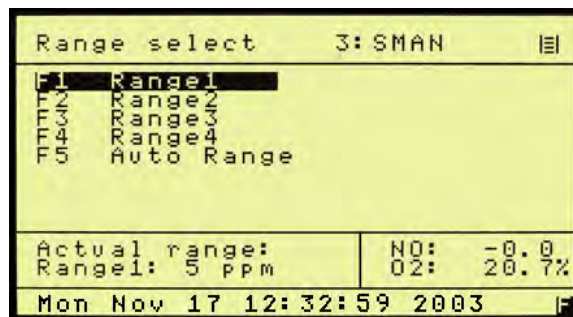


Figure 7-35 Range

7.8. F5 Setup

From the Main Menu, F5 brings up the setup menu. Span gas concentrations, calibration settings, range limits, alarms, password, linearization, system and measure settings can be changed. The Setup menu begins as shown below. A description of each parameter is shown in the information box. NOTE: Use the down arrow key to obtain the additional setup parameters.

Main Menu		1: SARE	LI
F1	Measurements		
F3	Diagnostics		
F5	Setup	»	
F7	Standby		
Measure sample		NO: -0.0	
		O2: 21.1%	
Mon Nov 17 12:32:59 2003			

Figure 7-36 Main menu (User level 4)

Setup		2: STBY	LI
F1	Span gas concentrations	»	
F2	Calibration settings	»	
F3	Range limits	»	
F4	Alarms	»	
F5	Password	»	
F6	Linearization	»	
F7	System settings	»	
F8	Measure settings	»	
Change span gas concentrations		NO: 0.0	
		O2: 20.5%	
Mon Nov 17 12:32:59 2003			

Figure 7-37 Setup menu 1

Setup		3: SMAN	LI
F2	Calibration settings	»	
F3	Range limits	»	
F4	Alarms	»	
F5	Password	»	
F6	Linearization	»	
F7	System settings	»	
F8	Measure settings	»	
F10	Version		
Set Times, Tolerances		NO: 0.0	
		O2: 20.6%	
Mon Nov 17 12:32:59 2003			

Figure 7-38 Setup menu 2

7.8.1. F1 Span Gas Concentration

For calibration, it is necessary to input the concentration of the span gas in ppm. For every range, the span gas concentration can be changed. After pressing F1 in the setup menu, a screen appears in which changes can be made. Select with the cursor buttons the range to change. The selected field turns black. To change parameters, switch to parameter input mode by pressing the Enter key. The input cursor (horizontal bar under the first character) then appears in the active edit field (black background). The cursor can be positioned with the right and left cursor keys, and the value displayed (number or letter) can be changed with the up and down cursor keys or entered directly. Every input has to be concluded by pressing the Enter key again. Then the input cursor disappears and a new range can be selected. The changes are saved by leaving the screen by pressing "Main" or Back". At the right side of the screen, the range limits of the 4 ranges are displayed. They cannot be changed in this screen.

Setup		5: SWET	
Span gas conc. range limits			
Range1:	95.200	5	
Range2:	270.000	300	
Range3:	1000.000	1000	
Range4:	3000.000	3000	
O2:	21.000		
		NO:	0.0
		O2:	20.6%
Mon Nov 17 12:32:59 2003			

Figure 7-39 Change span gas settings

7.8.2. F2 Calibration Settings

In the calibration settings menu, times, deviations and methods can be changed.

Setup		4: SENO	
F1 Times			
F2	Measuring deviations		
F3	Deviations		
F4	Calib. via valves		
F5	Calib. via probe		
Change automatic		NO:	0.0
calib. times		O2:	20.5%
Mon Nov 17 12:32:59 2003			

Figure 7-40 Change Auto Calibration Settings

7.8.3. F1 Times

There are four times (in seconds) for auto calibration that can be changed. Purge, measuring, calibration and verifying time. Changes are made and saved as above.

Setup		3: SMAN	⏏
Auto calibration times [sec]			
Purge	:	10	
Measuring	:	10	
Calibration	:	40	
Verifying	:	10	
Purge after	:	10	
		NO:	0.0
		O2:	20.5%
Mon Nov 17 12:32:59 2003			

Figure 7-41 Setup-times

7.8.4. F2 Measuring Deviations

During auto calibration, the measured value is only saved if it is within a certain time within an upper and a lower limit. These two limits format a working window. In the setup menu the deviation is in percent.

Setup		5: SWET	⏏
Measuring deviation[%]			
Range1:	2.00		
Range2:	2.00		
Range3:	2.00		
Range4:	2.00		
		NO:	0.0
		O2:	20.5%
Mon Nov 17 12:32:59 2003			

Figure 7-42 Measuring deviations

7.8.5. F3 Deviations

Here you can change absolute and relative deviation in percent. After auto calibration, it is checked to assure the deviations are within this limit. If the deviations are not in this limit, a warning "Deviation error!" appears.

Setup		1: SARA	⏏
Deviations[%]			
	absolute	relative	
Range1:	10.00	10.00	
Range2:	10.00	10.00	
Range3:	10.00	10.00	
Range4:	10.00	10.00	
		NO:	0.0
		O2:	20.5%
Mon Nov 17 12:32:59 2003			

Figure 7-43 Absolute versus relative deviations

7.8.6. F4 Calibrations via Solenoids

Calibrations can be made by using the solenoids for zero and span gas or by using the pump. Calibration via valves means that the zero gas is flown by the zero gas solenoid and the span gas is flown by the span gas solenoid.

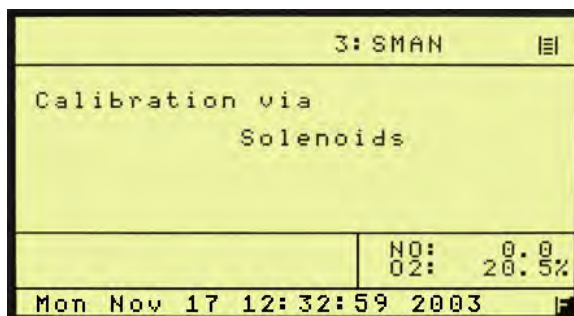


Figure 7-44 Calibrations via internal solenoid valves

7.8.7. F5 Calibration via Probe

Calibration via probe means that the zero and the sample gas is flown by the sample pump, the solenoids for zero and span gas are not used.

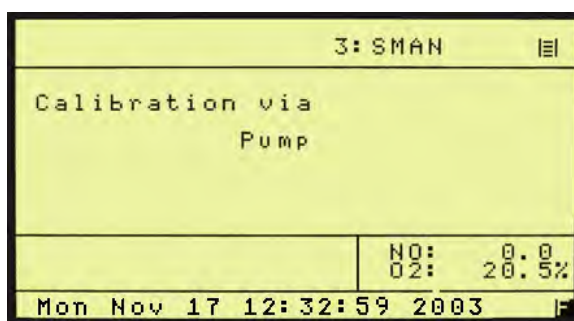


Figure 7-45 Calibration via probe

7.8.8. F3 Range Limits

There are 4 different ranges. The user can define the upper range limits in ppm.

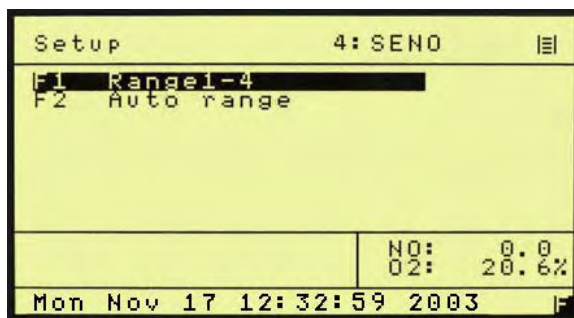


Figure 7-46 Change Range Limits

7.8.9. F1 Range 1-4 (Change Upper Range Limits)

In this menu the upper range limits can be changed. The new settings are saved by pressing MAIN or BACK. The auto range limits are automatically adapted. This means that if the upper range limit of range 1 for example has reached 90% of the upper range limit in the auto range mode, it is switched automatically to the second range.

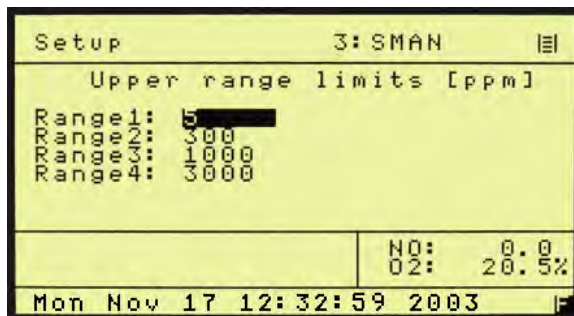


Figure 7-47 Change Upper Range Limits

7.8.10. F2 Change Auto Range Limits

Although the auto range limits are adapted automatically, it is possible to define them manually. Up means the value when the next higher range is selected in auto range mode, down the value when the next lower range is selected.

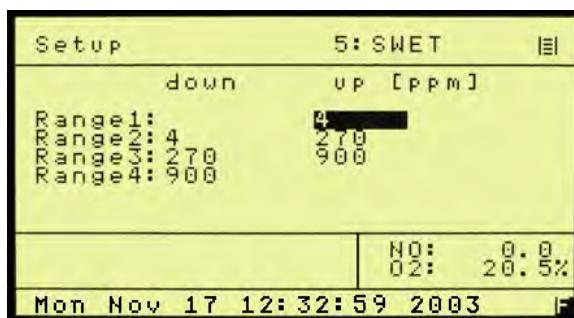


Figure 7-48 Change Auto Range Limits

7.8.11. Alarms

Error reports are always displayed in the lowest line of the screen. There are two pressures, three temperatures, one concentration and two voltages with alarm limits that can be defined. The user can define the range limits and, if exceeded, will display an error-message.

Alarms I		1: SARA	
-Temps:	Cell :	Min 65.00	Max 67.00
	Diode:	-5.50	-4.50
	Conv.:	204.00	207.00
	Oven :	65.00	67.00
	Pump :	65.00	67.00
	O2 :	1.00	5.00
page 1/2		NO: 0.0	
F1 - next page		O2: 20.5%	
Mon Nov 17 12:32:59 2003			

Figure 7-49 Set Temperature Alarms

Alarms II		1: SARA	
-Conc. alarms:		Min 500	Max 750
-Press:	Sample	3.82	3.88
	Air	14.00	16.00
-EPC:	Sample	1.00	6.00
	Air	1.00	5.00
page 2/2		NO: 0.0	
F1 previous page		O2: 20.5%	
Mon Nov 17 12:32:59 2003			

Figure 7-50 Set Concentration, Pressure and Voltage Alarms

7.8.12. Password

After turning on the analyzer, you are in access level 1. To change the access level or to change the passwords, press F5 (Setup) in the main menu and Press F5 (Password) again. The following screen appears:

Setup		1: SARA	
F1	Enter password		
F2	Change password		
F3	Reset passwords		
Enter password		NO: 0.0	
		O2: 20.5%	
Mon Nov 17 12:32:59 2003			

Figure 7-51 Enter / Change Password

7.8.13. F1 Enter Password

To change access level, press F1. The following screen appears:



Figure 7-52 Access Level Screen

F1 to F4 selects an access level. Move the cursor to the access level to be modified. You must enter the correct password for the access level desired. The passwords for the various operation levels consist of three numbers that must to be entered on the numeric keypad. If the code word is incorrect, you are asked to re-enter the codeword.

IMPORTANT TIP: When a new analyzer is powered up, it defaults to access level 1 (User). To operate ALL parameters and gain complete access, select F4. Press the Enter key twice and enter 444.

7.8.14. F2 Change Password

The passwords can only be changed, if you are in access level 4. After F2, enter your new 3 digit passwords.

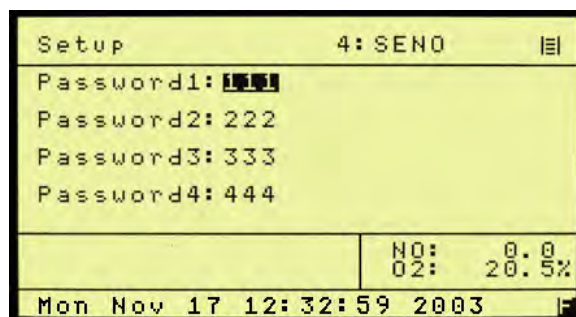


Figure 7-53 Passwords

IMPORTANT TIP: You MUST remember and record this new password. If this is lost, you will need to consult the factory for the default password!

7.8.15. F3 Reset Passwords

The passwords can only be changed, if you are in access level 4. Reset passwords will revert back to the factory defaults.

7.8.16. Linearization

Pressing F6 on the Setup screen brings up the Linearization screen. The analyzer can be linearized by a polynomial with 5 coefficients. By pressing F1, these 5 coefficients can be changed for each range. By pressing F2, the raw value can be displayed. This is the value before linearization and offset span correction. There are two values on the screen: The value at the top is the linearized, offset-span-corrected value, and the other value is the raw-value.

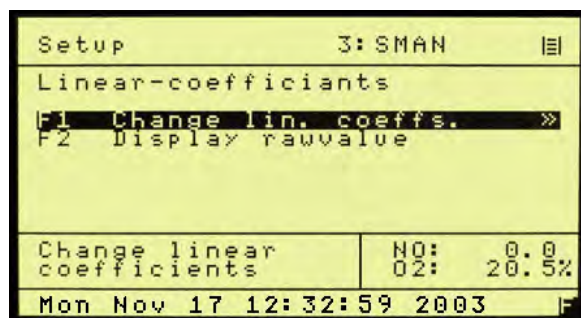


Figure 7-54 Linearization Screen

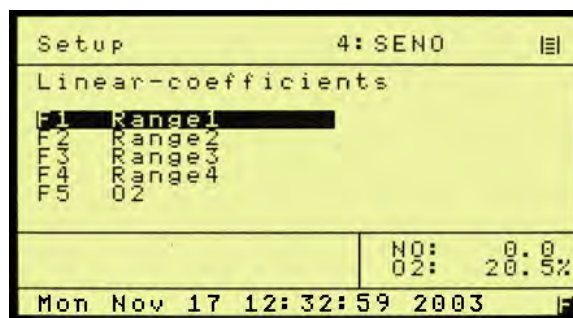


Figure 7-55 Coefficients Range Select



Figure 7-56 Linearization Coefficients

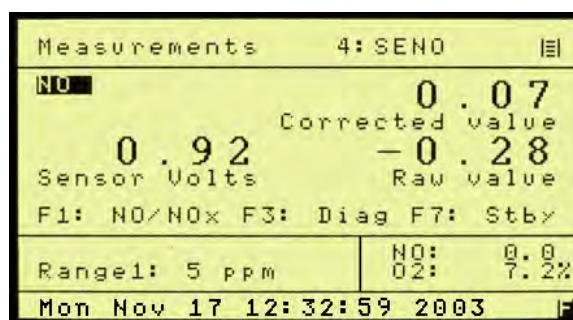


Figure 7-57 Range Raw Data with F2

7.8.17. F7 System Settings

This screen allows all the system settings to be displayed and modified.



Figure 7-58 system settings



Figure 7-59 System Setup Screen

7.8.18. F1 Real Time Clock

This brings up the clock time set screen; auto cal and auto cal enable screens.



Figure 7-60 Clock and Timing Setup Screen



Figure 7-61 Set Clock Screen

F1 brings up the clock set screen

The current time may be set by using the cursor to highlight the entry and using the numeric keys to change the values.

7.8.19. F2 Set autocalibration time

F2 brings up the autocalibration time set. As above, the date and times can be set by using the cursor to highlight the entry and using the numeric keys to change the values.

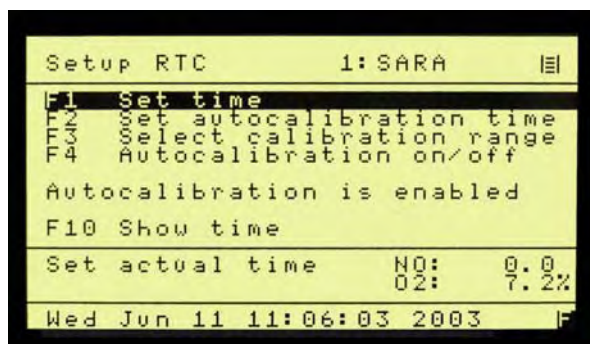


Figure 7-62 Select autocalibration time

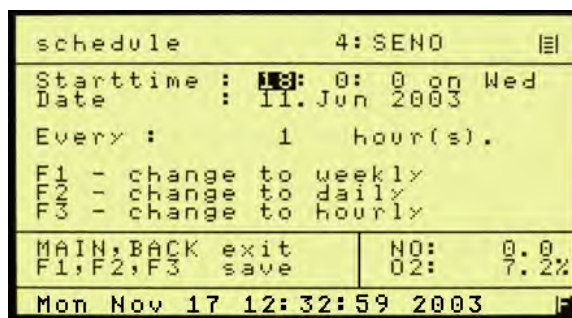


Figure 7-63 Set Autocalibration Cal Timing

7.8.20. F3 Set Auto Cal Ranges

Setup RTC		1: SARA		⏏
F1	Set time			
F2	Set autocalibration time			
F3	Select calibration range			
F4	Autocalibration on/off			
Autocalibration is enabled				
F10	Show time			
Set actual time		N0:	0.0	
		O2:	7.2%	
Mon Nov 17 12:32:59 2003				

Figure 7-64 Clock and Timing Setup Screen

7.8.21. F4 Autocalibration on/off

Setup RTC		2:STBY		[Menu]	
F1	Set time				
F2	Set autocalibration time				
F3	Select calibration range				
F4	Autocalibration on/off				
Autocalibration is disabled					
F10	Show time				
enable/disable autocalibration			N0:	0.0	
			O2:	7.2%	
Mon Nov 17 12:32:59 2003					

Figure 7-65 F4 Toggles Auto Cal ON of OFF

7.8.22. Auto calibration

Displays system time and status of autocalibration.

Actual time		5: SWET	
System time :			
Wed Jun 11 11:20:08 2003			
Next autocalibration :			
autocalibration off			
use [BACK] or		N0:	0.0
[MAIN] key		O2:	7.2%
Mon Nov 17 12:32:59 2003			

Figure 7-66 Autocalibration Status

7.8.23. F2 Displays TCP/IP Address

TCP/IP setup		3: SMAN	
IP-address:	192.000.000.246		
Netmask :	255.255.255.000		
Port :	7700		
Gateway :	255.255.255.000		
WinifPort:	2000		
HWaddress :	00.E0.4B.01.9D.F5		
Reboot for new settings		NOx: 255.4	
		O2: 20.3%	
Mon Nov 17 12:32:59 2003			

Figure 7-67 TCP/IP Address

7.8.24. F3 Displays Output Signal Assignments
(Used to Adjust Analog Output Channels)

assignment		5: SWET	
Output	Signal	Error on AOut	
1	RealTime	On	
2	02		
3	RealTime		
4	02		
		NOx: 255.3	
		O2: 20.4%	
Mon Nov 17 12:32:59 2003			

Figure 7-68 Output Assignments

7.8.25. F4 Displays Output Ranges
(Used to Adjust Scale of Analog Output Channels)

output ranges		5: SWET	
Output	Limit		
	lower	upper	Mode
1	4	21	mA
2	4	20	mA
3	0	0	mA
4	0	0	mA
0 in both fields use default range		NOx: 255.1	
		O2: 20.3%	
Mon Nov 17 12:32:59 2003			

Figure 7-69 Output Ranges

7.8.26. F5 Turns Status Line On or Off

The status line displays the AK Protocol action on the top line of the display.



Figure 7-70 Status Line

7.8.27. F8 Measure Settings

This screen allows several of the system settings to be displayed and modified.

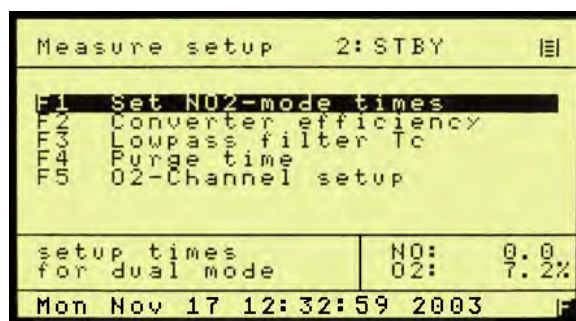


Figure 7-71 Menu Settings Screen

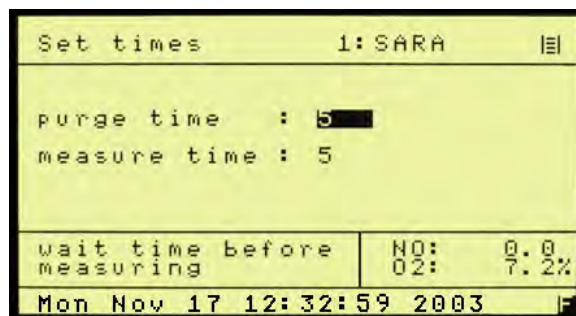
7.8.28. Set NO₂ Mode Times

Figure 7-72 Set NO₂ Purge and Measure Time

7.8.29. F2 Converter Efficiency

F2 on the Menu Settings screen allows the NO to NO₂ converter efficiency to be set to the actual measured converter efficiency. A value of 100% equals 1.00. F2 will prompt the operator through the NO_x efficiency test using a NO_x generator.

Setup 4: SENO	
Converter efficiency	
current : 1.00	
F1 - run auto calculation	
enter converter efficiency	
NO:	0.0
O2:	7.2%
Mon Nov 17 12:32:59 2003	

Figure 7-73 Set Converter Efficiency

7.8.30. Low Pass Filter Time Constant

F3 on the Menu Settings screen allows the software time constant to be set between 1 and 60 seconds. This is very useful in eliminating noise when measuring low level concentrations.

Lowpass filter K2: SMAN	
enter time constant of sample lowpass filter :	
Time constant (0..60): 1	
enter 0 to disable filter	
Mon Nov 17 11:06:21 2003	

Figure 7-74 Set Time Constant

7.8.31. F4 Purge Time

F4 on the Menu Settings screen sets the purge time before continuing with a zero or span calibration.

Purge Time K2: SARA	
Purge time : 15	
(this time is different to the one entered in calibration time setup)	
Mon Nov 17 11:06:29 2003	

Figure 7-75 Set Purge Time

7.8.32. F10 Displays the Current Analyzer and Software Versions

This displays the analyzer's information, including the factory recommended air and sample pressure settings.

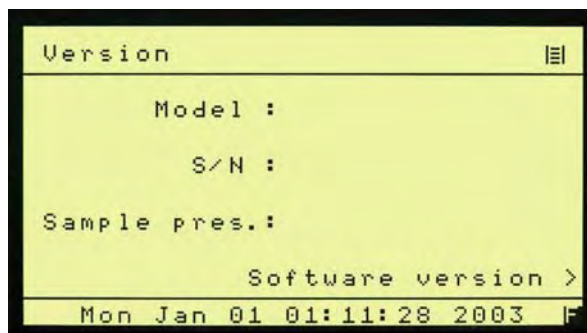


Figure 7-76 Analyzer Information Version

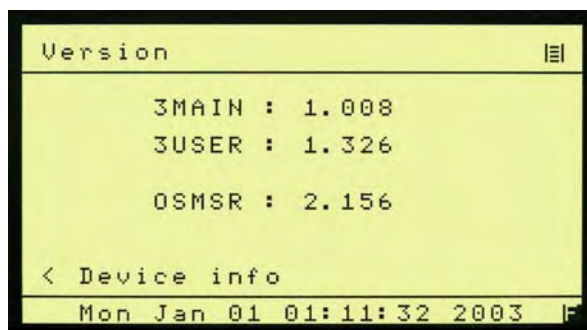


Figure 7-77 Software Version

7.9. F7 Remote / Manual Control

The analyzer can be remote-controlled by either a master computer or via contact closures. The TCP/IP and serial communication fully corresponds to the specifications of the AK protocol. To change remote/manual control, press F6 in the main menu. This toggles between remote and manual control.



Figure 7-78 Remote manual control

Main Menu (User Level 4)

7.10. F8 Standby

In Standby mode, pump is turned off and the solenoids are closed. The CAI logo is displayed.

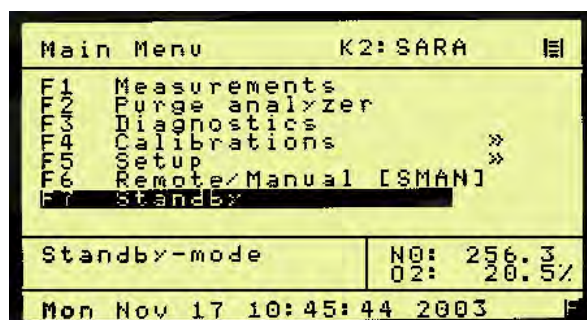


Figure 7-79 Standby selection

Main Menu (User Level 4)

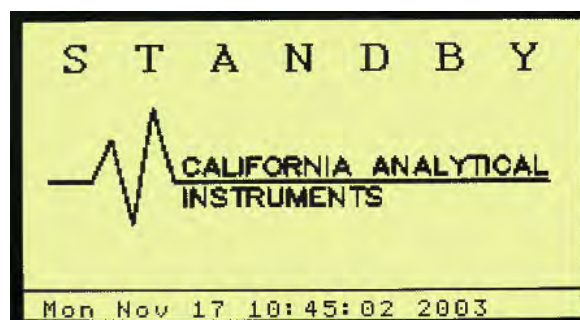


Figure 7-80 Standby screen

8. Analyzer Components

8.1. Rear Panel

The following details the rear panel connections:

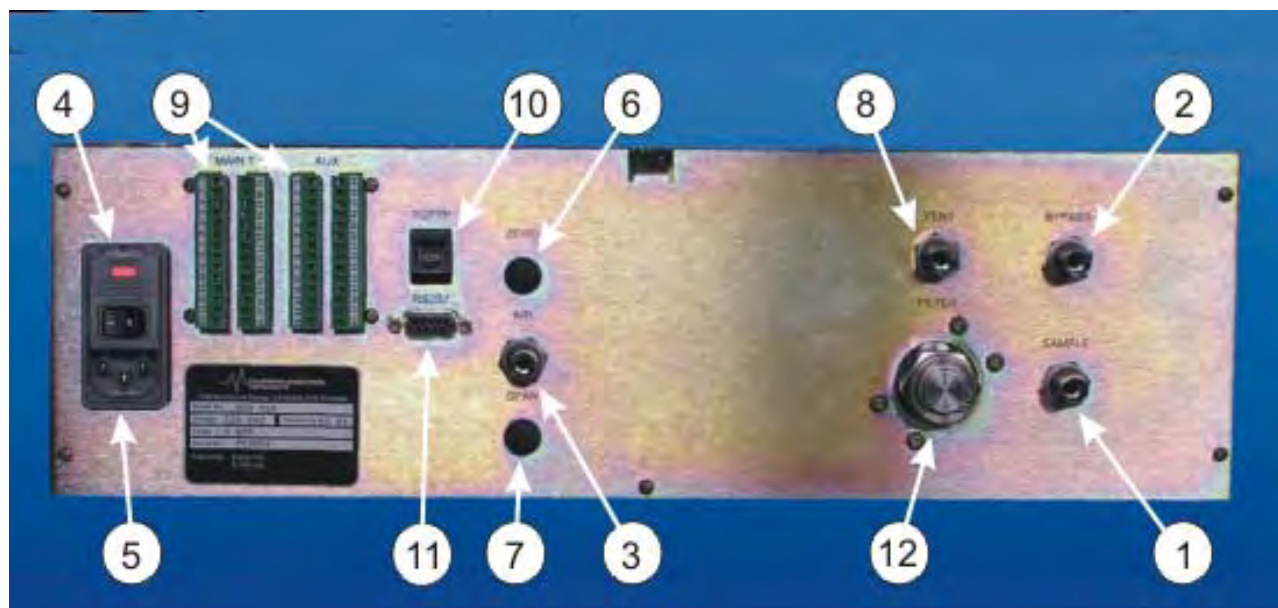


Figure 32: Rear Panel

- 1) Sample Gas Inlet: Feeds sample gas to the analyzer. ¼ Inch Tube.
- 2) Sample Gas Bypass Outlet: Exhaust for sample. ¼ Inch Tube.
- 3) Air Inlet: For feeding hydrocarbon free air or oxygen to the ozone generator.
- 4) Power Entry Module: Power connection, power switch, fuse compartment (2 Amp).
- 5) Rear Panel Power ON/OFF Switch: Turns ON/OFF line power to instrument.
- 6) Zero Gas Inlet: For feeding hydrocarbon free zero air to the analyzer. (Optional)
- 7) Span Gas Inlet: For feeding calibration gas to the analyzer. (Optional)
- 8) Vent: Exhaust from reaction chamber, ¼ inch tube fitting.
- 9) Output Connectors: Analog Outputs and Remote Functions.
- 10) TCP/IP Port to Network Connector.
- 11) Serial Port to Serial Connector
- 12) Filter: Analyzer Filter Housing

8.2. Main Connector (Standard 28 Pin Connector)**8.2.1. Main Connector (Standard 28 Pin Connector)**

Pin	Signal	Function	Pin	Signal	Function
1	Analog Output	Ground (Analog)	15	Digital Input	Control Range 3
2	Analog Output	Real Time	16	Digital Input	Control Range 4
3	Analog Output	NO	17	Digital Input	Auto Cal
4	Analog Output	NO ₂	18	Digital Input	Calibrate
5	Analog Output	O ₂	19	Digital Input	Zero
6	Digital Output	Ground (Digital)	20	Digital Input	Span
7	Digital Output	Sense Auto Range	21	Digital Input	Pump
8	Digital Output	Sense Range 1	22	Digital Output	Zero Gas Flow
9	Digital Output	Sense Range 2	23	Digital Output	Span Gas Flow
10	Digital Output	Sense Range 3	24	Digital Output	Sample Gas Flow
11	Digital Output	Sense Range 4	25	Digital Output	Local/Remote
12	Digital Input	Set Auto Range	26	Digital Output	Read Cal Mode
13	Digital Input	Control Range 1	27	Digital Output	Reserved
14	Digital Input	Control Range 2	28	Digital Output	Reserved

8.2.2. Auxiliary Connector (Standard 28 Pin Connector)

Pin	Signal	Function	Pin	Signal	Function
1	Analog Input	Ground	15	Digital Output	Ground (Alarm)
2	Analog Input	External Analog 1	16	Digital Output	Calibrate Alarm 1
3	Analog Input	External Analog 2	17	Digital Output	Reserved
4	Analog Input	Spare Analog	18	Digital Output	Reserved
5	Analog Input	Spare Analog	19	Digital Output	Reserved
6	Digital Output	Ground (Alarm)	20	Digital Output	Read Wet Mode
7	Digital Output	General Alarm	21	Digital Output	Read Overflow
8	Digital Output	Ch 1 Conc Alarm	22	Digital Output	Read NO Mode
9	Digital Output	Ch 2 Conc Alarm	23	Digital Input	Set Wet Mode
10	Digital Output	Reserved	24	Digital Input	Set Overflow Mode
11	Digital Output	Reserved	25	Digital Input	Set NO Mode
12	Digital Input	Reserved	26	DI/DO	spare
13	Digital Input	Reserved	27	DI/DO	Spare
14	Digital Input	Reserved	28	DI/DO	Spare

8.2.3. Digital Outputs – RS-232 (Standard 9 Pin DIN Connector)

Pin	Function
1	DCD Carrier Detect
2	RxD Receive Data
3	TxD Transmit Data
4	DTR Data Terminal Ready
5	Ground
6	DSR Data Set Ready
7	RTS Ready to Send
8	CTS Clear to Send
9	RI Ring Indicator

8.2.4. Digital Outputs – TCP/IP (8 Pin RJ-47 Connector)

Pin	Function
1	TDX+
2	TDX-
3	RXD+
4	Open
5	Open
6	RXD-
7	LNLED
8	LNLED

IMPORTANT TIP: For direct connect to a PC a crossover cable is required. Connection to a hub requires a straight cable.

8.3. Internal Component Locations

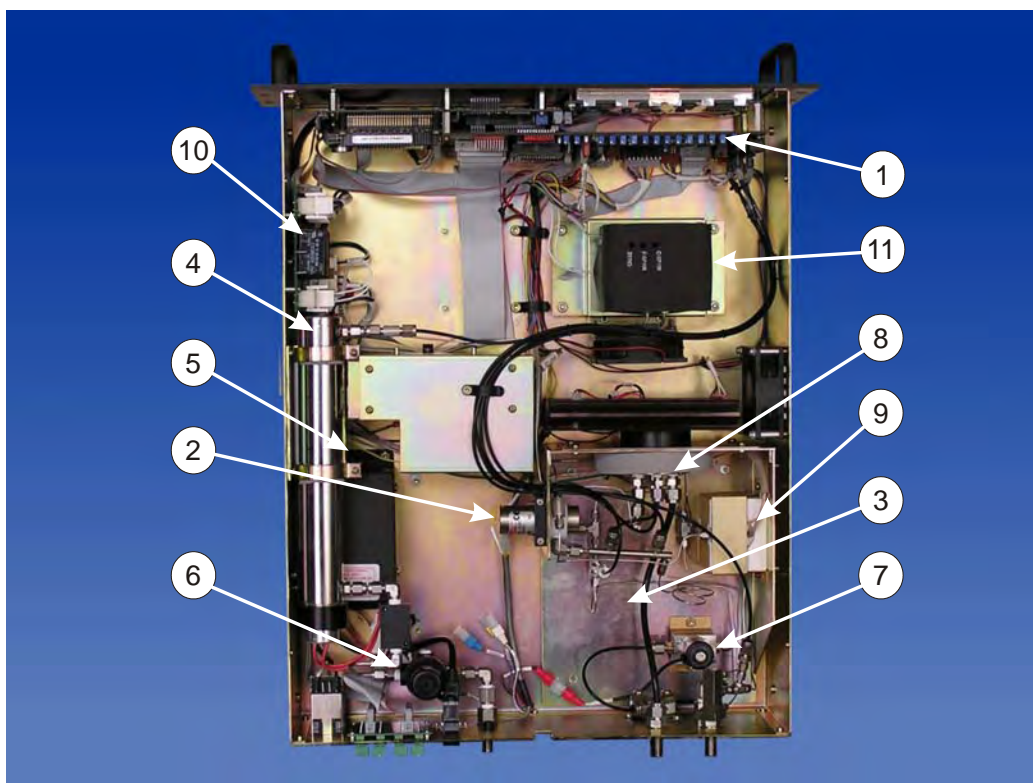
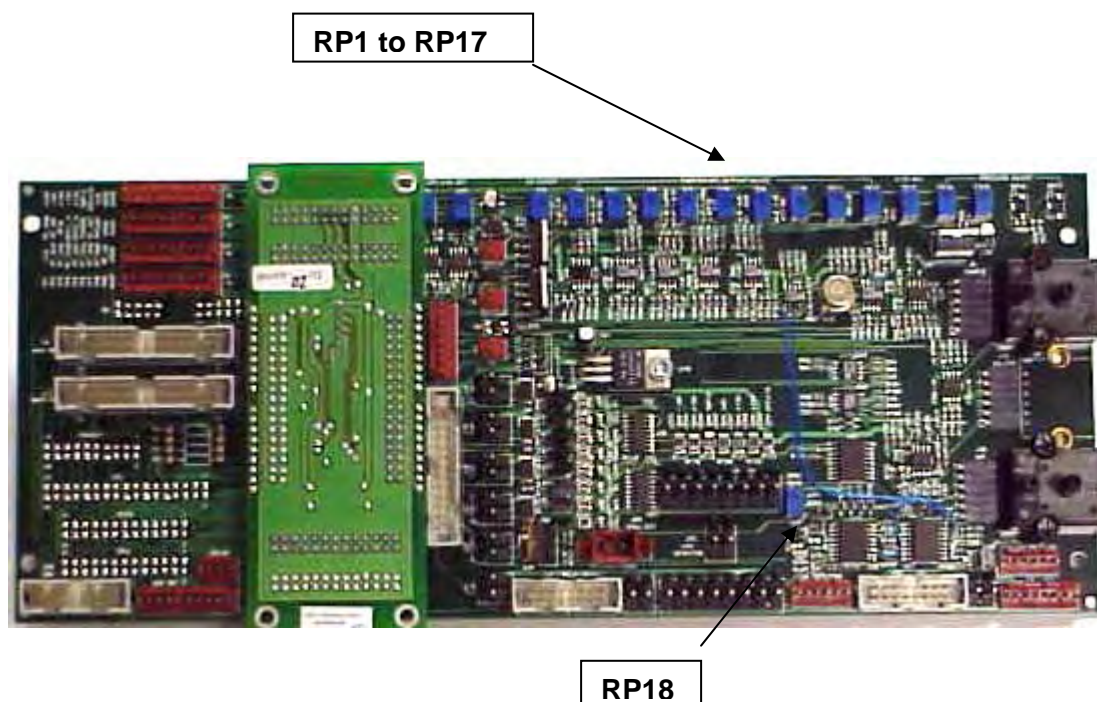


Figure 8-1 Major Internal Components

- 1) **Electronics:** Includes instrument electronics. (See Main Electronic Board)
- 2) **NO/NO_x Solenoid Valve:** Switches flow between the NO and NO_x mode.
- 3) **Optional Internal Sample Pump:** Provides sample to analyzer. (Not shown)
- 4) **Ozonator:** Contains UV Lamp.
- 5) **Ozonator High Voltage Supply:** Produces High Voltage to UV lamp.
- 6) **Proportional Flow Pressure Regulator:** Regulates flow of ozone.
- 7) **Proportional Flow Pressure Regulator:** Regulates flow of sample.
- 8) **Reaction Chamber & Detector Assembly:**
- 9) **NO/NO_x Converter:** Converts NO₂ to NO for total NO_x
- 10) **Relay Control Board:** Provides AC Voltage to Heaters, Pump and UV Transformer.
- 11) **Paramagnetic Oxygen Sensor:** Measures oxygen content of sample.

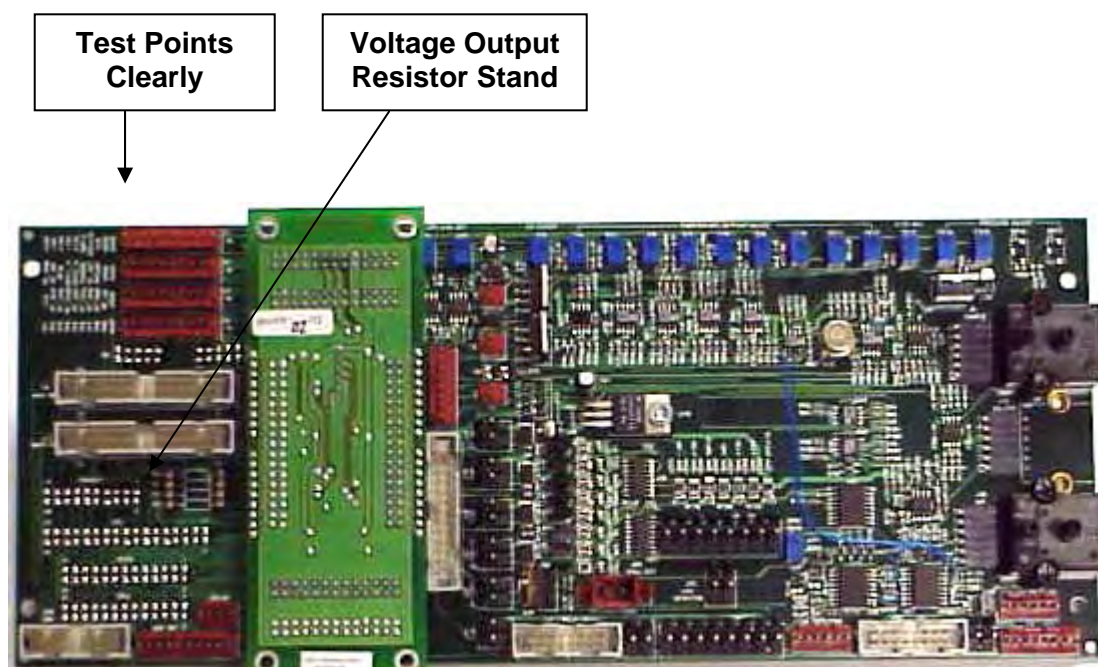
8.4. Main Electronics Board (Potentiometers)



8.5. Main Electronic Board Potentiometers

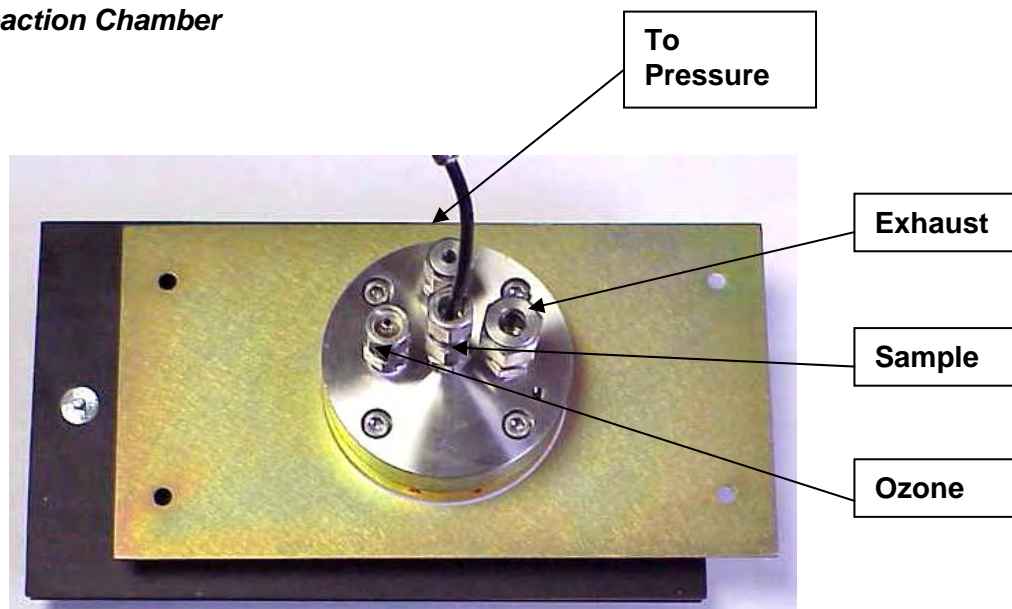
RP1 : EPC 9.5V Sample Set	RP10 : Chiller Zero Temp Set
RP2 : EPC 9.5V Air Set	RP11 : Chiller Span Temp Set
RP3 : O3 Cutoff	RP12 : Chiller Temp Set
RP4 : Cell Temp Set	RP13 : 12VDC Adjust
RP5 : Oven Temp Set	RP14 : Sample Pressure Set
RP6 : Pump Temp Set	RP15 : Air Pressure Set
RP7 : Converter Temp Set	RP16 : Not Used
RP8 : O2 Temp Set	RP17 : Not Used
RP9 : NH3 Temp Set	RP18 : PGA Balance

NOTE: Potentiometers are clearly labeled on both sides of the PCB.

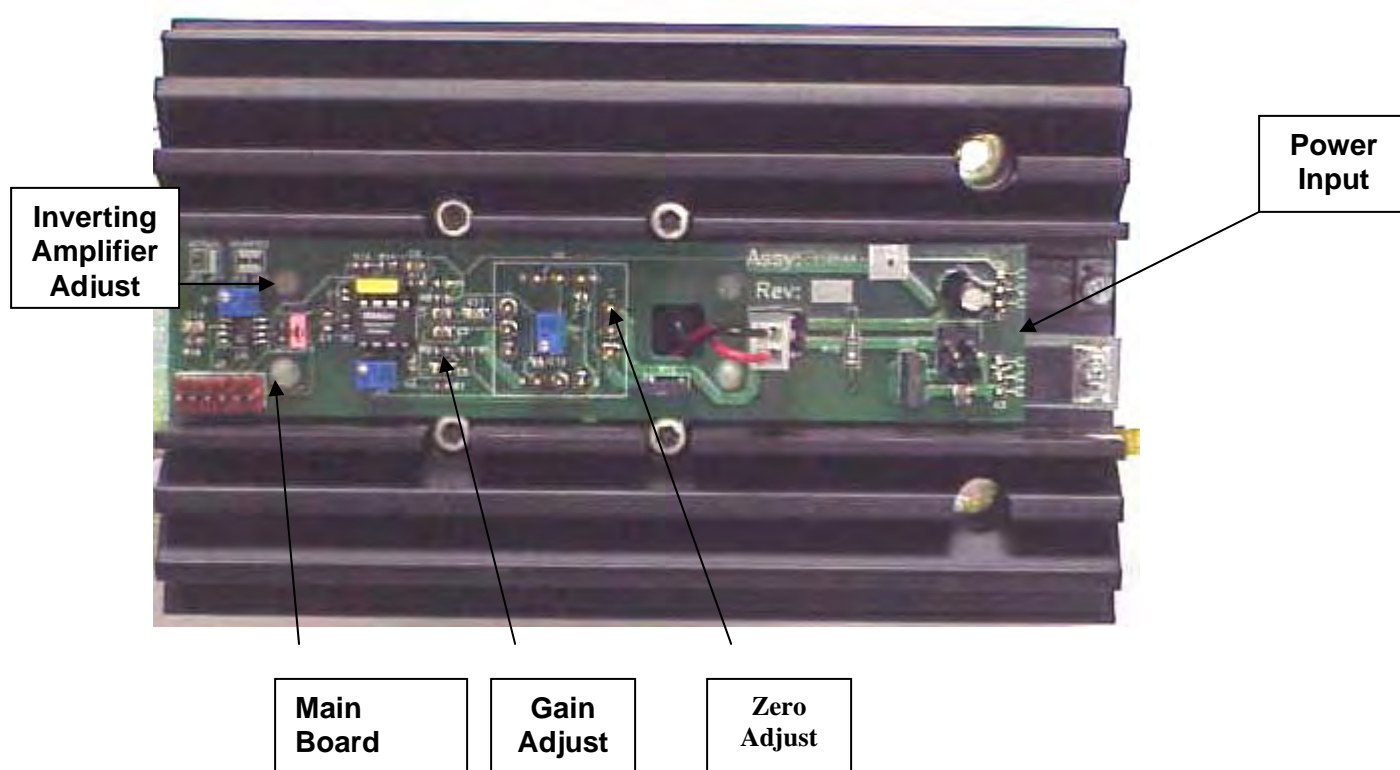
8.6. Main Electronics Board (Connectors)**8.7. Main Electronic Board Connectors**

J1	: Test Points	J2	: Test Points
J3	: Test Points	J4	: EPC Air Valve
J5	: Test Points	J6	: Digital Output 2 (DIDO Board)
J7	: EPC Sample	J8	: Sample Transducer
J9	: Aux Back Panel	J10	: Spare Digital Output
J11	: Diluter	J12	: Main Back Panel
J13	: Digital Input 2	J14	: NO/NO _x Valve
J15	: Diluter Transducer	J16	: Span Valve
J17	: Digital Output 1	J18	: Zero
J19	: Aux Power	J20	: Air Transducer
J21	: Sample Overflow Valve	J22	: Daisy Chain Input 1 (DIDO Board)
J23	: Wet/Dry Valve	J24	: Chiller Out
J25	: + 5 Volt Detector	J26	: Spare Analog Input
J27	: Chiller Temp Sense	J28	: Spare Back Panel
J29	: Spare Digital Input	J30	: Daisy Chain Output (DIDO Board)
J31	: Fan Power	J32	: Relay Board
J33	: Chiller Power	J34	: Power
J35	: Detector	J36	: O2 Detector
J37	: Thermocouple	J38	: RTD
JP1	: PGA Zero		

NOTE: Connections are clearly labeled on the PCB

8.8. Reaction Chamber

Reaction Chamber Assembly (Oven Side)

**Figure 8-2 Reaction Chamber Pre-Amplifier**

8.9. Relay Board Connections

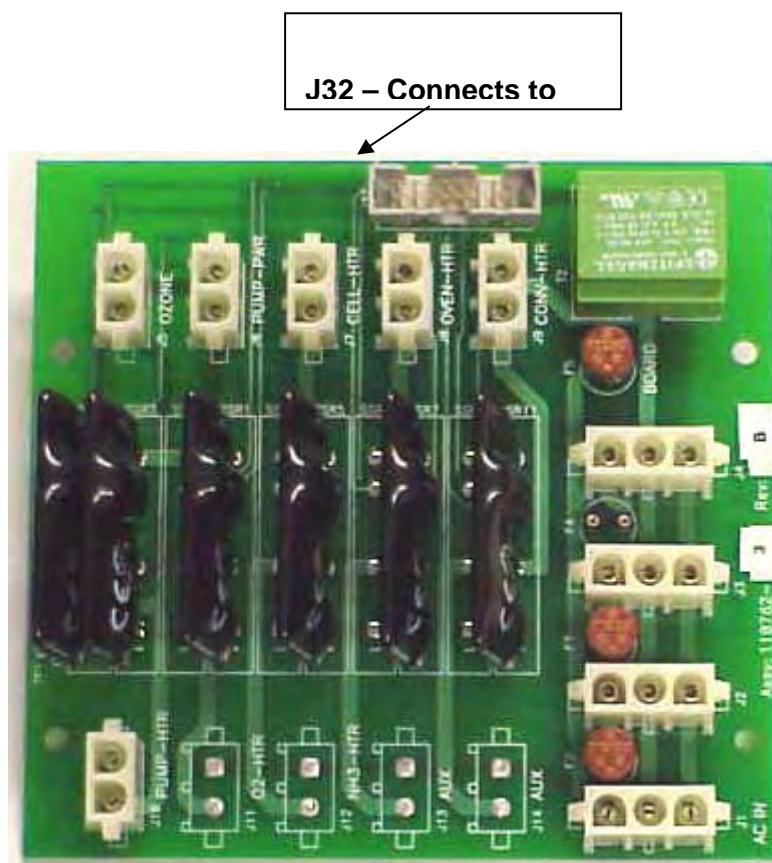


Figure 8-3 Relay Board Connections

J1	AC Input	J2	Power Supply 1
J3	Power Supply 2	J4	Power Supply 3
J5	Ozone Lamp	J6	Pump Power
J7	Cell Heater	J8	Oven Heater
J9	Converter Heater	J10	Pump Heater
J11	Optional O2 Heater	J12	Optional NH3 Heater
J13	Aux	J14	Aux

9. Operation

9.1. Preparation for Operation

Check that the external plumbing and wiring have been connected correctly, as described in this manual.

NOTE: *The internal ozone generator requires approximately 1 hour of continuous operation for the analyzer to achieve full zero and span calibration stability.*

9.2. Operation

- 12) Power On: Turn ON the power switch on the rear panel. The digital display should illuminate.
- 13) Introduce Ozone Supply (Air or O₂): Adjust the cylinder output pressure to 25 PSIG. The internal air pressure is factory set to deliver the air pressure required for optimum analyzer performance as indicated in the factory settings screen.
- 14) Air or O₂ Pressure Settings: Check the air pressure setting by referring to the diagnostic screen to check air pressure. The pressure should read as indicated in the factory settings screen.

Note: *Zero and span calibrations may also be initiated by an external computer or by remote contact closures.*

- 15) Zero Adjustment: Flow zero gas through the instrument by selecting the calibration screen and select either manual or auto calibrate. Perform a zero calibration for all ranges on both NO/NO_x and O₂ channels.
8. Span Adjustment: Flow span gas through the instrument by selecting the calibration screen and select either manual or auto calibrate. Perform a span calibration for all ranges on both NO/NO_x and O₂ channels.

NOTE: *The correct calibration gas values must be entered. The instrument is available from the factory with four ranges.*

- 16) NO/NO_x Function: The analyzer switches the NO_x converter in and out of the sample stream and is controlled from the measurement screen. In the NO mode, the sample bypasses the converter and the resultant analysis produces the value of NO (Only) in the sample. In the NO_x mode, the sample passes through converter and the resultant analysis produces the value of NO_x (NO + NO₂) in the sample. The analyzer will also display the values of NO_x, NO and NO₂. The NO mode may be switched in and out remotely by a contact closure or computer. Remote control wiring is terminated in the rear panel connector. (See Appendix).
- 17) Sample Pressure Check: With sample gas flowing through the instrument, check the sample pressure setting by referring to the diagnostic screen. The sample pressure should read as indicated in the factory pressure settings screen.
- 18) Sample Pump: If the analyzer is supplied with the optional internal sample pump, it is always on in the measure mode. It is turned off during calibration and may be manually turned off by putting the analyzer in standby.
- 19) Sample Line: Make certain the sample line is flushed before connecting to the analyzer sample inlet.

- 20) Instrument Power: Turn instrument power on and allow the reaction chamber and NO_x converter to stabilize before turning on the sample pump and/or connecting the sample line.
- 21) Sampling System: Prepare and check the sample system. Check the sample pressure as indicated in the factory settings screen.
- 22) Air or O₂ Pressure: Check the Air/O₂ pressure for proper setting as indicated in the factory setting screen. Readjust internal pressure as required. Note: Cylinder pressure should be set at 25 PSIG.
- 23) Zero & Span Calibration: Zero and span adjustment should be checked every 24 hours by either manual or automatic calibrations.
- 24) Reaction Chamber Assembly: Dust, water droplets, or mist entering the reaction chamber assembly may cause drift due to contamination. If the calibration procedure fails to bring the instrument to zero, check the chamber for contamination.

9.3. Shut Down Procedure

- 1) Turn off the zero, span and air/O₂ cylinders.
- 2) If the analyzer contains the optional internal sample pump, disconnect the sample line from the rear inlet port. Do NOT turn off the sample pump or analyzer power at this point.
- 3) Allow the analyzer to draw in room air for approximately 5 minutes, or flush out any remaining sample which may cause condensation as the analyzer cools.
- 4) Turn off the optional internal sample pump by setting the analyzer to standby.
- 5) Turn off the analyzer power.
- 6) Back-flush the sample line (and filter) of any sample before disconnecting and powering down.

10. Functional Description

10.1. Operating Principle- NO/NO_x

The California Analytical Model 650 Analyzer utilizes the chemiluminescent method of determination of oxides of nitrogen (NO or NO_x) in a sample gas. In the NO mode, the NO in the sample is quantitatively converted to NO₂ by gas phase oxidation with molecular ozone produced by the UV reaction of cylinder air. Generally, 10 to 15 percent of these NO₂ molecules are elevated to an electronically-excited state. This reaction is immediately followed by reversion to a non-excited state and emission of photons. The photons impinge on a photodiode detector (PHOTODIODE) which generates a low DC current directly proportional to the NO contained in the sample gas. This current is amplified by a precision electrometer and presented to digital panel meter and recorder output. In the NO_x mode, the sample is first routed to the NO_x converter where the NO₂ component is reduced to NO. The complete sample is analyzed by the PHOTODIODE as above.

10.1.1. Reaction Chamber

The sample and ozone are delivered to the reaction chamber via the unique regulated flow system described below. The sample and ozone are mixed together at the center of the chamber where the reaction takes place. The sample is vented from the chamber through a 1/8 inch stainless steel tube. The chamber contains a red filter which is sealed with an integral O Ring. The chamber assembly is O Ring mounted to the PHOTODIODE. The complete chamber and PHOTODIODE assembly is housed in an RFI shielded enclosure.

10.1.2. Flow System

The basic function is to deliver highly regulated flows of sample and air or O₂ to the ozonator and reaction chamber assemblies. The EPC valve delivers approximately 15 PSIG to a pre-set capillary and consequently accurately predetermines the ozone flow rate. The air supply cylinder should be set to 25 psig. The sample is presented to the reaction chamber via a precision, factory set electronically controlled proportional pressure valve through a capillary. This pressure is factory set at approximately 3.85 PSIG. A close coupled bypass capillary minimizes "dead volume" and improves response time. Sample inlet pressure and regulated air pressures are monitored by internal pressure transducers and presented in PSIG via the diagnostics screen. NOTE: The correct pressures are determined by the factory for optimum analyzer performance and measured by N.I.S.T. traceable standards. They are recorded on the Factory Settings Screen.

10.1.3. Main Electronics Board

The main electronics board contains the instrument power supplies and required instrument electronics. A single transformer provides power to the main circuit board and includes provisions for 110/220 VAC at 50/60 Hz input.

10.1.4. Relay Board

The relay circuit board contains the logic circuitry required to control and switch the AC power to the required heaters and sample pump.

10.2. Principle of Operation-Oxygen

The paramagnetic susceptibility of oxygen is significantly greater than that of other common gases, and consequently, the molecules of oxygen are attracted much more strongly by a magnetic field than the molecules of the other gases. Most of the other gases are slightly diamagnetic, which means that their molecules are then repelled by a magnetic field.

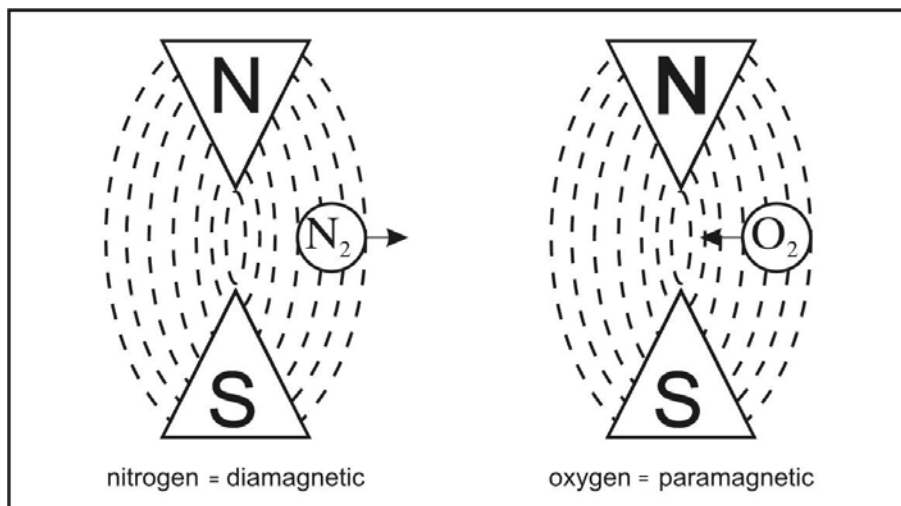


Figure 10-1 Magnetic Susceptibility of gases

The principle of the magneto dynamic cell is based upon Faraday's method of determining the magnetic susceptibility of a gas. The cell consists of two nitrogen-filled quartz spheres arranged in the form of a dumbbell. A single turn of platinum wire is placed around the dumbbell that is suspended in a symmetrical non-uniform magnetic field.

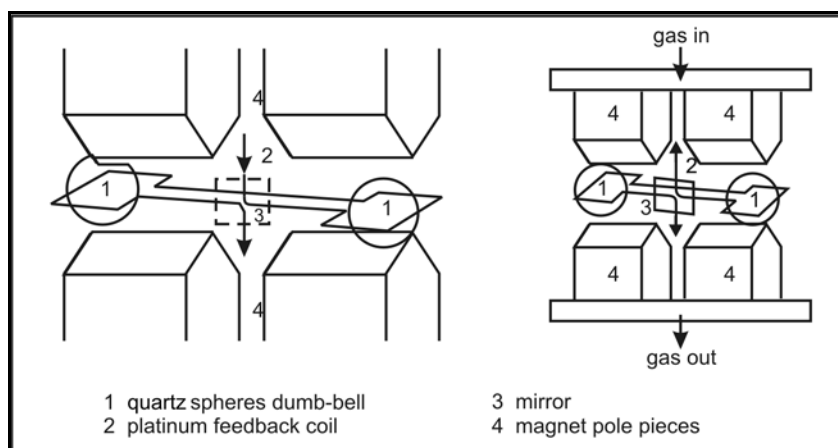


Figure 10-2 The Measuring cell in theory

When the surrounding gas contains oxygen, the dumbbell spheres are pushed out of the magnetic field by the change in the field that is caused by the relatively strong paramagnetic oxygen. The torque acting on the dumbbell is proportional to the paramagnetic properties of the surrounding gas and, therefore, it can be used as a measure of the oxygen concentration.

The distortion of the dumbbell is sensed by a light beam and projected on a mirror attached to the dumbbell whereof it is reflected to a pair of photocells. When both photocells are illuminated equally, the output will be zero. The output from the photocells is connected to an

amplifier, which in turn is fed to the feedback coil of the measuring cell. If the oxygen content of the gas sample changes, the corresponding current output of the amplifier, which is proportional to the oxygen content, produces a magnetic field in the feedback coil opposing the forces and thereby causing the dumbbell to rotate.

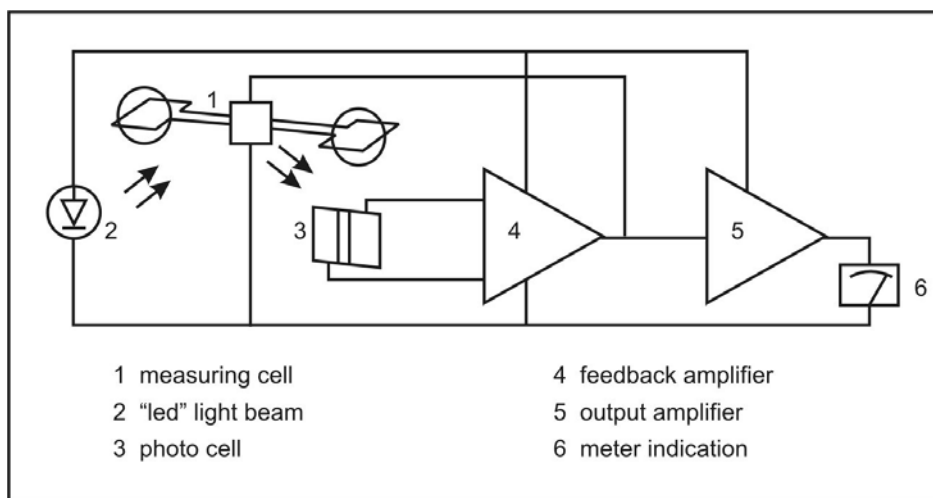


Figure 10-3 Principle of operation

Since the feedback current from the amplifier is proportional to the oxygen content of the gas sample, the output signals that are produced by the amplifier will be accurate and linear. The paramagnetic susceptibility of oxygen varies inversely as the square of the absolute temperature. To provide compensation for changes in analyzer temperature, a temperature sensitive element in contact with the measuring cell assembly is included in the feedback current circuit.

10.3. Cross sensitivity of gases

The very high magnetic susceptibility of oxygen is the basis of the paramagnetic measuring principle. In comparison to oxygen, other gases have such a minor susceptibility that most of them are insignificant. Exceptions to this are the nitrogen oxides. However, as these gases are in most cases present in a very low concentration, the error is still negligible.

Example 1

The residual oxygen percentage is measured in a closed carbon dioxide (CO₂) atmosphere. Nitrogen (N₂) is used for "zero calibration."

According to the list of cross-sensitivities, the error for 100 % CO₂ at 20° C is 0.27%. In order to obtain a higher accuracy, this means that for the zero calibration the reading should be adjusted at +0.27% with N₂, in order to compensate the error of CO₂.

Since the values of cross-sensitivities are based on 100% volume of that particular gas, the error at 50% by volume CO₂ and 50% by volume N₂ is 0.135%.

Example 2

Given the following gas composition at a temperature of 20° C:

5% volume Oxygen (O₂)	+100.00 x 10⁻² x 5 =	+5.0000
40% volume Carbon Dioxide(CO₂)	-0.27 x 10⁻² x 40 =	-0.1080
1% volume Ethane(C₂H₆)	-0.43 x 10⁻² x 1 =	-0.0043
54% volume Nitrogen (N₂)	0.00 X 10⁻² x 54 =	0.0000
Gives a reading (% by volume) of:		+4.8877

As this example shows, the total error (5.000 minus 4.8877) is 0.1123.

Note: see Table 10-1 below for cross sensitivity values of typical gases.

Table 10-1 Cross Sensitivity of gases

All values based on nitrogen 0% / oxygen 100%

Gas	Formula	20 °C	50 °C
Argon	Ar	-0.23	-0.25
Acetylene	C ₂ H ₂	-0.26	-0.28
Acetone	C ₃ H ₆ O	-0.63	-0.69
Acetaldehyde	C ₂ H ₄ O	-0.31	-0.34
Ammonia	N ₃	-0.17	-0.19
Benzene	C ₆ H ₄	-1.24	-1.34
Bromine	Br ₂	-1.78	-1.97
Butadiene	C ₄ H ₆	-0.85	-0.93
Isobutylene	(CH ₃) ₂ CH=CH ₂	-0.94	-1.06
n-Butane	C ₄ H ₁₀	-1.10	-1.22
Chlorine	Cl ₂	-0.83	-0.91
Hydrogen Chloride	HCL	-0.31	-0.34
Nitrous Oxide	N ₂ O	-0.20	-0.22
Diacetylene	(CHCl) ₂	-1.09	-1.20
Ethane	C ₂ H ₄	-0.43	-0.47
Ethylene Oxide	C ₂ H ₄ O ₂	-0.54	-0.60
Ethylene	C ₂ H ₄	-0.20	-0.22
Ethylene Glycol	CH ₂ OHCH ₂ OH	-0.78	-0.88
Ethylbenzene	C ₈ H ₁₀	-1.89	-2.08
Hydrogen Fluoride	HF	+0.12	+0.14
Furan	C ₄ H ₄ O	-0.90	-0.99
Helium	He	+0.29	+0.32
n-Hexane	C ₆ H ₁₄	-1.78	-1.97
Krypton	Kr	-0.49	-0.54
Carbon Monoxide	CO	-0.06	-0.07
Carbon Dioxide	CO ₂	-0.27	-0.29
Methane	CH ₄	-0.16	-0.17
Methanol	CH ₄ O	-0.27	-0.31
Methylene Chloride	CH ₂ Cl ₂	-1.00	-1.10
Neon	Ne	+0.16	+0.17
n-Octane	C ₈ H ₁₈	-2.45	-2.70
Phenol	C ₆ H ₆ O	-1.40	-1.54
Propane	C ₃ H ₈	-0.77	-0.85
Propylene	C ₃ H ₆	-0.57	-0.62
Propene	CH ₃ CH=CH ₂	-0.58	-0.64
Propylene Oxide	C ₃ H ₆ O	-0.90	-1.00
Propylene Chloride	C ₃ H ₇ Cl	-1.42	-1.44
Silane	SiH ₄	-0.24	-0.27
Styrene	C ₇ H ₆ =CH ₂	-1.63	-1.80
Nitrogen	N ₂	-0.00	-0.00
Nitrogen Monoxide	NO	+42.70	+43.00
Nitrogen Dioxide	NO ₂	+5.00	+16.00
Oxygen	O ₂	+100.00	+100.00
Sulfur Dioxide	SO ₂	-0.18	-0.20
Sulfur Fluoride	SF ₆	-0.98	-1.05
Hydrogen Sulfide	H ₂ S	-0.41	-0.43
Toluene	C ₇ H ₈	-1.57	-1.73
Trichloroethylene	C ₂ HCl ₃	-1.56	-1.72
Vinyl Chloride	C ₂ H ₃ Cl	-0.68	-0.74
Vinyl Fluoride	CH ₃ F	-0.49	-0.54
Water	H ₂ O	-0.03	-0.03
Hydrogen	H ₂	+0.23	+0.26
Xenon	Xe	-0.95	-1.02

11. Reaction Chamber Servicing

11.1. *Disassembly Procedure*

- 1) Shut off ALL gas flow.
- 2) Remove power from the instrument.
- 3) Remove the top cover retaining screws.
- 4) Remove all 4 tubes from the 4 way cross.
- 5) Remove the 4 screws securing the photodiode and reaction chamber from the oven.
- 6) Remove the photodiode electrical connector from the main circuit board.
- 7) Remove the chiller connection from the photodiode/reaction chamber.
- 8) Separate the photodiode and heat sink assembly from the reaction chamber by removing the 4 Allen screws from the front of the heat sink. Save the 2 black rubber "O" rings.
- 9) Separate the mounting plate and the glass filter from the reaction chamber. Save the 2 Teflon spacers and "O" ring.
- 10) Separate the manifold from the gold reaction chamber. NOTE the position of the holes in the Teflon gasket relative to the assembly screw holes. The large hole is ozone.

11.2. *Assembly Procedure*

- 1) Wash the reaction chamber glass filter and manifold separately in detergent using a test tube brush. Be careful of the sample tube in the manifold. Do not use abrasives.
- 2) Dry by blowing clean with dry nitrogen.
- 3) Reassemble the chamber assembly in reverse order per the above. Make certain the sample tube is centered when assembling the manifold to the reaction chamber.

12. Troubleshooting

12.1. Ozone Air/O₂ Supply

The Air/O₂ flow is controlled by an EPC valve. It requires 25 psig cylinder supply pressure and is factory set to deliver approximately 10 to 20 psig to the ozone capillary. This pressure may be monitored by the diagnostics display. The flow rate from the capillary is very low and will require a bubble flow meter to accurately determine proper flow.

12.2. Sample Supply

The sample flow is controlled by an adjustable electronic proportional pressure valve. This valve requires a 10 to 25 PSIG sample supply pressure to deliver the proper pressure to the sample capillary. This pressure may be monitored by the diagnostics meter at any time after inlet sample has been applied. The sample flow rate from the capillary is very low and will require a bubble flow meter to determine proper flow rate. If the pressure is properly set, and a clogged capillary is suspected, replace the sample capillary.

NOTE: *If the analyzer contains an optional internal sample pump, the introduction of a pressurized sample gas in excess of 1.5 PSIG will damage the pump.*

12.3. NO/NO_x Converter

Several published test procedures require periodic NO_x efficiency tests to be performed on the converter to determine NO₂ to NO conversion efficiency utilizing a NO_x generator. The CAI Model NOxGen may be used for this procedure. A short test using NO₂ calibration gas is also defined in the U.S Federal Register, Title 40, Part 86.332.79 (e).

13. AK Protocol Format

The master computer and the Model 650 analyzer communicates via the RS232 serial link. The Model 650 analyzer acts as a "slave" and only responds to commands.

Serial Interface Parameters:

- 1) Baud from 300 to 9600 bps, can be selected via the display.
- 2) 7 or 8 data bits, 1 or 2 stop bits, and the parity (yes/no).
- 3) The data transmission is full duplex (no echo) with XON/XOFF protocol.
- 4) The "don't-care" byte" (byte 2) is adjustable (factory setting 20H).

Command Format:	
<STX>	02H Example: ASTZ K0
don't care	any byte (default 20H)
function code	code 4 byte long (e.g., ASTZ)
space 20H	20H
channel N° always "K0" for the analyzer	
space	20H (only if followed by data, otherwise <ETX>)
data	data bytes (depending on the command)
<ETX>	03H
Answer Format:	
<STX>	02H Example: STZ 0 SREM STBY
don't care	adjustable, factory setting 20H
function code	same code as command package (e.g., ASTZ)
space	20H
status	0 without error or 1 to 9 when error (see also ASTF command)
space	20H (only if followed by data, otherwise <ETX>)
data	parameter (depending on the command)
<ETX>	03H

13.1. Serial Interface and AK-Commands

The serial interface enables remote control of the Model 650 analyzer by a master computer. It is implemented as an RS232 V24 interface and meets all requirements of the AK protocol.

A 9-pin male connector at the back of the unit is used to connect a master computer with the following pin assignment:

Pin 3 = Txd (transmit)

Pin 2 = Rxd (receive)

Pin 5 = Gnd (ground)

13.2. Interface Parameters

Baud rate:	9600, 4800, 2400, 1200, 600, 300 baud
Data bits:	7 or 8
Stop bit:	1 or 2
Don't care:	1 byte, adjustable (e.g. 32)
Parity:	Even, odd, none
XON/XOFF:	Active or not active

13.3. General AK Requirements

- 1) If the command message contains no error, the acknowledge message contains the echo of the function code and the error status number (1 to 9).
- 2) If the transfer was faulty or the function code unknown, the answer contains four question marks (example. "???? 0").
- 3) If the displayed value is not valid, a "#" is placed in front of the measured value (example: "AIKG 0 #9999").
- 4) If a control or adjusting command is sent via the serial interface while the measuring device is in "Manual" mode, it sends an answer like "SLIN 0 K0 OF".
- 5) If a channel does not exist, the answer for control and adjusting commands is e.g. "ATEM 0 3 NA" in which 3 is the number of the sub-channel.
- 6) If the device is busy with a running function (SLIN, for example), every arriving control command is ignored (except SRES and STBY); and the response message is e.g. "SMAN 0 BS. If in the mode "SINT" an additional "SINT KO" command is received, the integrator is reset to 0 and the integration is restarted.
- 7) If the command message contains data that the measuring device cannot process ("ESYZ K0 ABC", for example,) the response message is "ESYZ 0 SE". A syntax error is recognized if the data does not match the expected format or if the parameters do not fit the expected size.
- 8) Numbers are in floating-point format with decimal point. The decimal point can be dropped for integers.
- 9) If you switch from "Manual" to "Remote" at the device, it remains in "Manual" mode until a "SREM K0" is received by the control computer. On the display, this mode is indicated by REME" (Remote enable) on the status line. In manual mode, query commands via the serial interface are possible at any time.

13.4. Scans**AKON:** Measured concentration value

Command	Response	Description
_AKON_K0	_AKON_s_z.z_y.y_x.x_w.w	Measured concentration value is responded z.z: Current measured value y.y: NO x.x: NO2 w.w: NOx y.y,x.x,w.w are only used in dual measure mode. Otherwise "O.O" will be returned

AEMB: Set measuring range

Command	Response	Description
_AEMB_K0	_AEMB_s_Mn	Current measuring range is responded

AMBE: Measuring range limit

Command	Response	Description
_AMBE_K0	_AMBE_s_M1_w.w_M2_x.x_M3_y.y_M4_z.z	All existing measuring range limits are responded
_AMBE_K0_Mn	_AMBE_s_Mn_z.z	Range limit of Range Mn is responded

AKAK: Calibration gas concentrations

Command	Response	Description
AKAK_K0	_AKAK_s_M1_w.w_M2_x.x_M3_y.y_M4_z.z	All existing calibration gas values are responded
AKAK_K0_Mn	AKAK_s_Mn_z.z	Calibration gas value of Range Mn is responded

AMBU: Upper and lower range switchover values for auto range

Command	Response	Description
_AMBU_K0	_AMBU_s_M1_w.w_W.W_M2_x.x_X.X_M3_y.y_Y.Y_M4_z.z_Z.Z	Lower and upper range switchover value of auto range are responded

ASTZ: Normal device status

Command	Response	Description
_ASTZ_K0	_ASTZ_s_SREM_STBY__SENO_SARE_SDRY	Device status is responded

Possible states:

SREM: remote	STBY: standby	SENO: NO mode	SARE: Autorange on	SDRY: Chiller on
SMAN: manual	SPAU: pause	SMAN: NO _x mode	SARA: Autorange off	SWET: Chiller off
	SMGA: measuring gas			
	SNGA: zero gas			
	SEGA: end gas			
	SATK SNGA: zero gas during autocal			
	SATK SEGA: end gas during autocal			
	SLIN: For compatibility only			
	SSPL: purging			
	SKOP: measure			

ASTF: Error status

Command	Response	Description
_ASTF_K0	_ASTF_s_f1_f2_f3..._f15	Current error number is responded

Errors:

1	Sample Pressure Failure	10	EPC Coil Sample Failure
2	Air Pressure Failure	11	EPC Coil Air Failure
3	Oven Temp Failure	12	Range Overflow
4	Converter Temp Failure	13	ADC Range Overflow
5	Pump Temp Failure	14	ADC Range Underflow
6	Diode Temp Failure	15	Range 1 is not calibrated
7	Cell Temp Failure	16	Range 2 is not calibrated
8	Peltier Gas Temp Failure	17	Range 3 is not calibrated
9	Reaction Chamber Temp Failure	18	Range 4 is not calibrated

AKEN: Device identification

Command	Response	Description
_AKEN_K0	_AKEN_s_devicename	Device identification is responded
_AKEN_K1	_AKEN_s_model	Device model
_AKEN_K2	_AKEN_s_serialno	Device serial number
_AKEN_K3	_AKEN_s_airpressure	Suggested input air pressure
_AKEN_K4	_AKEN_s_samplepressure	Suggested input sample pressure

ARMU: Raw value

Command	Response	Description
_ARMU_K0	_ARMU_s_z.z	Raw value before linearization and offset-span-correction is responded

ATEM: Temperatures

Command	Response	Description
_ATEM_K0	_ATEM_s_z.z_y.y...	All Temperatures in degrees Celsius are responded
_ATEM_K0_x	_ATEM_s_z.z	Temperature of x in degrees Celsius is responded

Description of x:

X	CLD
1	Oven Temp
2	Converter Temp
3	Pump Temp
4	Diode Temp
5	Cell Temp
6	Peltier Temp
7	Reaction Chamber Temp

ADRU: Pressures

Command	Response	Description
_ADRU_K0	_ADRU_s_z.z_y.y_...	All pressures are responded
_ADRU_K0_x	_ADRU_s_z.z	Pressure of x is responded

Description of x:

1	Sample Pressure
2	Air Pressure
3	Sample EPC Coil Voltage
4	Air/Ozone EPC Coil Voltage

ADUF: Flows

Command	Response	Description
_ADUF_K0	_ADRU_s_z.z_y.y_...	All flows are responded
_ADUF_K0_x	_ADRU_s_z.z	Flow of x is responded

Description of x:

1	Sample Flow
2	Air Flow

AGRD: Polynom coefficients

Command	Response	Description
_AGRD_K0_Mn	_AGRD_s_Mn_a0_a1_a2_a3_a4	Polynom coefficients of range Mn are responded

AANG: Deviation from zero point after autocalibration

Command	Response	Description
_AANG_K0	_AANG_s_M1_z.z_da_dr_ M2_z.z_da_dr_ M3_z.z_da_dr_ M4_z.z_da_dr_	Deviation from zero point after autocalibration

AAEG: Deviation from end point after autocalibration

Command	Response	Description
_AAEG_K0	_AANG_s_M1_z.z_da_dr_ M2_z.z_da_dr_ M3_z.z_da_dr_ M4_z.z_da_dr_	Deviation from end point after autocalibration

AFDA: Purge and Autocalibration times

Command	Response	Description
_AFDA_K0_SATK	_AFDA_s_z_y_x_w_Z.Z	Autocalibration times: z: Purge time y: Calibration time x: Total Calibration time w: Verify time (z,y,x,w in seconds)
_AFDAKO_SSPL	AFDA_s_z.z	Purge time will be responded

APAR: Request Autocalibration tolerance values

Command	Response	Description
_APAR_K0_SATK	_APAR_s_z.z_y.y_x.x_w.w	Autocalibration tolerance value (%): z.z: Range 1 y.y: Range 2 x.x: Range 3 w.w: Range 4

AKAL: Deviations from calibration

Command	Response	Description
_AKAL_K0_	_AKAL_s_M1_z.z_y.y_x.x_w.w _AKAL_s_M2_z.z_y.y_x.x_w.w _AKAL_s_M3_z.z_y.y_x.x_w.w _AKAL_s_M4_z.z_y.y_x.x_w.w	Deviation (ppm): z.z: Zero gas relative to last calibration y.y: Zero gas factory calibration x.x: Span gas relative to last calibration w.w: Span gas factory calibration

ASYZ: Respond System Time

Command	Response	Description
_ASYZ_K0_	_ASYZ_s_yymmdd_hhmmss	Respond system time yyymmdd:year, month, day (each 2 characters wide, no spaces) hhmmss:hour, minutes, seconds)

AT90: Respond Lowpass filter time

Command	Response	Description
_AT90_K0_	_AT90_s_t	Respond lowpass filter time t=filter time in seconds

ADAL: Diagnostic alarm limits

Command	Response	Description
_ADAL_K0	_ADAL_s_a1.min_a1.max...f12.max	All alarms are responded
_ADAL_K0_x	_ADAL_s_x.min_x.max	Alarm limits of x

Alarm Limits:

1	Sample Pressure	7	Cell Temp
2	Air Pressure	8	Peltier Gas Temp
3	Oven Temp	9	EPC Coil Sample Voltage
4	Converter Temp	10	EPC Coil Air/Ozone Voltage
5	Pump Temp	11	Reserved
6	Diode Temp	12	Sample Content

ATCP: Query TCP/IP settings

Command	Response	Description
_ATCP_K0	_ATCP_s_zzz.zzz.zzz.zzz	zzz: TCP/IP Address
	_ATCP_s_yyy.yyy.yyy.yyy	yyy: TCP/IP subnet mask
	_ATCP_s_xxxx	xxxx: TCP/IP port

AENT: Query calibration gas flow setting

Command	Response	Description
_AENT_K0	_AENT_s_x	x=10: Calibration through sample gas inlet (pump) y=11: Calibration through zero/span valves

13.5. Control commands**SRES:** Reset

Command	Response	Description
_SRES_K0	_SRES_s	Reset

SPAU: Pause

Command	Response	Description
_SPAU_K0	_SPAU_s	Pause mode

STBY: Standby

Command	Response	Description
_STBY_K0	_STBY_s	Standby mode

SNGA: Open valve for zero gas calibration

Command	Response	Description
_SNGA_K0	_SNGA_s	Open valve for zero gas calibration of actual measuring range
_SNGA_K0_Mn	_SNGA_s	Open valve for zero gas calibration of range Mn

SEGA: Open valve for end gas calibration

Command	Response	Description
_SEGA_K0	_SEGA_s	Open valve for end gas calibration of actual measuring range
_SEGA_K0_Mn	_SEGA_s	Open valve for end gas calibration of range Mn

SSPL: Purge Analyzer with zero gas

Command	Response	Description
_SSPL_K0	_SSPL_s	Open valve for zero gas and purge the analyzer

SLIN: Linearization mode

Command	Response	Description
_SLIN_K0	_SLIN_s	Change status to SLIN (only for compatibility)

SKOP: Converter Check

Command	Response	Description
_SKOP_K0	_SKOP_s	Change status to SKOP and activate sample pump (only for compatibility)

SWET: Chiller off – Wet mode measuring

Command	Response	Description
_SWET_K0	_SWET_s	Switch chiller off

SDRY: Chiller on – Dry mode measuring

Command	Response	Description
_SDRY_K0	_SDRY_s	Switch chiller on

SATK: Start automatic calibration

Command	Response	Description
_SATK_K0	_SATK_	Start automatic calibration of all ranges
_SATK_K0_Mn	_SATK_s	Start automatic calibration using range Mn

SEMB: Set measuring range

Command	Response	Description
_SEMB_K0_Mn	_SEMB_s	Set measuring range Autorange is disabled

SARE: Auto range on

Command	Response	Description
_SARE_K0	SARE_s	Set auto range on

SARA: Auto range off

Command	Response	Description
_SARA_K0	_SARA_s	Set autorange off

SREM: Remote mode for AK-commands

Command	Response	Description
_SREM_K0	_SREM_s	Set device in remote mode

SMAN: Manual control to control device manually

Command	Response	Description
_SMAN_K0	_SMAN_s	Set device in manual mode

SMGA: Start measuring

Command	Response	Description
_SMGA_K0	_SMGA_s	Start measuring Turn on pump for sample gas

SNKA: Saves measured value as new offset.

Command	Response	Description
_SNKA_K0	_SNKA_s	Saves measured value of actual range as new offset if zero valve is opened

SEKA: Saves measured value as new span value

Command	Response	Description
_SEKA_K0	_SEKA_s	Saves measured value of actual range as new span value if span valve is opened

SENO: Converter off

Command	Response	Description
_SENO_K0	_SENO_s	Set converter off Only NO is measured

SNOX: Converter on

Command	Response	Description
_SNOX_K0	_SNOX_s	Set converter on All kinds of NO _x are measured

SNO2: Converter on

Command	Response	Description
_SNO2_K0	_SNO2_s	Activates dual measure mode. Analyzer switches periodically between NO and NO _x mode and displays NO, NO ₂ , NO _x

SFGR: Reset calibration settings to factory default Converter on

Command	Response	Description
_SFGR_K0	_SFGR_s	Reset all calibration settings to their factory settings

SENT: Set calibration gas flow

Command	Response	Description
_SENT_K0_x	_SENT_s	x=10: Calibration through sample gas inlet (pump) y=11: Calibration through zero/span valves

13.6. Settings**EKAK:** The four span gas concentration values are set

Command	Response	Description
_EKAK_K0_M1_w.w_M2_x.x_M3_y.y_M4_z.z	_EKAK_s	Set end gas values

EMBE: The four measuring range end values are set

Command	Response	Description
_EMBE_K0_M1_w.w_M2_x.x_M3_y.y_M4_z.z	_EMBE_s	Set range limits

EMBU: The upper and the lower range switchover for autorange are set

Command	Response	Description
_EMBU_K0_M1_w.w_W.W_M2_x.x_X.X_M3_y.y_Y.Y_M4_z.z_Z.Z	_EMBU_s	Set lower and upper range switchover limits

EKEN: Set new device identification

Command	Response	Description
_EKEN_K0_new device-name	_EKEN_s	Set new device identification Maximum length of device name are 40 characters

NOTE: To change device identification, you must first rename the device to “RESET”. Now a name up to 40 letters can be given.

NOTE: The device name must not have any blanks between, i.e. “CAI CLD” is not allowed. You can use underlines, i.e. “CAI_CLD”.

EGRD: Set polynom coefficients

Command	Response	Description
_EGRD_K0_Mn_a0_a1_a2_a3_a4	_EGRD_s	Set polynom coefficients of range Mn

EFDA: Set autocalibration and purge times

Command	Response	Description
_EFDA_K0_SATK_z_y_x_w	_EFDA_s	Set autocalibration times: z= Purge time y=Calibration time x=Total calibration time w=Verify time (z,y,x,w in seconds)
_EFDA_K0_SSPL_z	_EFDA_s	Set analyzer purge time to z seconds

EPAR: Set autocalibration tolerance values

Command	Response	Description
_EPAR_K0_SATK_z.z_y.y_x.x_w.w	_EPAR_s	Autocalibration Tolerance value (%): z.z= Range 1 y.y= Range 2 x.x= Range 3 w.w= Range 4

ESYZ: Set System Time

Command	Response	Description
_ESYZ_K0_yymmdd_hhmmss	_ESYA_s	Respond system time: yyymmdd:year, month, day (each 2 characters wide, no spaces) hhmmss: hour, minutes, seconds)

ET90: Set Lowpass Filter Time

Command	Response	Description
_ET90_K0_t	_ET90_s	Set lowpass filter time: t= filter time in seconds

EDAL: Diagnostic alarm limits

Command	Response	Description
_EDAL_K0_a1.min_a1.mas_..._a12max	_EDAL_s	Set all alarm limits
_EDAL_K0_x_x.min_xmax	_EDAL_s	Set alarm limits of x

Alarm Limits:

1	Sample Pressure	7	Cell Temp
2	Air Pressure	8	Peltier Gas Temp
3	Oven Temp	9	EPC Coil Sample Voltage
4	Converter Temp	10	EPC Coil Air/Ozone Voltage
5	Pump Temp	11	Reserved
6	Diode Temp	12	Sample Content

ETCP: Set TCP/IP Parameters

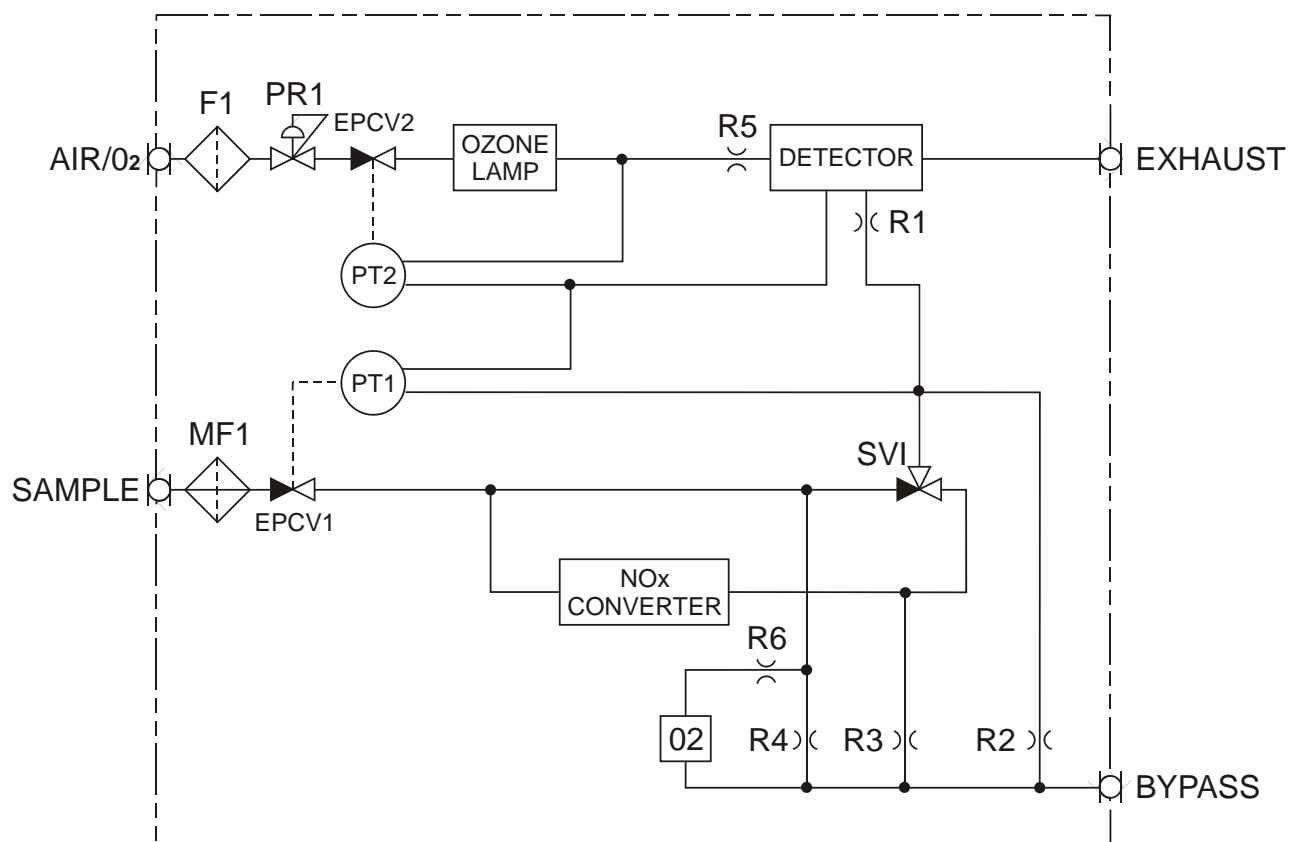
Command	Response	Description
_ETCP_K0_zzz.zzz.zzz.zzz	_ETCP_s	zzz= TCP/IP address
_ETCP_K0_yyy.yyy.yyy.yyy		yyy= TCP/IP subnet mask
_ETCP_K0_xxxx		xxxx= TCP/IP port
		All changes take effect after next power on cycle

13.7. Abbreviations used

Mn	: Measuring range number
M1 .. M4	: Measuring Range 1 .. 4
w.w .. Z.Z.	: Numerical value
x	: Number
t	: Numeric integer value
a0 .. a4	: Polynom coefficients
s	: Status
yyymmdd	:Date of format year, month and day with 2 characters each and no spaces
hhmmss	:Time of format hour, minute and second with 2 characters each and no spaces

14. Appendix

14.1. MODEL 650 NO_x/O₂ Flow Diagrams



650 - NOXYGEN FLOW DIAGRAM

Figure 14-1: Standard Analyzer

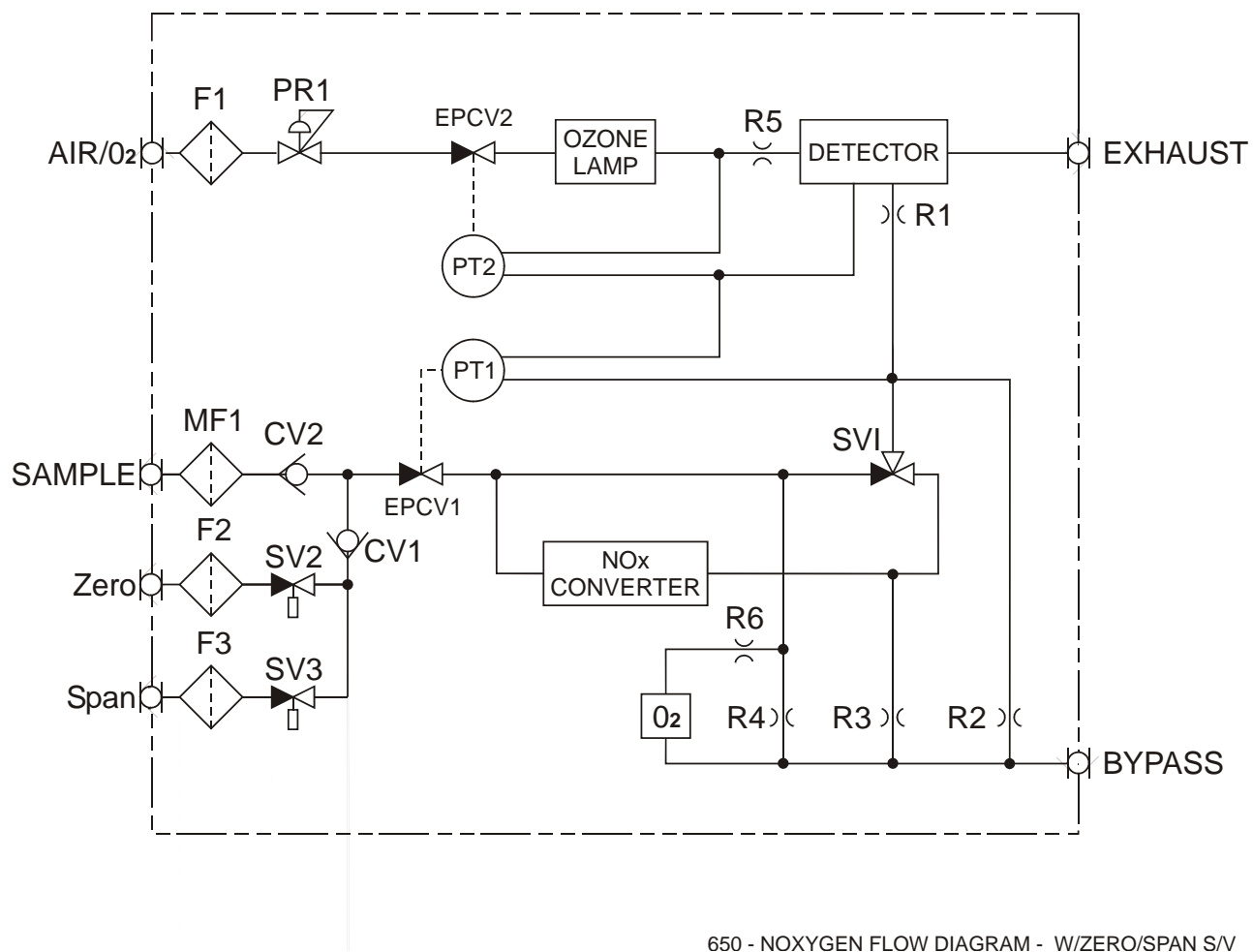
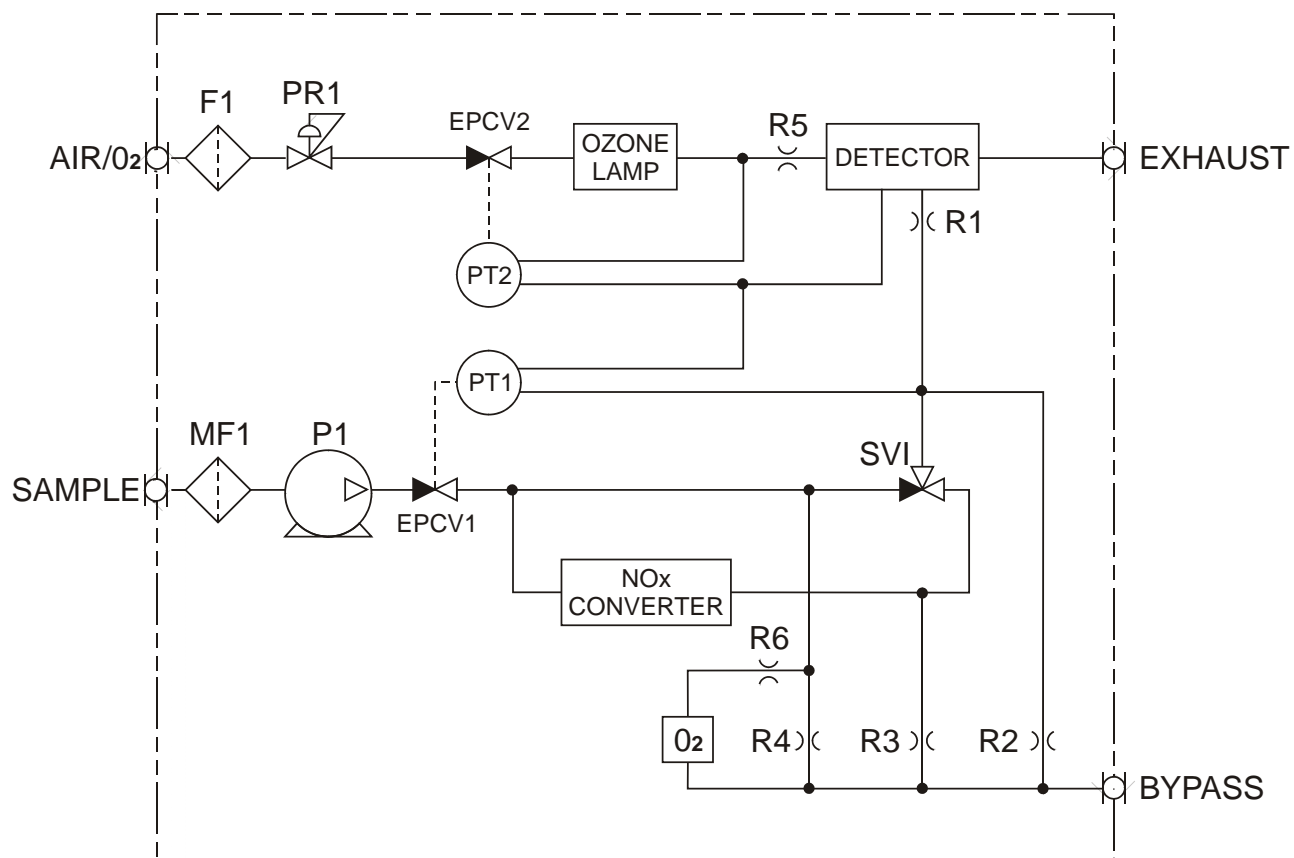
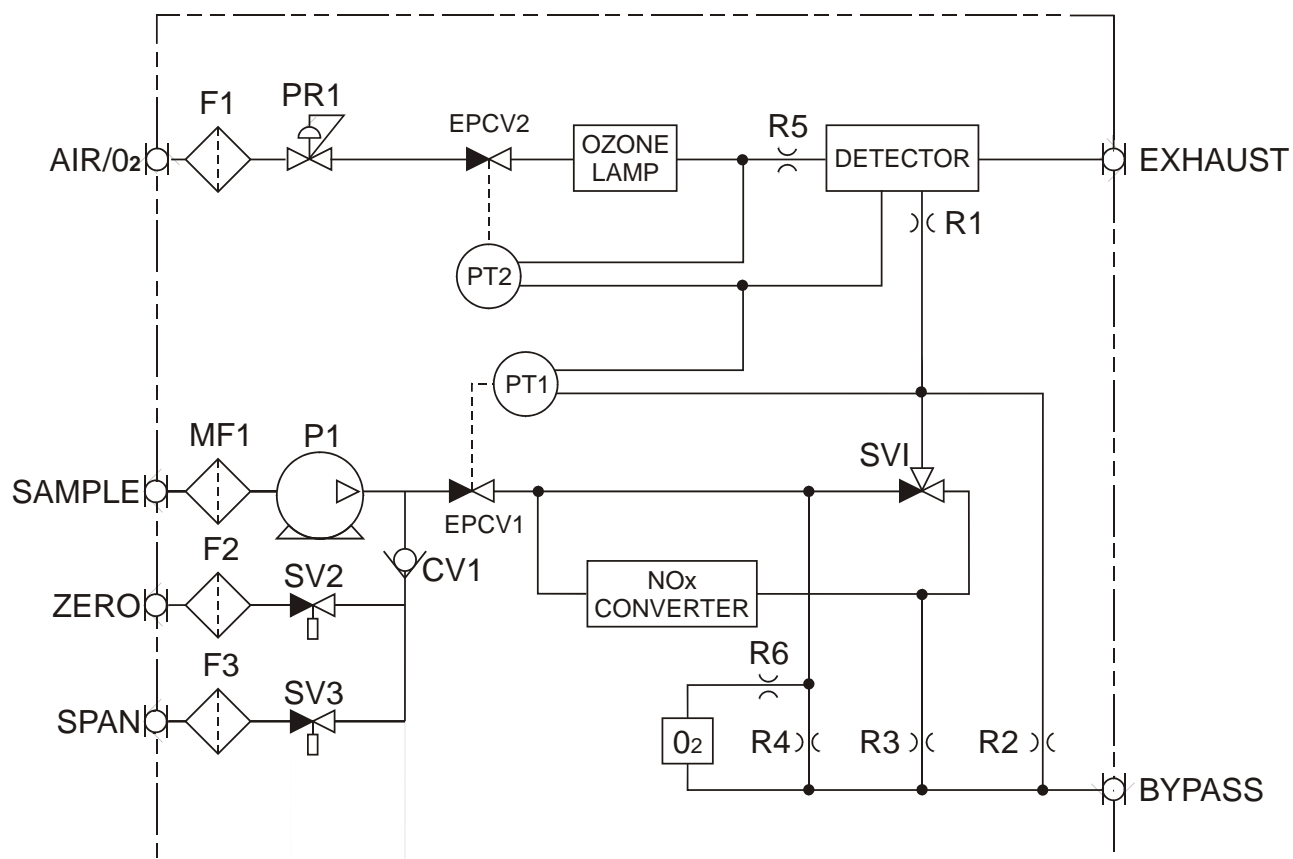


Figure 14-2: Standard Analyzer with Optional Zero/Span Solenoids



650 - NOXYGEN FLOW DIAGRAM - W/PUMP

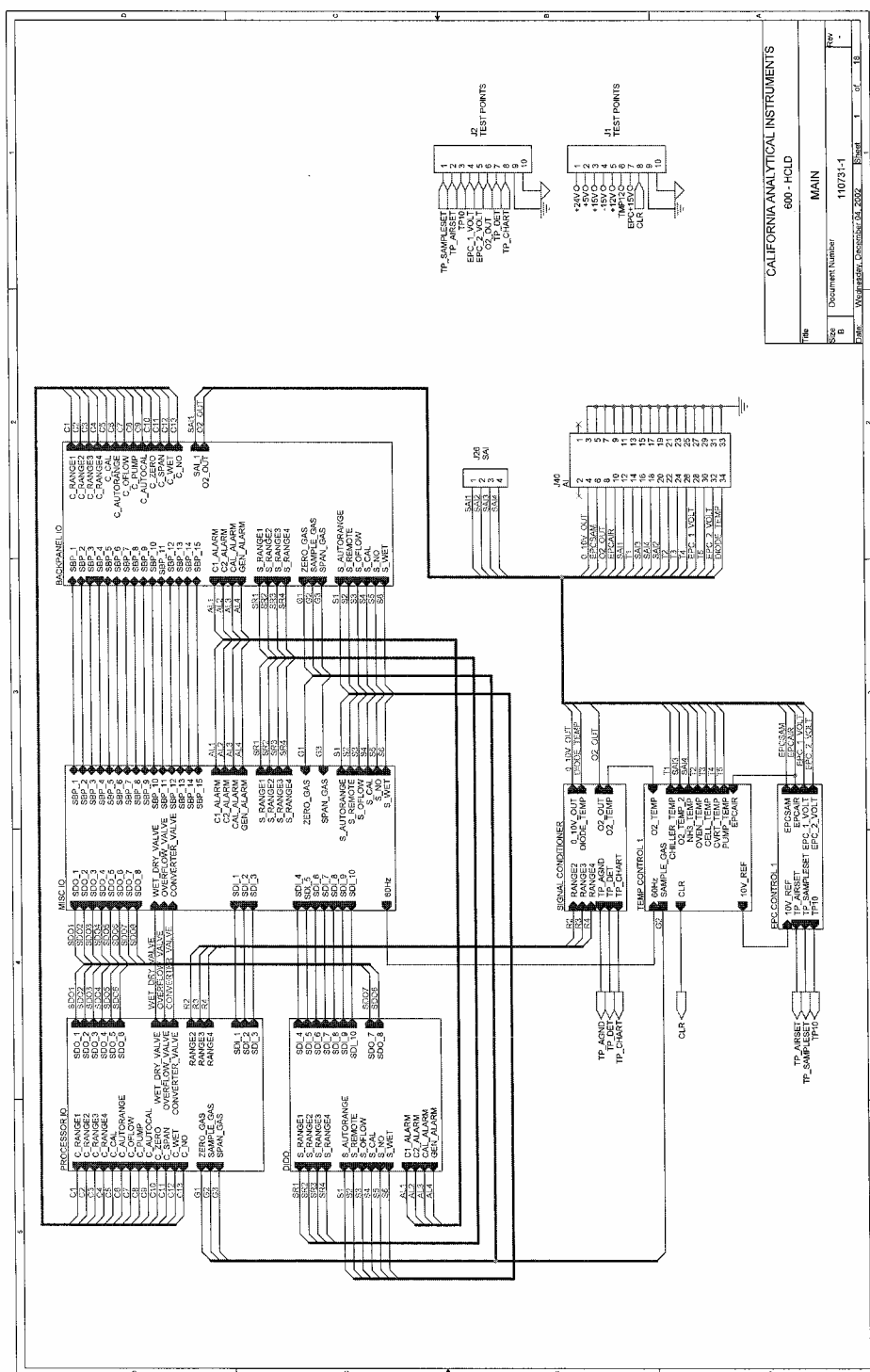
Figure 14-3: Standard Analyzer with Optional Sample Pump



650 - NOXYGEN FLOW DIAGRAM W/PUMP AND ZERO/SPAN S/V

Figure 14-4: Standard Analyzer with Optional Sample Pump and Zero/Span Solenoids

14.2. Electrical Block Diagram



AK-Protocol

CAI – CLD-Analyzers

Version : 1.9 25.06.2004
Program Version : Nmain 1.417

Title: AK-Protocol specification for CAI-CLD analyzers**Project: CAI****Protocol description****PEUS Systems GmbH**

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Author Michael Speck	Checked by	Approved by
Date 19.October 2001	Date	Date
Signature: MSp	Signature:	Signature:

Version	Release Date	Changed Sections	Reason of Change
1.1			New software features
1.2	05 th Mar 2002	1.1 Scans 1.2 Control commands 1.3 Settings	New software features
1.3	03 May 2002	1.3.8 EPAR	Wrong description
1.4	May 17, 2002	1.1.21 ADAL; 1.3.11 EDAL	Software change
1.5	Jul 16, 2002	1.1.23 ATCP; 1.3.12 ETCP	New feature
1.6	Jan 23, 2003	1.2.8 SKOP	New features
1.601	Jan 30, 2003	1.1.7 ASTF	Correction
1.700	Feb 07, 2003	1.1.1 AKON	New feature AGRW/EGRW New feature
1.701	Mar 19, 2003	AEMB, AMBE, AKAK, ARMU, ATEM, AGRD, ADAL, EKAK, EGRD, EDAL, SNKA, SEKA SKOR, ARO2, ERO2	New features, bugfixes
1.702	Mar 21, 2003	1.1.14 AFGR 1.3.6 EFGR 1.1.13 AGRD	Changed functionality Corrected description

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1.703	Dec 08, 2003	1.1.1 AKON 1.1.9 ARMU 1.1.11 ADRU 1.1.23 ADAL 1.1.27 AVER 1.1.28 AUDP 1.2.26 SUDP 1.3.12 EDAL 1.3.15 EUDP	added timestamp added timestamp added reac. chamber pressure added new alarm New: Version info New: UDP streaming New: UDP streaming added new alarm New: UDP streaming
1.8	Mar 19, 2004	1.1.29 ARAW 1.1.16 ASTZ	New command Changed: added new status
1.9	Jun 25, 2004	1.1.28 AUDP 1.3.15 EUDP	changed format updated

Addressee	Return Until	Expected Problems	

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1 AK-Commands

1.1 SCANS

1.1.1 AKON: Measured concentration value

Command	Response	Description
_AKON_K0	_AKON_s_z.z_y.y_x.x_w.w_t	Measured concentration value is responded z.z: current measured value y.y: NO x.x: NO ₂ w.w : NO _x y.y, x.x, w.w are only used in Dual measure mode. Otherwise "0.0" will be returned t: Timestamp
_AKON_K1	_AKON_s_z.z_t	Return O ₂ concentration (only available on CLD's with additional O ₂ sensor) t: Timestamp

1.1.2 AEMB: Currently set measuring range

Command	Response	Description
_AEMB_K0	_AEMB_s_Mn	Current measuring range is responded
_AEMB_K1	_AEMB_s_M1	Measuring range of O ₂ channel. Always M1

1.1.3 AMBE: Measuring range limit

Command	Response	Description
_AMBE_K0	_AMBE_s_M1_w.w_M2_x.x_M3_y.y_M4_z.z	All existing measuring range limits are responded
_AMBE_K0_Mn	_AMBE_s_Mn_z.z	Range limit of Range Mn is responded
_AMBE_K1	_AMBE_s_M1_w.w	Range Limit of O ₂ -Channel (if installed)

1.1.4 AKAK: Calibration gas concentrations

Command	Response	Description
_AKAK_K0	_AKAK_s_M1_w.w_M2_x.x_M3_y.y_M4_z.z	All existing calibration gas values are responded
_AKAK_K0_Mn	_AKAK_s_Mn_z.z	Calibration gas value of Range Mn is responded
_AKAK_K1	_AKAK_s_M1_w.w	Calibration gas concentration for O ₂ channel (if installed)

1.1.5 AMBU: Upper and lower range switchover values for autorange

Command	Response	Description
_AMBU_K0	_AMBU_s_M1_w.w_W.W_M2_x.x_X. X_M3_y.y_Y.Y_M4_z.z_Z.Z	Lower and upper range switchover value of autorange are responded

1.1.6 ASTZ: Normal device status

Command	Response	Description
_ASTZ_K0	_ASTZ_s_SREM_STBY_SENO_ SARE_SDRY	Device status is responded

Possible states:

SREM: <i>remote</i>	STBY: <i>standby</i>	SENO: <i>NO mode</i>	SARE: <i>autorange on</i>	SDRY: <i>Chiller on</i>
SMAN: <i>manual</i>	SPAU: <i>pause</i>	SNOX: <i>NOx mode</i>	SARA: <i>autorange off</i>	SWET: <i>Chiller off</i>
	SMGA: <i>measuring gas</i>	S2NO NO – dual mode		
	SNGA: <i>zero gas</i>	S2NX NOx – dual mode		
	SEGA: <i>end gas</i>			
	SATK SNGA: <i>zero gas during autocal</i>			
	SATK SEGA: <i>end gas during autocal</i>			
	SLIN: For compatibility only			
	SSPL: purging			
	SKOP: measure			

1.1.7 ASTF: Error status

Command	Response	Description
_ASTF_K0	_ASTF_s_f1_f2_f3_.._f15	Current error number is responded

Errors:

1	Sample Pressure Failure
2	Air Pressure Failure
3	Oven Temp Failure
4	Converter Temp Failure
5	Pump Temp Failure
6	Diode Temp Failure
7	Cell Temp Failure
8	Peltier Gas Temp Failure
9	O ₂ Temp Failure (only if installed)
10	EPC Coil Sample Failure

11	EPC Coil Air/Ozone Failure
12	Range Overflow
13	ADC Range Overflow
14	ADC Range Underflow
15	Range 1 is not calibrated
16	Range 2 is not calibrated
17	Range 3 is not calibrated
18	Range 4 is not calibrated

1.1.8 AKEN: Device information

Command	Response	Description
_AKEN_K0	_AKEN_s_devicename	Device identification is responded
_AKEN_K1	_AKEN_s_model	Device model
_AKEN_K2	_AKEN_s_serialno	Device serial number
_AKEN_K3	_AKEN_s_airpressure	Suggested input air pressure
_AKEN_K4	_AKEN_s_samplepressure	Suggested input sample pressure

1.1.9 ARMU: Rawvalue

Command	Response	Description
_ARMU_K0	_ARMU_s_z.z_t	Rawvalue before linerisation and off-set-span-correction is responded t: Timestamp
_ARMU_K1	_ARMU_s_z.z_t	Rawvalue before linerisation of O ₂ channel t: Timestamp

1.1.10 ATEM: Temperatures

Command	Response	Description
_ATEM_K0	_ATEM_s_z.z.y.y_ ...	All Temperatures in degrees Celsius are responded
_ATEM_K0_x	_ATEM_s_z.z	Temperature of x in degrees celsius is responded

Description of x:

X	CLD
1	Oven Temp
2	Converter Temp
3	Pump Temp
4	Diode Temp
5	Cell Temp
6	Peltier Temp
7	O ₂ Temp

1.1.11 ADRU: Pressures

Command	Response	Description
_ADRU_K0	_ADRU_s_z.z.y.y_ ...	All Presures are responded
_ADRU_K0_x	_ADRU_s_z.z	Pressure of x is responded

Description of x:

1	Sample Pressure
2	Air Pressure
3	Sample EPC Coil Voltage
4	Air EPC Coil Voltage
5	Reaction Chamber pressure

1.1.12 ADUF: Flows

Command	Response	Description
_ADUF_K0	_ADUF_s_z.z_y.y_ ...	All Flows are responded
_ADUF_K0_x	_ADUF_s_z.z	Flow of x is responded

Description of x:

1	Sample Flow
2	Air Flow

1.1.13 AGRD: Polynom coefficients

Command	Response	Description
_AGRD_K0_Mn	_AGRD_s_a0_a1_a2_a3_a4	Polynom coefficients of range n are responded
_AGRD_K1_M1	_AGRD_s_a0_a1_a2_a3_a4	Polynom coefficients of O ₂ channel (if installed)

1.1.14 AFGR: Factory set polynom coefficients (calibration defaults) NOT FOR CUSTOMERS !

Command	Response	Description
_AFGR_K0_Mn	_AFGR_s_a0_a1_a2_a3_a4	Factory default polynom coefficients of range Mn are responded
_AFGR_K1_M1	_AFGR_s_a0_a1_a2_a3_a4	Factory default polynomial coefficients of O ₂ channel

1.1.15 AANG: Deviation from zero point after autocalibration

Command	Response	Description
_AANG_K0	_AANG_s_M1_z.z_da_dr_ M2_z.z_da_dr_ M3_z.z_da_dr_ M4_z.z_da_dr_	Deviation from zero point after auto-calibration

1.1.16 AAEG: Deviation from end point after autocalibration

Command	Response	Description
_AAEG_K0	_AANG_s_M1_z.z_da_dr_ M2_z.z_da_dr_ M3_z.z_da_dr_ M4_z.z_da_dr_	Deviation from end point after auto-calibration

1.1.17 AFDA: Purge and Autocalibration times

Command	Response	Description
_AFDA_K0_SATK	_AFDA_s_z_y_x_w_Z.Z	Autocalibration times: z : Purge time y : Calibration time x : Total calibration time w : Verify time (z, y, x, w in seconds)
_AFDA_K0_SSPL	_AFDA_s_z.z	Purge time will be responded

1.1.18 APAR: Request autocalibration tolerance values

Command	Response	Description
_APAR_K0_SATK	_APAR_s_z.z_y.y_x.x_w.w	Autocalibration Tolerance value [%]: z.z : Range 1 y.y : Range 2 x.x : Range 3 w.w : Range 4

1.1.19 AGRW: Request maximum allowed absolute/relative deviations

Command	Response	Description
_AGRW_K0_Mn	_AGRW_s_z.z_y.y	Allowed deviations of range n [%]: z.z : absolute y.y : relative

1.1.20 AKAL: Deviations from calibration

Command	Response	Description
_AKAL_K0	_AKAL_s_M1_z.z_y.y_x.x_w.w _M2_z.z_y.y_x.x_w.w _M3_z.z_y.y_x.x_w.w _M4_z.z_y.y_x.x_w.w	Deviation [ppm]: z.z : Zero gas relative last calibration y.y : Zero gas factory calibration x.x : Span gas relative last calibration w.w : Span gas factory calibration

1.1.21 ASYZ: Respond System Time

Command	Response	Description
_ASYZ_K0	_ASYZ_s_yymmdd_hhmmss	Respond system time. yymmdd : year, month, day (each 2 characters wide, no spaces) hhmmss : hour, minutes, seconds (each 2 characters, no spaces)

1.1.22 AT90: Respond Lowpass Filter Time

Command	Response	Description
_AT90_K0	_AT90_s_t	Respond lowpass filter time. t : filter time constant in seconds

1.1.23 ADAL: Diagnostic alarm Limits

Command	Response	Description
_ADAL_K0	_ADAL_s_a1.min_a1.max...f12.max	All alarm limits are responded
_ADAL_K0_x	_ADAL_s_x.min_x.max	Alarm limits of x

Alarm Limits:

1	Sample Pressure
2	Air Pressure
3	Oven Temperature
4	Converter Temperature
5	Pump Temperature
6	Diode Temperature
7	Cell Temperature
8	Peltier Gas Temperature
9	EPC Coil Sample Voltage
10	EPC Coil Air/Ozone Voltage
11	Reserved (<i>ignore content</i>)
12	Sample Content
13	O ₂ Temperature (if installed)
14	Reaction Chamber pressure

1.1.24 ATCP: Query TCP/IP settings

Command	Response	Description
_ATCP_K0	_ATCP_s_zzz.zzz.zzz.zzz _yyy.yyy.yyy.yyy _xxxx	zzz: TCP/IP adress yyy: TCP/IP subnet mask xxxx: TCP/IP port

1.1.25 AENT: Query calibration gas flow setting

Command	Response	Description
_AENT_K0	_AENT_s_x	x=10: Calibration through sample gas inlet (pump) x=11: Calibration through zero/span valves

1.1.26 ARO2: Query O₂ reference value

Command	Response	Description
_ARO2_K1	_ARO2_s_x.x	O ₂ reference which is used for O ₂ correction of NO/NO _x

1.1.27 AVER: Query software version

Command	Response	Description
_AVER_K0	_AVER_s_NMAIN_z_NUSER_y_OS MSR_x	z: Main version x.xxx.b_dd.mm.yyyy y: User version x.xxx.b_dd.mm.yyyy x: OSMSR version x.xxx_dd.mm.yyyy

1.1.28 AUDP: Query UDP data streaming parameter

Command	Response	Description
_AUDP_K0	_AUDP_s_<UDPPort>_<DataFrequency>_<Mode>_<UDP_IP>_<Data>_<On/Off>	Port: port for open the UDP connection DataFrequency: Frequency for transmit the data in Hz Mode: A: ASCII Mode UDP_IP: Alternative IP address for open the UDP connection when it should not use the IP of connected TCP/IP client. Data: AK commands that will be streamed over UDP On/Off: 0 – UDP streaming is off 1 – UDP streaming is on

1.1.29 ARAW: Raw detector volts

Command	Response	Description
_ARAW_K0	_ARAW_s_z.z_t	z.z: Raw detector volts t: Timestamp
_ARAW_K1	_ARAW_s_z.z_t	z.z: Raw detector volts of O ₂ channel t: Timestamp

1.2 CONTROL COMMANDS

1.2.1 SRES: Reset

Command	Response	Description
_SRES_K0	_SRES_s	Reset

1.2.2 SPAU: Pause

Command	Response	Description
_SPAU_K0	_SPAU_s	Pause mode

1.2.3 STBY: Standby

Command	Response	Description
_STBY_K0	_STBY_s	Standby mode

1.2.4 SNGA: Open valve for zero gas calibration

Command	Response	Description
_SNGA_K0	_SNGA_s	Open valve for zero gas calibration of actual measuring range
_SNGA_K0_Mn	_SNGA_s	Open valve for zero gas calibration of range Mn

1.2.5 SEGA: Open valve for end gas calibration

Command	Response	Description
_SEGA_K0	_SEGA_s	Open valve for end gas calibration of actual measuring range
_SEGA_K0_Mn	_SEGA_s	Open valve for end gas calibration of range Mn

1.2.6 SSPL: Purge Analyzer with zero gas

Command	Response	Description
_SSPL_K0	_SSPL_s	Open valve for zero gas and purge the analyzer

1.2.7 SLIN: Linearization mode

Command	Response	Description
_SLIN_K0	_SLIN_s	Change Status to SLIN (only for compatibility)

1.2.8 SKOP: Converter Check

Command	Response	Description
_SKOP_K0	_SKOP_s	Change Status to SKOP and activate sample pump (only for compatibility)

1.2.9 SWET: Chiller off - Wet mode measuring

Command	Response	Description
_SWET_K0	_SWET_s	Switch Chiller off

1.2.10 SDRY: Chiller on – Dry mode measuring

Command	Response	Description
_SDRY_K0	_SDRY_s	Switch chiller on.

1.2.11 SATK: Start automatic calibration

Command	Response	Description
_SATK_K0	_SATK_	Start automatic calibration of all Ranges
_SATK_K0_Mn	_SATK_s	Start automatic calibration using range Mn

1.2.12 SEMB: Set measuring range

Command	Response	Description
_SEMB_K0_Mn	_SEMB_s	Set measuring range Autorange is disabled

1.2.13 SARE: Auto range on

Command	Response	Description
_SARE_K0	_SARE_s	Set auto range on

1.2.14 SARA: Auto range off

Command	Response	Description
_SARA_K0	_SARA_s	Set autorange off

1.2.15 SREM: Remote mode for AK-commands

Command	Response	Description
_SREM_K0	_SREM_s	Set device in remote mode

1.2.16 SMAN: Manual control to control device manually

Command	Response	Description
_SMAN_K0	_SMAN_s	Set device in manual mode

1.2.17 SMGA: Start measuring

Command	Response	Description
_SMGA_K0	_SMGA_s	Start measuring Turn on pump for sample gas

1.2.18 SNKA: Saves measured zero value as new offset

Command	Response	Description
_SNKA_K0	_SNKA_s	Saves measured value of actual range as new offset if zero valve is opened
_SNKA_K1	_SNKA_s	Save measured O ₂ value as new offset of O ₂ channel

1.2.19 SEKA: Saves measured span value as new span value

Command	Response	Description
_SEKA_K0	_SEKA_s	Saves measured value of actual range as new span value if span valve is opened
_SEKA_K1	_SEKA_s	Calculate new O ₂ channel gain factor

1.2.20 SENO: Converter off

Command	Response	Description
_SENO_K0	_SENO_s	Set converter off Only NO is measured

1.2.21 SNOX: Converter on

Command	Response	Description
_SNOX_K0	_SNOX_s	Set converter on All kinds of NOx are measured

1.2.22 SNO2: Enable dual measure mode

Command	Response	Description
_SNO2_K0	_SNO2_s	Activates dual measure mode. The Analyzer switches periodically between NO and NO _x mode and displays NO NO ₂ NO _x

1.2.23 SFGR: Reset calibration settings to factory default

Command	Response	Description
_SFGR_K0	_SFGR_s	Reset all calibration settings to their factory default settings.

1.2.24 SENT: Set calibration gas flow

Command	Response	Description
_SENT_K0_x	_SENT_s	x=10: Calibration through sample gas inlet (pump) x=11: Calibration through zero/span valves

1.2.25 SKOR: Enable/Disable correction functions

Command	Response	Description
_SKOR_K1_x	_SKOR_s	x=ON: enable O ₂ correction x=OFF: disable O ₂ correction

1.2.26 SUDP: Start / Stop UDP data streaming

Command	Response	Description
_SUDP_K0_ON	_SUDP_s	Start Data streaming via the UDP channel. You need to configure the channel before with EUDP command
_SUDP_K0_OFF	_SUDP_s	Stop streaming via the UDP channel

1.3 SETTINGS

1.3.1 EKAK: The span gas concentration values are set

Command	Response	Description
_EKAK_K0_M1_w.w_M2_x.x_M3_y.y_M4_z.z	_EKAK_s	Set end gas values
_EKAK_K1_Mn_w.w	_EKAK_s	n=1: Set span gas concentration for O ₂ channel (if installed)

1.3.2 EMBE: The four measuring range end values are set

Command	Response	Description
_EMBE_K0_M1_w.w_M2_x.x_M3_y.y_M4_z.z	_EMBE_s	Set range limits

1.3.3 EMBU: The upper and the lower range switchover for autorange are set

Command	Response	Description
_EMBU_K0_M1_w.w_W.W_M2_x.x_X.X_M3_y.y_Y.Y_M4_z.z_Z.Z	_EMBU_s	Set lower and upper range switchover limits

1.3.4 EKEN: Set new device identification

Command	Response	Description
_EKEN_K0_new device-name	_EKEN_s	Set new device identification Maximum length of device name are 40 characters

Note:

To change device identification, you must first rename the device to "RESET".

Now a name up to 40 letters can be given.

Note: The device name must not have any blanks between, f.e. "CAI CLD" is not allowed.

You can use underscore, f.e. "CAI_CLD".

1.3.5 EGRD: Set polynom coefficients

Command	Response	Description
_EGRD_K0_Mn_a0_a1_a2_a3_a4	_EGRD_s	Set polynomial coefficients of range Mn
_EGRD_K1_M1_a0_a1_a2_a3_a4	_EGRD_s	Set polynomial coefficients for O ₂ channel (if installed)

1.3.6 EFGR: Set factory polynom coefficients (calibration defaults) NOT FOR CUSTOMERS !

Command	Response	Description
_EFGR_K0_Mn_a0_a1_a2_a3_a4	_EFGR_s	Set factory polynomial coefficients of range Mn
_EFGR_K1_M1_a0_a1_a2_a3_a4	_EFGR_s	Set factory polynomial coefficients of O ₂ channel

1.3.7 EFDA: Set autocalibration and purge times

Command	Response	Description
_EFDA_K0_SATK_z_y_x_w	_EFDA_s	Set autocalibration times : z : Purge time y : Calibration time x : Total calibration time w : Verify time (z, y, x, w in seconds)
_EFDA_K0_SSPL_z	_EFDA_s	Set Analyzer purge time to z seconds

1.3.8 EPAR: Set autocalibration tolerance values

Command	Response	Description
_EPAR_K0_SATK_z.z_y.y_x.x_w.w	_EPAR_s	Autocalibration Tolerance value [%]: z.z : Range 1 y.y : Range 2 x.x : Range 3 w.w : Range 4

1.3.9 EGRW: Set maximum allowed absolute/relative deviations

Command	Response	Description
_EGRW_K0_Mn_z.z_y.y	_EGRW_s	Allowed deviations for range n [%]: z.z : absolute y.y : relative

1.3.10 ESYZ: Set System Time

Command	Response	Description
_ESYZ_K0_yymmdd_hhmmss	_ESYZ_s	Respond system time. yymmdd : year, month, day (each 2 characters wide, no spaces) hhmmss : hour, minutes, seconds (each 2 characters, no spaces)

1.3.11 ET90: Set Lowpass Filter Time

Command	Response	Description
_ET90_K0_t	_ET90_s	Set lowpass filter time. t : filter time constant in seconds

1.3.12 EDAL: Diagnostic alarm Limits

Command	Response	Description
_EDAL_K0_x_x.min_x.max	_EDAL_s	Set alarm limits of x.

Alarm Limits:

1	Sample Pressure
2	Air Pressure
3	Oven Temperature
4	Converter Temperature
5	Pump Temperature
6	Diode Temperature
7	Cell Temperature
8	Peltier Gas Temperature
9	EPC Coil Sample Voltage
10	EPC Coil Air/Ozone Voltage
11	Reserved (<i>set min and max to 0.0</i>)
12	Sample Content
13	O ₂ Temperature
14	Reaction chamber pressure

1.3.13 ETCP: Set TCP/IP parameters

Command	Response	Description
_ETCP_K0_zzz.zzz.zzz.zzz _yyy.yyy.yyy.yyy _xxxx	_ETCP_s	zzz: TCP/IP adress yyy: TCP/IP subnet mask xxxx: TCP/IP port All changes take effect after next power on cycle

1.3.14 ERO2: Set O₂ reference value

Command	Response	Description
_ERO2_K1_x.x	_ERO2_s	Set O ₂ reference value used for O ₂ correction of NO/NO _x

1.3.15 EUDP: Set UDP Data streaming parameters

Command	Response	Description
_EUDP_K0_<UDPPort>_<DataFrequency>_[<Mode>]_[<UDP_IP>]_[DATA]	_EUDP_s	<p>Configure an UDP channel for data streaming of the measuring values via Ethernet UDP.</p> <p>Port: port for open the UDP connection</p> <p>DataFrequency: Frequency for transmit the data in Hz</p> <p>Mode: A: ASCII Mode (optional)</p> <p>UDP_IP: Alternative IP address for open the UDP connection when it should not use the IP of connected TCP/IP client (optional).</p> <p>DATA: See description below (optional)</p>

DATA format:

DATA is any number of AK commands delimited by a semicolon (;). Replace spaces in the AK command with a underscore (_).

If data is given UDP_IP has to be set to a legal IP address or a hyphen (-) if default address should be used.

If DATA is omitted, "AKON K0" is used as default streaming data.

Format of the streaming Data via UDP:

ASCII Mode:

The measuring values will be sent with ASCII signs. The format is:

<Sequence number> <data>

The sequence number will be incremented with every data packet, which is sent.

<data> is the AK four character code followed by the answer. See corresponding AK command description.

Example:

Sending "EUDP K0 7001 2 A – AKON_K0;ADUF_K0" will give following streaming result:

"123 AKON 4.07 901.33 22.50 3481639460 ADUF 4.30 4.59 4.45", where 123 is the sequence number.

1.4 ABBREVIATIONS USED

Mn	: Measuring range number
M1 .. M4	: Measuring Range 1 .. 4
w.w .. Z.Z	: Numerical value
t	: Numeric integer value
x	: Number
yyymmdd	: Date of format Year, Month and Day with two characters each and no spaces
hhmmss	: Time of format Hour, Minute and Second with two characters each and no spaces
a0 .. a4	: Polynom coefficients
s	: Status