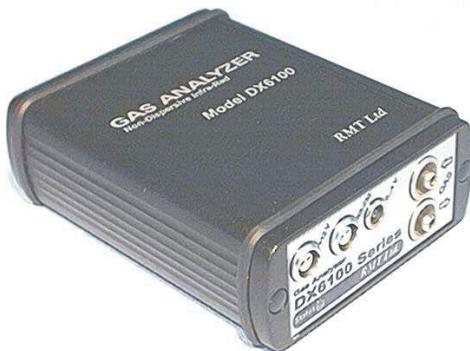


RMT Ltd.
Joint Stock Company

**Modular Gas Analyzer
DX6100 Series**

User Guide



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Limited Warranty

RMT Ltd warrants that DX6100 Gas Analyzer, if properly used and installed, will be free from defects in material and workmanship and will substantially conform to RMT's publicly available specification for a period of one (1) year after date of DX6100 Gas Analyzer was purchased.

If the DX6100 Gas Analyzer which is the subject of this Limited Warranty fails during the warranty period for the reasons covered by this Limited Warranty, RMT, at this option, will :

REPAIR the DX6100 Gas Analyzer; **OR**

REPLACE the DX6100 Gas Analyzer with another DX6100 Gas Analyzer.

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1. Introduction

The company RMT Ltd introduces new DX6100 series of Modular Gas Analyzers.

The principle of operation is based on selective absorption of IR radiation by gas molecules.

The differential double frequency optical scheme provides high accuracy in wide ranges of humidity and temperature due to the internal thermostabilization.

New type of middle infrared combined optocomponent with built-in thermoelectric cooling is used.

There are several models suitable for the following gases : CO₂, CH₄, C_nH_m, water vapor.

Advantages

- ***high selectivity and stability,***
- ***wide range of measured concentrations,***
- ***very small response time,***
- ***the long service life.***

Features

- ***no moving parts,***
- ***minimum dimensions and light weight,***
- ***minimum power consumption.***

2. Theory of Operation

Principles of Operation

The NDIR (Non-Dispersive Infra-Red Spectroscopy) measurement method is implemented in the DX6100 Analyzer.

The analyzer provides gases concentration measurement based on the classical double channel optical scheme (Fig. 2.1). One of the beams (measuring channel) has the wavelength which is tuned to the optical absorption line of the measured gas. The other beam (reference channel) has the wavelength which is out of the adsorption band of the measured gas.

Intensities of two light beams passed through the measured gas sampling cell are compared.

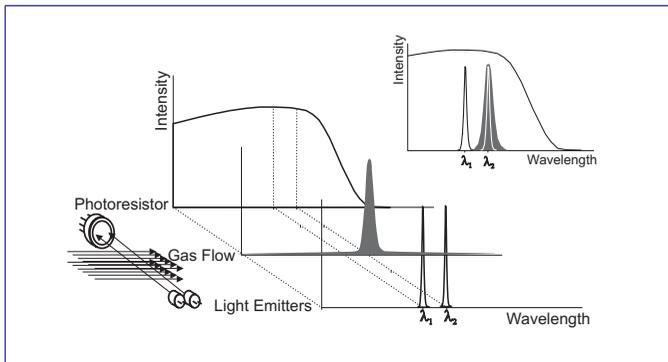


Fig. 2.1. The principle of gas concentration

According to the Beer–Bouguer–Lambert law, light absorption in gas volume is proportional to the absorbing gas concentration:

$$I = I_0 \cdot e^{-\alpha LX}$$

where

- I_0 – intensity of light before pass through the gas volume;
- I – intensities of light after pass through the gas volume;
- α – absorption coefficient of the gas at the chosen light wavelength;
- L – optical pass length;
- X – gas concentration.

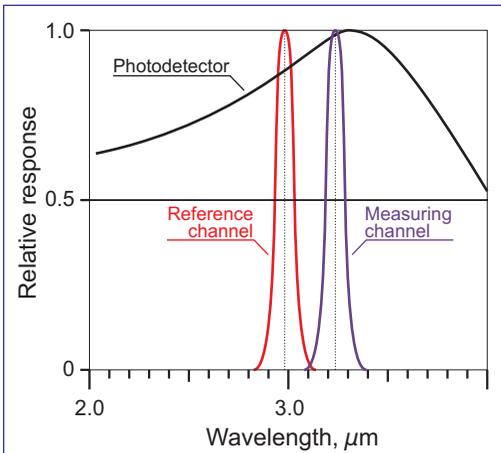


Fig. 2.2. Spectral bands of light emitters for methane analyzer

At a fixed L and known absorption α it is possible to find gas concentration using measured intensity of light (measuring channel) that passed from Light Emitter to Photodetector.

Reference channel is used for indirect measuring of the initial intensity of light, and allows to eliminate actual measurements conditions (total transparency of gas volume, optics imperfection and so on).

In Fig. 2.2 the example of spectral bands of light emitters for methane analyzer is shown.

The detailed description of the optocomponent is given in Chapter 3.

In Fig. 2.3 the spectral bands of light emitters of the optopair are given in comparison with methane absorption spectra.

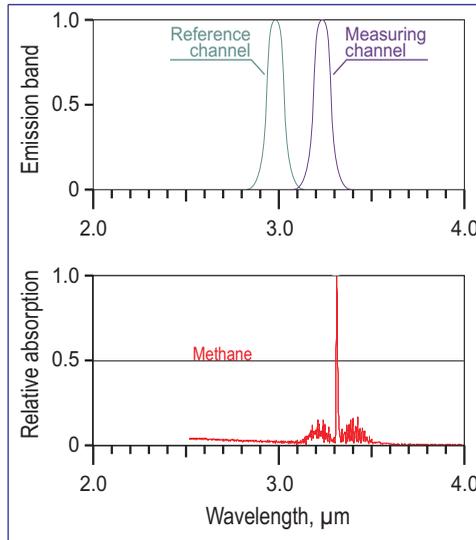


Fig. 2.3. Spectral bands of light emitters and methane

Design Features

The DX6100 Gas Analyzer is specially designed for a fast response, high sensitivity, low noise and low power consumption.

A number of design features contribute to the performance :

- The infrared sources are special narrow–band pulsed Light Emitters which operate in microsecond range. The light sources have long life (more then 10,000 hours).
- Radiation from Light Emitters passes through the gas sampling cell, reflects from the mirror and is focused onto the wide–band Photodetector.
- Both Light Emitters and Photodetector chips are integrated into a single housing and placed onto a miniature TE cooler for thermostabilization.
- Microcontroller provides temperature regulation with better then 0.1°C accuracy. The temperature is software selectable from ambient down to –20°C.
- Heat, dissipated from warm side of the TE cooler, leads to few degrees of overheating of gas sampling cell above ambient. This factor plays a role of vapor anti–condensation at operation in wet conditions.

- All driving function of Light Emitters and Detector are operated by on-board microcontroller.
- Pre-amplified outputs are maintained by the microcontroller. The final result is the digital data of measured gas concentration and is available in realtime through RS-232C or analog port.
- For signal processing the calibrating data of Optical Unit is used. The data is stored in Optical Unit's EEPROM.
- The RS-232C port is also used for remote control from computer.

Operation Overview

The order of measurements with DX6100 device is as follows:

1. Firstly, individual calibration of device is required with using of standard gas mixtures.

The Detector output signal is non-linear with respect to measuring gas concentration. In spite of theoretical formula the intensity of light which passed through gas sampling cell, is the integral of various optical rays from Light Emitter. Also sensitivity of Detector and performance of Light Emitter depend very from its operating temperatures.

Detector's output signals (both measuring U_m and reference U_r channels) are measured to calculate the following D ratio as a function of known concentration X of standard mixtures.

Zero ratio $D_0 = f(X=0)$ at zero gas concentration is used for polynomial extrapolation of calibration results as:

$$D = \frac{U_m}{U_r}$$

$$Y = \frac{D_0}{D}$$

$$X = A_0 + A_1 \cdot Y + A_2 \cdot Y^2 + A_3 \cdot Y^3 + A_4 \cdot Y^4$$

calculated coefficients $A_0 \dots A_4$ of polynomial expression and zero ratio D_0 are stored into device internal on-board EEPROM memory.

The first calibration is made by Manufacturer.

The factory standard calibration uses not less than 5 standard gas mixtures.

Several calibrations as above described are made at different ambient temperatures (in specified operating range) and at corresponding optimal operating temperatures of integrated detector – emitter pair.

Up to 15 such calibrations are possible to store for further application.

Format of calibration data stored in EEPROM memory chip is described below in Chapter 4 “Internal Commands of Analyzer”.

2. During routine operation the detector’s output signals are measured to calculate D ratio. Using known “zero” ratio D_0 value Y is calculated.

Finally, using known polynomial coefficients $A_0 \dots A_4$ gas concentration X is calculated with high accuracy. Resulted concentration is calculated in absolute mmol/m^3 units.

Device provides (if required) recalculation of the concentration into relative ppm units. But to convert absolute units (mmol/m^3) into relative (ppm) ones it is necessary to use ambient temperature and pressure.

The values of ambient temperature and pressure can be input by a user manually into device memory at the beginning of experiment.

Default values are extracted by device microcontroller from memory and are correspond to ambient conditions at calibration procedure.

Also it is possible to use value of measured ambient temperature provided by on-board digital thermo-sensor.

3. To preserve high accuracy of the device it is necessary to do “zero” adjustments periodically as recommended in Chapter “Maintenance” of the Manual.

4. Periodicity of device recalibration is 1 year. It could be done at the factory of Manufacturer, or by a user with the help of corresponding DX6100 Vision software.

Temperature Compensation

Gas Analyzer's operating software contains a function of compensation of measured gas temperature.

The algorithm of the procedure is as follows:

Digital temperature sensor is built into the Gas Analyzer. It monitors continuously the temperature T_m during measurement process. This temperature is compared with temperature (T_C) of calibrating data, stored into EEPROM.

Using of the above values the compensation is made as:

$$X_T = X_{T_c} \cdot \left(\frac{T_m}{T_C} \right)$$

where T_m and T_C are used in Kelvin.

The compensation procedure could be switched on/off with using of remote commands to RS-232C port from an external computer. Default state is ON.

It is also possible to retrieve operating temperature during measurements. Details of the command availability are described below in Chapter 4 "Internal Commands of Analyzer".

3. Hardware

Inside the Analyzer

The DX6100 Analyzer consists of three main parts, shown in Fig. 3.1:

- DX6106 Optical Unit
- 6101 Controller Module
- 6102 Optocomponent Mating Module

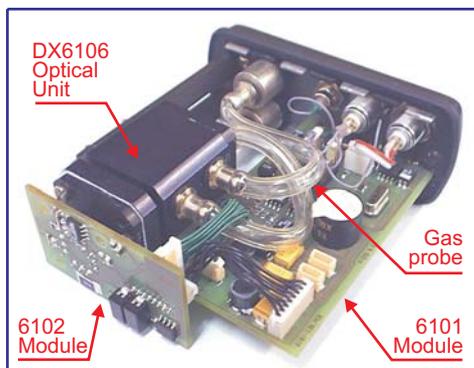


Fig. 3.1. DX6100 Analyzer with the cover removed

Those parts combined together and housed into a body form a completed version of DX6100 analyzer.

The same components taken separately, supplemented by a set of special cables, form a Kit for OEM applications (DX6100 OEM) analyzer.

DX6106 Optical Unit

The DX6106 Optical Unit is the head part of the Gas Analyzer. It consists of an isolated gas sampling cell (the spherical mirror and the sapphire window are placed at the end sides) and a new generation integrated optopair with 6102 electronic module.



The internal volume of the gas cell depends on Optical Unit version. The gas sampling cell has two gas inlets with 5.0 mm internal diameter.

The gas sampling cell can be easily disassembled for service of internal optics (mirror and window). For this



Fig. 3.3. DX6106 Optical Unit with optopair detached

purpose both the top and bottom covers can be removed and the optical components extracted out.

The mirror has special SiO₂ safety layer.

DX6106 Optical Units are manufactured in two versions: with DX6106.C2 and DX6106.C4 gas sampling cells (Table 3.1).

Table 3.1. The versions of Optical Units

		Total path length	Internal volume
DX6106.C2	2	55	4.7
DX6106.C4	4	100	10.4

Depending on what gas and what limiting concentration value must be measured by the Analyzer, it is furnished with one or the other sampling cells. The exteriors of both units are shown in Fig. 3.4 and Fig. 3.5.



Fig. 3.4. DX6106.C2 gas sampling cell



Fig. 3.5. DX6106.C4 gas sampling cell

The optical schemes of gas cells are represented in Fig. 3.6 and Fig. 3.7.

The outline dimensions of DX6106.C2 and DX6106.C4 Optical Units are shown in Fig. 3.8 and Fig 3.9 respectively.

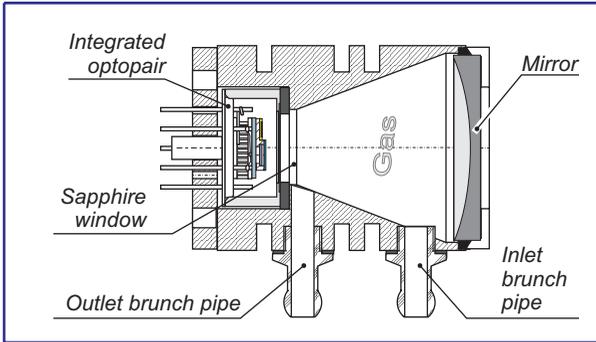


Fig. 3.6. DX6106.C2 Optical Unit construction

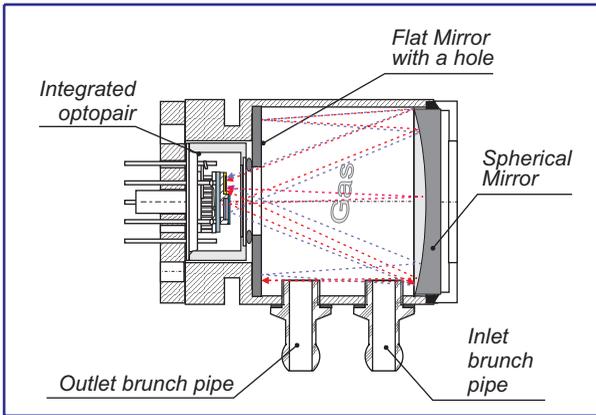


Fig. 3.7. DX6106.C4 Optical Unit construction

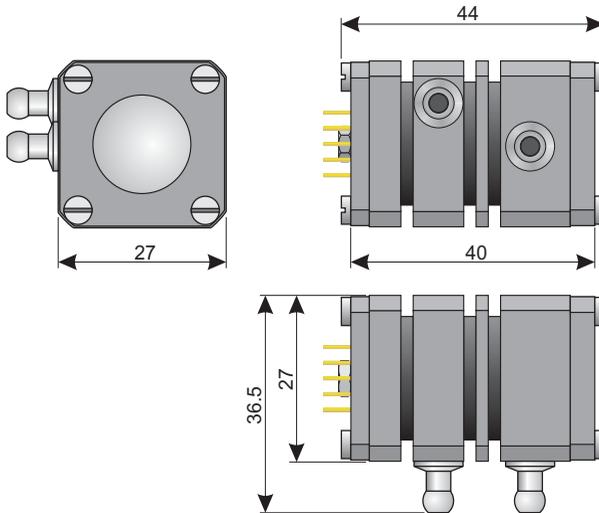


Fig. 3.8. DX6106.C2 Optical Unit outline dimensions (in millimeters)

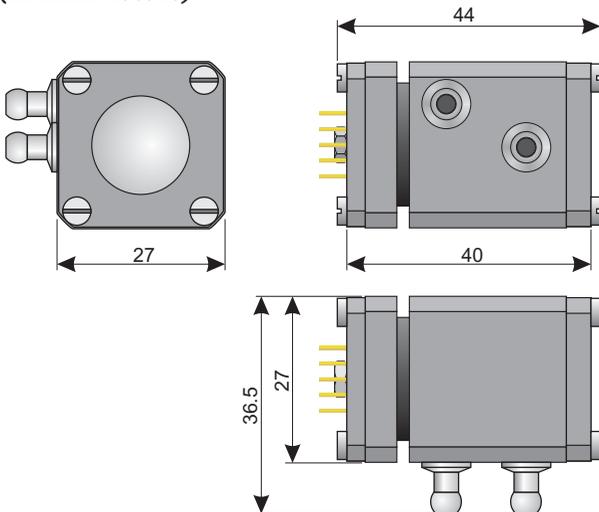


Fig. 3.9 DX6106.C4 Optical Unit outline dimensions (in millimeters)

Optocomponents

The new generation OPRI opto-pair consists of three opto-elements integrated into one case : two narrow-band light emitters (of about $0.1 \mu\text{m}$ emission band) and one wide-band photodetector.

The optopair consists of two special solid state light emitters (light sources) and one sensitive element (photodetector).

The peak emission wavelength of one light emitter is near the absorption band of measured gas (measuring channel).

The peak wavelength of the other one is out of the absorption band of gas (reference channel).

The photodetector has approximately equal sensitivity to signals of both emitters.

All the elements of the optopair are mounted onto the cooling surface of a single stage thermoelectric module with an internal thermosensor (Fig. 3.10).

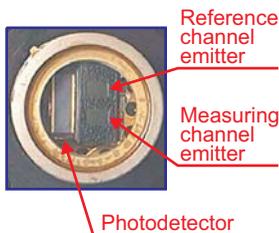


Fig. 3.10. OPRI elements arrangement

A number of steps have been taken to decrease the optoelements mutual influence.

The pins layout of the optopair is shown in the Fig. 3.11.

As an example, the parameters of optoelements for methane (CH₄) measurements are introduced in the table below:

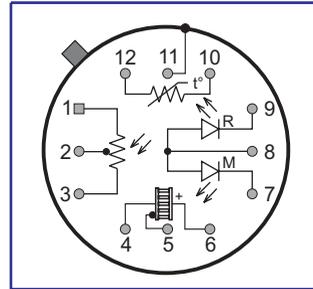


Fig. 3.11. OPxxx optopair pins layout (top view)

Element	Peak wavelength [μm]	Bandwidth [μm]
Measuring channel emitter	3.23	0.1
Reference channel emitter	2.98	0.1
Photodetector	3.3	2.5

The above table is illustrated with Fig. 3.12.

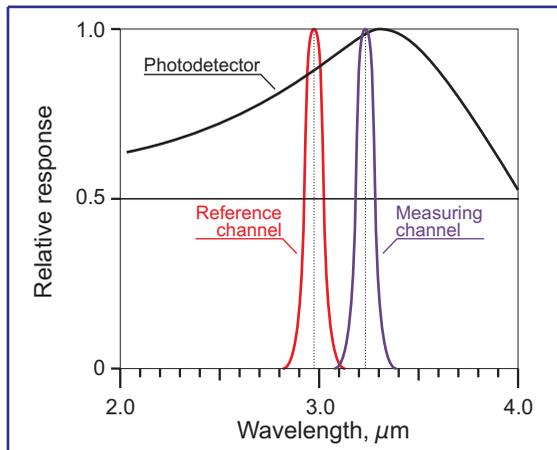


Fig. 3.12. Emission bands of light emitters for methane analyzer

Thermistors

For temperature driving by TE coolers, NTC thermistors built into cold the side of TE cooler are used. These thermistors are used in scheme with serial loading resistor R_L and voltage reference U_{REF} .

Output signal from the thermistor scheme depends on its resistivity, which changes with temperature as :

$$U_{TR} = U_{REF} \left(\frac{R_L}{R_L + R_T} \right)$$

One can see that accuracy of temperature measurement depends directly on U_{REF} .

In electronic PCBs of Optical Sensor, 4.096 V Precision Voltage Reference is used .

Typical dependence of thermistor's scheme output vs measured temperature is presented in Fig. 3.13.

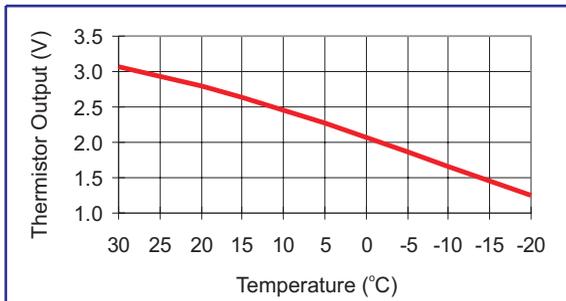


Fig. 3.13. Thermistor's circuit output vs measured temperature

Thermoelectric Coolers

Driving by built-in TE cooler requires particular attention.

First of all, the TE coolers are the components which consume largest part of power (Fig. 3.14).

Second, the operation of TE coolers directly affect performance parameters of Optical Sensor.

This ratio is approximately $100\%/20^{\circ}\text{C}$. It is equivalent to temperature drift $1\%/0.2^{\circ}\text{C}$. It means that if the thermo-stabilization should be with accuracy of 0.1 deg, then accuracy of measurements will be 0.5%.

Accuracy of thermostabilization must correspond to the gas concentration measurements sensitivity.

Operating temperature of TE cooler should must be selected as optimal: too lower temperature stabilization leads to higher power consumption; at higher temperature the output signals (and signal/noise ratio) are lower.

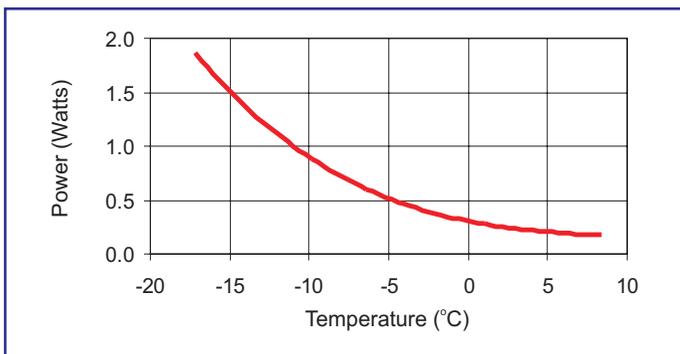


Fig. 3.14. TEC power consumption vs operation temperature

6101 Controller Module

The 6101 Controller Module (Fig. 3.15) provides the following functions:

- amplification and processing of detector's output signals,
- storage of identifier and individual calibration parameters.
- thermostabilization of optocomponent using built-in PID algorithm of TE cooler regulation with thermosensor,
- signals forming for light emitters driving
- filtering and digitizing of Detector's pre-amplified output,
- conversion of amplified output signals into gas concentration using stored calibration data,
- driving by the gas analyzer through RS-232 port,
- light and sound alarm.

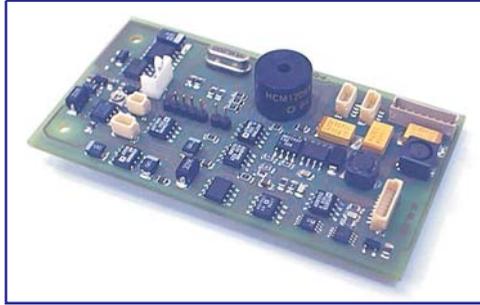


Fig. 3.15. 6101 Controller Module

The major connectors and parts placement at the 6101 Module's board are shown in Fig. 3.16.

The outline dimensions of the 6101 Module are given in Fig. 3.17.

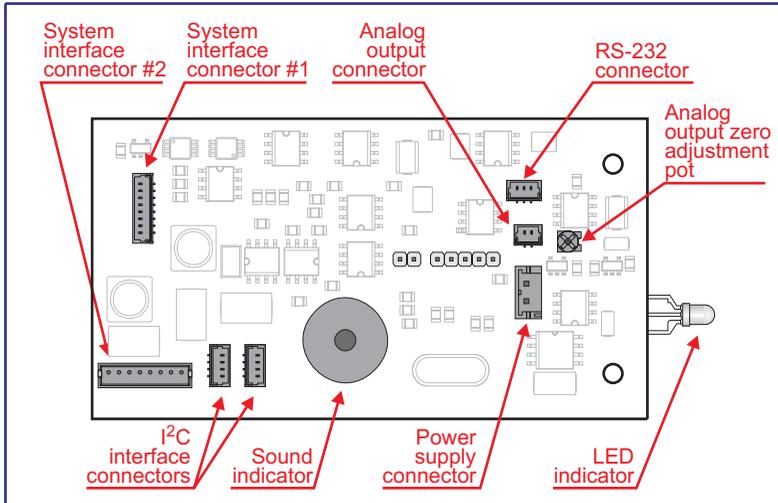
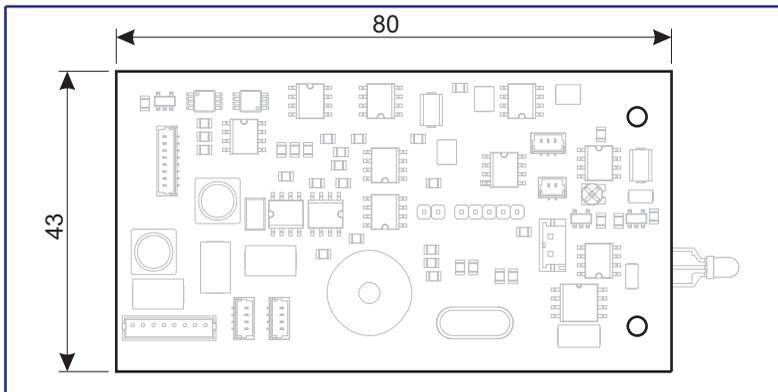


Fig. 3.16. Placement of the major connectors and parts at the



*Fig. 3.17. 6101 Module outline dimensions
(in millimeters)*

6102 Optocomponent Mating Module

The 6102 Optocomponent Mating Module (Fig. 3.18) provides:

- preamplification of photodetector's signals,
- light emitters driving,
- power supply of photodetector and thermistors with precise voltage.

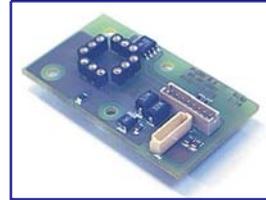


Fig. 3.18. 6102 Optocomponent Mating Module

The connectors and optopair location at the 6102 Module's board is shown in Fig. 3.19.

The outline dimensions of 6101 Module are given in Fig. 3.20.

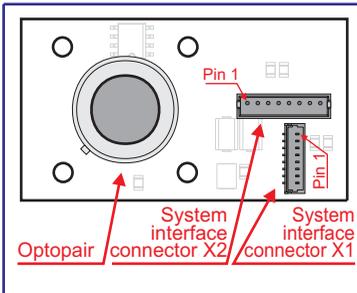


Fig. 3.19. Location of the connectors and optopair at the 6102 Modules board.

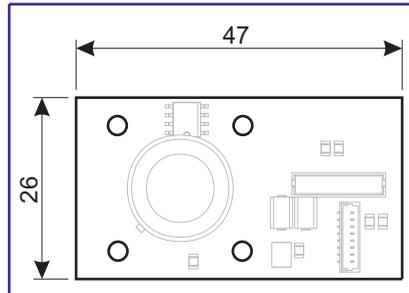


Fig. 3.20. 6102 Module outline dimensions (in millimeters)

Functional Diagram

The DX6100 Gas Analyzer functional diagram is shown in Fig. 3.21.

6102 Optocomponent Mating Module is connected with 6101 Controller Module with two special cables via miniature 8 pin System Interface connectors.

Digital Thermometer is an optional module for the measurement of an absolute value of ambient temperature with 0.5°C accuracy.

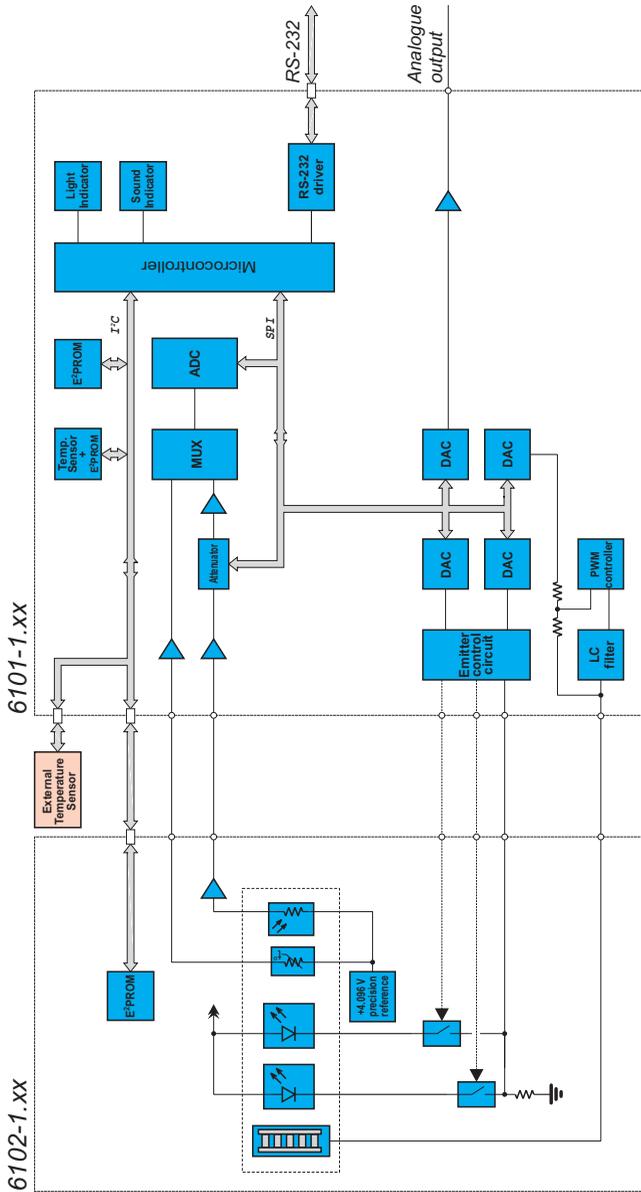
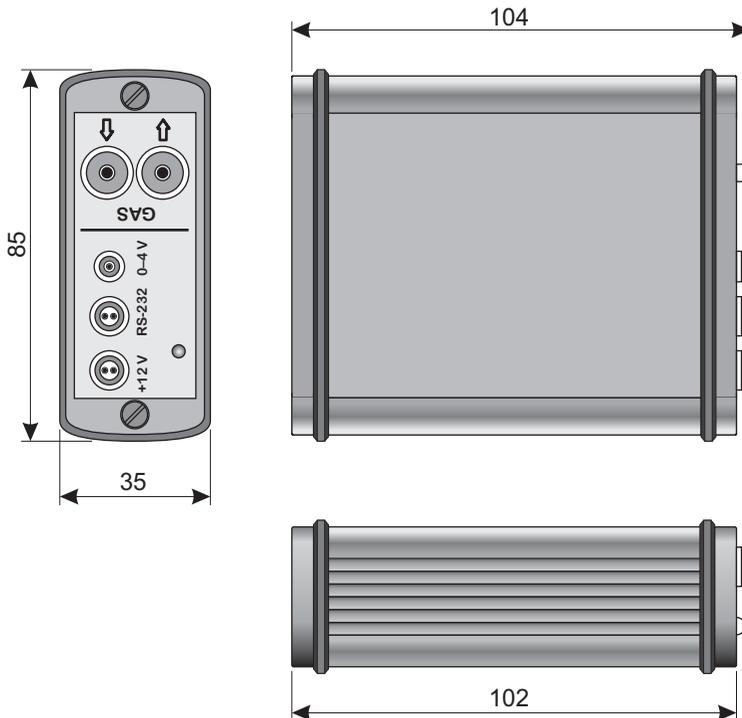


Fig. 3.21. Functional Diagram of DX6100 Gas Analyzer

Housing and Dimensions

The enclosure of the analyzer is made of painted aluminum alloy. Extruded body of the enclosure is closed by covers from end faces. The rubber gaskets placed between body and covers provide the enclosure with water resistance.

The overall dimensions of the DX6100 Analyzer are shown in a Fig. 3.22.



*Fig. 3.22. DX6100 Analyzer outline dimensions
(in millimeters)*

4. Analyzer Commands

Assignment of Commands

The remote control by Analyzer is available using RS–232 port by a set of commands.

They could be divided into two groups:

- driving commands,
- setting commands.

All commands have the same format – the symbol string, which consists of the command name identifier and a list of its parameters. Some commands have no parameters.

The ASCII format is used. All commands must be entered by lower–case letters.

<Space> or <Tab> symbols are used within command string as delimiters.

“Comma” is used to replace a parameter which is not changed during the command execution.

For reduction of parameters or preview of its current status the same commands identifiers are used.

To preview a command preset status only the identifier of the command is typed. Then the command status is returned.

If the command is typed with a list of parameters, then new parameters substitute the preset ones. The “Comma” symbol instead of some parameters in the parameter list allows to preserve the earlier preset value.

To transfer any command to Analyzer it is necessary to execute the connection protocol. As the result, the Analyzer terminates the current operation, accepts a new command (or new parameters of the command) and executes the command.

The device which sends the command will be named **master** (a remote computer, an interrogator and so on), Analyzer will be named **slave**.

For simplification of connecting protocol a buffering of input data stream is recommended. The protocol represents the following exchanging order:

master: sends to slave <CR> symbol, and moves into the waiting state;

slave: receives symbol <CR>, returns the string
'NL' '>',

and holds up current operation and moves to the waiting state – waiting for a command's input (parameters);

master: if within 5 second it receives any string ending with symbol '>', it sends to the slave the first

symbol of the command and moves to the waiting state (waiting for the echo), otherwise it repeats attempts of the contact establishing;

slave: receives the next command symbol. If <CR> is received, then transferring of the command is finished, slave executes the received command (during command execution it is possible contacting) and returns the symbol <CR> (for slave the operation is finished). If the next symbol is received, then slave returns echo and waits for a further command symbol. If during further 20 seconds no command symbol is received, slave returns the following sequence "error" <CR> and returns to continuation of the current command execution (for slave the connection attempt was unsuccessful);

master: receives the echo symbol. If it is <CR>, then it means that the transferred command is received and executed by slave (for master transferring of a command is finished by transferring of <CR>), in the input buffer of master the transferred command with list of parameters must be present. If the echo symbol is the earlier transferred command symbol then master transfers the next command symbol and waits for an echo. If during 5 second the echo is not received it means that transferring is unsuccessful.

During the operation of Analyzer through RS–232 port, the telemetry information is transferring. It could contain both measuring data and any other accompanying information.

Structure and repeating rate of output data could be preset.

The commands can be divided into the following groups:

- the commands for preset parameters of Analyzer, which allow to do adjustment operations (**hw**, **sy**, **pr**),
- the commands for preset calibration parameters of Analyzer (**fn**),
- the commands for preset dynamical parameters, which establish the volume and repeating rate of telemetry and some parameters of statistic data treatments (**jb**, **di**),
- the commands which allow to start and stop measurements (**go**, **gc**, **gt**, **st**).

In the Table below the specifications of commands are presented.

Command's mnemonics	Description
di <Outcont>	Control the structure of output telemetry
fn <Num> <Tinv> <Pinv> <Rang> <A ₀ > <A ₁ > <A ₂ > ... <A ₇ >	View/edit calibration tables
gc <Num>	Start of calibration Mode
go <Num>	Start of Measuring Mode
gt <Num>	Start of Test Mode
hw <Nu> <Ksign> <Im> <Ir>	View/edit the table of preset parameters of hardware
id [#] <Text>	View/edit identifier of an unit
jb <Warn> <Alarm> <Trep> <Nrep> <Ka> <Delay>	View/edit parameters of measuring cycle
pr <Vc> <Kp> <Ki> <Dev>	View/edit parameters of digital temperature regulator
sf <Smf> <Nz>	View/edit parameters of digital filters
s t	Stop any operation mode
sy [#] <Dtl> <Dta> <Tclk> <Cclk> <Nms> <Ct>	View/edit parameters of hardware synchronization
tp <Tinv> <Pinv>	Temperature range selection
tr <Nu> <Tc> <Tinv> <Nhw> <Nfn> <DO>	View/edit the table of temperature ranges
ws <Mod> <St>	Reading status of the sensor
ze	Sensor zero correction

Analyzer Commands

The descriptions of the DX6100 analyzer commands are given below in alphabetical order.

DI command

Format:

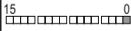
di <Outcont>

This command controls the structure of the output telemetry.

The *Outcont* parameter is entered and displayed in the HEX format. The output of each parameter of telemetry is enabled/disabled (1/0) by the appropriate bit of the *Outcont* parameter.

If *Outcont* is omitted, the current value of parameter will be displayed.

Format of *Outcont* parameter

Bit	Bit position	Mnemonic	Description	Format	Units
B ₀ 0		Usign	The output signal of measuring channel	word	ADC units
B ₀ 1		Uref	The output signal of reference channel	word	ADC units
B ₀ 2		Tc	The temperature of the optopair	word	ADC units

Format of *Outcont* parameter (continued)

DI

Bit	Bit position	Mnemonic	Description	Format	Units
B ₀ 3	15 <input type="checkbox"/> 0	Vc	The cooler supply voltage	word	DAC units
B ₀ 4	15 <input type="checkbox"/> 0	R	In the Measuring mode : the measuring gas concentration. In the Calibration mode : not normalized value of measuring channel response	float	
B ₀ 5	15 <input type="checkbox"/> 0	D	Not normalized value of measuring channel response	float	
B ₀ 6	15 <input type="checkbox"/> 0	Tamb	The ambient temperature	word	0.1K
B ₀ 7	15 <input type="checkbox"/> 0	Num	The measurement number in a current session	long	
B ₀ 8	15 <input type="checkbox"/> 0	Tel	Enables output of the telemetry parameters set		
B ₀ 9	15 <input type="checkbox"/> 0	Buff	Enables data accumulation in the internal buffer		
B ₁ 0	15 <input type="checkbox"/> 0	Snd	Enables the sound alarm. If the sound alarm is enabled, at excess of gas concentration over the Warning threshold level the Sensor generates periodic signal with 1 Hz frequency. At excess concentration over the Alarm level the Sensor generates periodic signal with 2 Hz frequency.		
B ₁₁	15 <input type="checkbox"/> 0	Dbg	Enables Debug mode. If it is enabled, the telemetry is outputted irrespective of a TECs conditions		

DI Format of *Outcont* parameter (continued)

Bit	Bit position	Mnemonic	Description	Format	Units
B ₁ 2	15 <input type="checkbox"/> 0	Unit	<p>The units of the gas concentration measuring :</p> <p>0 – The outcome is represented in [mmol/g]. (It is more exact, in those units, in which the Sensor had been calibrated). The measuring units recalculation is OFF.</p> <p>1 – The outcome is represented in [ppm]. (The Sensor should be calibrated in [mmol/g]). Thus the translation of concentration outcomes from the relative units [mmol/g] into the absolute ones [ppm] is performed.</p> <p>The scaling is possible at calibration.</p>		
B ₁ 3	15 <input type="checkbox"/> 0	Cori	<p>Enables the internal temperature sensor using for temperature range selection and recalculation of outcomes into the absolute units of concentration measurement [ppm].</p> <p>If Cori bit is set, the internal sensor is used. Otherwise the value of temperature is calculated either on the external sensor indications, or by TP variable using.</p> <p>The value of pressure always is extracted from TP variable.</p>		

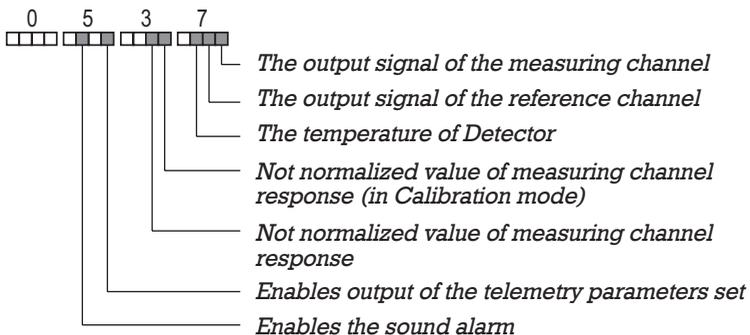
Format of *Outcont* parameter (continued)

DI

Bit	Bit position	Mnemonic	Description	Format	Units
B ₁ 4	15 0	Core	Enables the external temperature sensor using for temperature range selection and recalculation of outcomes into absolute units of concentration measurement [ppm]. If Cori bit is set and Core bit is reset, the external sensor is used. If Cori and Core bits are reset, the value of temperature from TP variable is used. The value of pressure always is extracted from TP variable.		
B ₁ 5	15 0		<i>Reserved</i>		

Example:

> di 537<Enter>



FN command

Format:

fn <Num> <Tinv> <Pinv> <Rank> <A₀> <A₁> <A₂> ... <A₇>

View/edit calibration tables.

Each table contains 15 lines. The reference to a particular line is present in each line of temperature ranges table.

Format of calibration table

Parameter	Description	Format	Range
<i>Num</i>	The number of calibration table	byte	[0...14]
<i>Tinv</i>	The ambient temperature, at which calibration was made	word	[2330...3130]
<i>Pinv</i>	The ambient pressure, at which calibration was made	word	[800...1200]
<i>Rang</i>	The polynomial's order plus 1	byte	[2...7]
<i>A₀</i>	The constant term of a polynomial	float	
<i>A₁</i>	Factor at the member of the 1st order	float	
...	
<i>A₇</i>	Factor at the member of the 7th order	float	

Example

> fn0 2930 1006 4 -10.578, 1.37<Enter>

0 – calibrations table line #0

Conditions of realization of calibration:

2930 – the ambient temperature is equal to
293°K

1006 – the ambient pressure is equal 100.6 kPa

4 – the order of the approximating
polynomial is equal 3 (4 – 1)

-10.578 – the constant term (A_0) of a polynomial is
equal to -10.578

, – the A_1 term of the polynomial has
remained without change

1.37 – the A_2 term of the polynomial is equal
1.37

– the A_3 term of the polynomial has
remained without change

– the $A_4 \dots A_7$ terms are unused

GC command

Format:

gc <Num>

Start in the **Calibration** mode.

Num designates the calibration table line (temperature range) [0... 14], for which the calibration is executed.

Example

> gc0<Enter>

0 – start in the **Calibration** mode. The line
0 of temperature ranges table is in use.

GO command

Format:

go <Num>

Start in the **Measurement** mode.

Num designates the calibration table line (temperature range) [0.. 14].

If *Num* is omitted, the sensor automatically determines temperature range.

If the indicated line is filled with incorrect data or if the sensor operates in the automatic mode and cannot select a suitable range, the *Error* diagnostics is given.

.....

Example

> **go**<Enter>

- start in the **Measurement** mode with automatically selected temperature range.

GT command

Format:

gt <Num>

Start in the **Test** mode.

Num designates the calibration table line (temperature range) [0.. 14].

Example

> **gt0**<Enter>

0 – start in the Test mode. The line 0 of temperature ranges table is in use.

HW command

Format:

hw<Nu> <Ksign> <Im> <Ir>

View/edit the table of preset parameters of hardware.

The hardware table contains 15 lines, which are used by activity of the sensor in different temperature ranges. The reference to the particular line is present in each line of temperature ranges table.

List of parameters

Parameter	Description	Format	Range
<i>Num</i>	The line number in the table of hardware preset parameters	byte	[0...14]
<i>Ksign</i>	The gain of a channel of a measuring signal processing	byte	[0...255]
<i>Imc</i>	The pumping current of the light emitter of the measuring wavelength channel	word	[0...4095]
<i>Irc</i>	The pumping current of the light emitter of the reference wavelength channel	word	[0...4095]

Example

> hw0 80, 4000<Enter>

- 0 – HW table's line #0
 - 80 – the number of cycles of measurements is equal to 1000
 - ,
 - the pumping current of Light Emitter of the measuring wavelength channel is left unchanged
 - 4000 – the pumping current of Light Emitter of the reference wavelength channel is equal to 4000 units
-



It is not recommended to change parameters of HV, set by Manufacturer.

ID command

Format:

id[#] <Text>

View/edit identifier of a unit.

List of parameters

Parameter	Description	Format	Range
[#]	The password for an identifier editing		
Text	Identifier of the unit	ASCII	up to 79 char.

The identifier consists of three fields

DX6100 <SWrev> <UNid>

Field	Content
<i>DX6100</i>	The unit brand. Fixed field, cannot be edited
<i>SWrev</i>	The software revision #. Fixed field, cannot be edited
<i>UNid</i>	Unit identifier. The field can be edited

JB command

Format:

jb <Warn> <Alarm> <Trep> <Nrep> <Ka> <Delay>

View/edit parameters of the **JB** block.

List of parameters

Parameter	Description	Units	Format	Range
<i>Warn</i>	<p>The threshold level, at excess of which the sensor emits light and sound (if enabled) "Danger" signals:</p> <ul style="list-style-type: none"> the LED is flashing yellow with 1 Hz frequency, the buzzer sounds with the same frequency. <p>The threshold level is set for the normalized concentration value, i.e. the value of concentration is multiplied by <i>Ka</i> at first, and then is compared with the threshold.</p>		word	[0...65535]
<i>Alarm</i>	<p>The threshold level, at excess of which the sensor emits light and sound (if enabled) "Alarm" signals:</p> <ul style="list-style-type: none"> the LED is flashing red with 2 Hz frequency, the buzzer sounds with the same frequency. <p>The threshold level is set for the normalized concentration value, i.e. the value of concentration is multiplied by <i>Ka</i> at first, and then is compared with the threshold.</p>	[sec-0.01]	word	[0...65535]
<i>Trep</i>	Repeating rate of telemetry data output	[sec-0.01]	word	[5...65535]

List of parameters (continued)

JB

Parameter	Description	Units	Format	Range
<i>Nrep</i>	Total number of measurement cycles. If "0" is set, then the number of measurement cycles is unlimited.		word	[5...65535]
<i>Ka</i>	Factor of normalization of an analog signal. If $Ka = 0$, analog output is disabled		float	[0.01...100]
<i>DeLay</i>	Delay time before auto-start. If $DeLay = 0$, then auto-start is disabled	[sec 0.01]	word	[0...65535]

Example

> **jb** 1000 4000 100 1000 0.1 0<Enter>

- 1000 – the threshold “**Danger**” level is equal to 100 (1000×0.1)
- 4000 – the threshold “**Alarm**” level is equal to 400 (4000×0.1)
- 100 – the repeating rate of telemetry data output is equal to 1 sec (0.01×100)
- 1000 – the total number of measurement cycles is equal to 1000
- 0.1 – the factor of normalization of an analog signal is equal to 0.1
- 0 – auto – start is disabled

PR command

Format:

pr <Vc> <Kp> <Ki> <Devt>

View/edit parameters of digital temperature regulator.

List of parameters

Parameter	Description	Units	Format	Range
Vc	The cooler supply voltage	DAC units	word	[0...4095]
Kp	Factor of the proportional part of the digital temperature regulator		float	[10...0.01]
Ki	Factor of the integral part of the digital temperature regulator		float	[0.1...0.001]
Devt	Maximum permissible deviation from the preassigned temperature	DAC units	byte	[1...255]

Example

> pr<Enter> 2000 2 0.02 70

2000 – the TE cooler supply voltage is equal to 16000 DAC units,

2 – the factor of the proportional part of the digital temperature regulator is equal to 2,

0.02 – the factor of the integral part of the digital temperature regulator is equal to 0.02,

70 – the maximum permissible deviation from preassigned temperature is equal to 70 ADC units.

SF command

Format:

sf <Smf> <Nz>

View/edit parameters of digital filters.

List of parameters

Parameter	Description	Format	Range
<i>Smf</i>	The smoothing factor of the digital filter for statistical data processing: <u>Smf = 0</u> : The data is averaged over telemetry output period. <u>Smf = 1</u> : The smoothing is OFF. The data updating periodicity is equal to 100 ms. <u>Smf > 1</u> : The smoothing factor is equal to $Smf \times 0.1$ sec.	word	[0...65535]
<i>Nz</i>	Number of cycles of measurements for statistics accumulation on a ZE command	word	[0...65535]

Example

> **sf 1 1000**<Enter>

- 1 – the smoothing factor of the digital filter for statistical data processing is equal to 0.1 sec
- 1000 – the number of cycles of measurements is equal to 1000

ST command

Format:

st

The command stops any operation mode.

.....

Example

> **st**<Enter>

– the sensor is stopped

SY command

Format:

sy[#] <Dt1> <Dta> <Tclk> <Cclk> <Nms> <Ct>

View/edit parameters.



Only experienced persons can use this command for parameters editing. Partial or even total loss of working efficiency may occur owing to incorrect use of SY command.

List of parameters

Parameter	Description	Units	Range
[#]	The password for an identifier editing		
<i>Dt1</i>	Pulse duration of light emitters	μs	[1...250]
<i>Dta</i>	Delay between light emitter pulse fall and output signals sampling start	μs	[0...100]
<i>Tclk</i>	The main synchronization clock period	μs	[3000...5000]
<i>Cclk</i>	Divider of the main synchronization clock period for LED indicator and time counter. Recommended value is 10,000/ <i>Tclk</i>		[1...20]
<i>Nms</i>	Sample size of the first level digital filter		[1...50]
<i>Ct</i>	Divider of the main synchronization clock period for timing of TEC's temperature regulator.		[1...10]

Example**SY**

> **sy 50 5 5000 2 10 2**<Enter>

- 50 – the pulse duration of light emitters is equal to 50 μs
 - 5 – the delay between light emitter pulse fall and output signals sampling start is equal to 5 μs
 - 5000 – the main synchronization clock period is equal 5000 μs
 - 2 – clock period for LED indicator is equal to 0.5 sec (2 Hz)
 - 10 – the sample size of the first level digital filter is equal to 10 readouts
 - 2 – the period of TEC's temperature regulator synchronization is $5000 / 2 = 2500$
-

TP command

Format:

tp <Tinv> <Pinv>

This command is used for temperature range selection and updating results on temperature and pressure.

If some of <Tinv> or <Pinv> parameters are out of the allowed limits of change, the indications of internal sensors are used.

List of parameters

Parameter	Description	Units	Format	Range
<i>Tinv</i>	Ambient temperature	[0.1°K]	long	[2330...3230]
<i>Pinv</i>	Ambient pressure	[0.1 kPa]	long	[500...1500]

Example

> **tp 2980 1013<Enter>**

2980 – the ambient temperature is equal to
298°K (25°C)

1013 – the ambient pressure is equal to 101.3
kPa

TR command

Format:

tr<Nu> <Tc> <Tinv> <Nhw> <Nfn> <D0>

View/edit the table of temperature ranges.

The table contains 15 lines. Each line contains values of parameters, at which the sensor works in the given temperature range.

List of parameters

Parameter	Description	Units	Format	Range
<i>Nu</i>	Line number of the temperature ranges table		byte	[0...14]
<i>Tc</i>	Operating temperature of TE cooler		word	[10000...60000]
<i>Tinv</i>	Ambient temperature (upper bound) at which this table line is used	[0.1°K]	word	[2330...3230]
<i>Nhw</i>	The line of equipment table, which currently is in use in this temperature range		byte	[0...9]
<i>Ntc</i>	The line number in the calibration table, which is used for linearization of the sensor's readouts at measurement of gas concentration		byte	[0...9]
<i>Dc0</i>	The sensor's response at zero gas concentration		float	

Example

> tr0 20000 2930 0 0 1.01<Enter>

- 20000 – the operating temperature of TE cooler
- 2930 – the upper bound of ambient temperature at which this line is used is equal to 293.0°K
- 0 – the line #0 of equipment table **HW**
- 0 – the line #0 of calibration table for gas concentration measurement
- 1.01 – the sensor's response at zero gas concentration

WS command

Format:

ws <Mod> <St>

Reading status of the sensor.

List of parameters

Parameter	Description																
<i>Mod</i>	Operational mode of the sensor: 0 – Sensor is OFF 1 – Test mode 2 – Measurement mode 3 – Calibration mode																
<i>St</i>	<p>The general status of the analyzer:</p> <table border="1"> <thead> <tr> <th>7</th> <th>6</th> <th>5</th> <th>4</th> <th>3</th> <th>2</th> <th>1</th> <th>0</th> </tr> </thead> <tbody> <tr> <td>Data is ready</td> <td colspan="3">Reference channel TEC's field</td> <td colspan="4">The number of the temperature range</td> </tr> </tbody> </table> <p><u>TEC's fields format:</u></p> <p>Bits 2 0 <input type="checkbox"/><input type="checkbox"/><input type="checkbox"/> The TEC is OFF</p> <p><input type="checkbox"/><input checked="" type="checkbox"/><input type="checkbox"/> The TEC's temperature setting is in progress</p> <p><input type="checkbox"/><input type="checkbox"/><input checked="" type="checkbox"/> It is too cold, TEC is out of normal operation</p> <p><input type="checkbox"/><input checked="" type="checkbox"/><input type="checkbox"/> It is too hot, TEC is out of normal operation</p> <p><input checked="" type="checkbox"/><input type="checkbox"/><input type="checkbox"/> Everything is OK</p> <p><input checked="" type="checkbox"/><input type="checkbox"/><input type="checkbox"/> It is cold, TEC's temperature is stable, but TE cooler is near its minimum operating current</p> <p><input type="checkbox"/><input checked="" type="checkbox"/><input type="checkbox"/> It is hot, TEC's temperature is stable, but TE cooler is near its maximum operating current</p>	7	6	5	4	3	2	1	0	Data is ready	Reference channel TEC's field			The number of the temperature range			
7	6	5	4	3	2	1	0										
Data is ready	Reference channel TEC's field			The number of the temperature range													

Example:

> ws<Enter> 0 C1

0 – **Measuring** mode

C1 – The general status of the device:



ZE command

Format:

ze

Correction of zero of the sensor.

The command will be accepted, if the sensor is in the **Calibration** mode. Otherwise the command will be rejected and the message ERROR given.

After obtaining the command the sensor terminates a telemetry output for the time necessary for the statistics collecting for an evaluation of value of parameter D_0 .

After completion of accumulation of statistics the measured value of D_0 is recorded into the appropriate line of calibration table according to the selected operational temperature range. The statistics accumulation is made by summation NZ of smoothed measurements. Parameter NZ is changed by **SF** command.

Example

> **ze**<Enter>

– correction of zero of the sensor.

Format of Output Telemetry

The telemetry information is outputted as a sequence of numbers, separated by the <Space> symbol. The numbers are in ASCII format.

The sequence is enclosed by curly brackets (“{” and “}”), begins from the <CR> symbol and is closed by the <LF> symbol.

Format of numbers and measurement units are indicated in the table on the next page.

The structure of the outputted telemetry information is determined by the DI command.

The order of parameters' arrangement in the line of the telemetry information is the following:

{ <Num> <Usign> <Uref> <Tc> <Vc> <Tamb> <D> <R> }

Any of the parameters is presented in this line only in the event that its output is allowed by the appropriate bit of parameters of **di** command.

Mnemonic	Description	Format	Units
Num	The measurement number in a current session	long	
Usign	The output signal of the measuring channel	word	ADC units
Uref	The output signal of the reference channel	word	ADC units
Tc	The temperature of the optopair	word	ADC units
Vc	The cooler supply voltage	word	DAC units
Tamb	The ambient temperature	word	0.1K
D	Not normalized value of the measuring channel response	float	ADC units
X	The measuring gas concentration	float	ppm mmol/m ³

Example:

```
>di 417F
```

```
>go
```

```
{ 36098 32692 18988 1400 2930 2824 1.1066}
```

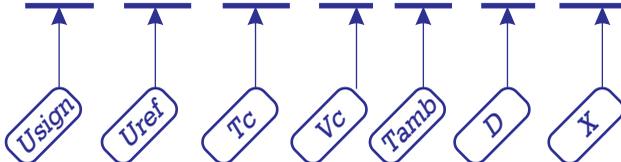
```
{ 36051 32607 18984 1384 2930 2824 1.1050}
```

```
{ 35988 32568 18987 1381 2930 2823 1.1050}
```

```
{ 36044 32712 18991 1381 2930 2822 1.1018}
```

```
{ 36119 32622 18987 1364 2930 2821 1.1059}
```

```
{ 35998 32667 18988 1358 2930 2820 1.1011}
```



EEPROM Data Format

Various operating parameters can be stored in on-board EEPROM circuit:

- calibration data,
- synchronization parameters,
- measuring mode presets,
- TE cooling algorithm presets,
- Optical Unit identification.

See recommended EEPROM data structure in Table 3.1.

The formats of the First Calibration Data Block is given in Table 3.2.

Formats of other reserved (if applied) Calibration Data

Table 3.1. EEPROM Data Format

Item	Address (hex)	Content	Command
1	0000	Calibration data block (first calibration data)	fn 0
2	0018	Calibration data block	fn 1
3	0030	Calibration data block	fn 2
4	0048	Calibration data block	fn 3
5	0060	Calibration data block	fn 4
6	0078	Block of synchronization parameters*	hw
7	0082	Block of parameters of measuring cycle*	jb
8	008C	Parameters of thermostabilization of Detector*	pr
9	008C	Parameters of thermostabilization of Light Emitter*	em
10	008C	Optical Unit Identifier	id

Table 3.2. Format of the First Calibration Data Block

Item	Address (hex)	Content	Name	Format
1	0000	TE coolers Operating Temperature	T_C	int16
2	0002	Ambient Temperature of Calibration	T_{env}	int16
3	0004	"Zero" Value	d_0	float
4	0008	Polynomial Coefficient A_0	A_0	float
5	0014	Polynomial Coefficient A_1	A_1	float
6	0020	Polynomial Coefficient A_2	A_2	float
7	0024	Polynomial Coefficient A_3	A_3	float
8	0028	Polynomial Coefficient A_4	A_4	float
9	002C	Polynomial Coefficient A_5	A_5	float
10	0030	Polynomial Coefficient A_6	A_6	float

5. Working with DX6100 Analyzer

In general it is not required anything for the Analyzer operation except the external power source.

But for many purposes, such as the change of tunings of the analyzer, zero adjustment, calibration and so on, the control computer is necessary.

The user can control Analyzer with computer by two ways.

The first way is based on the use of any communication program. Thus the analyzer is controlled with the help of special commands entered manually via a keyboard.

The second way is based on using of the **DX6100 Vision II** software. The **DX6100 Vision II** software provides all possible operational modes of the DX6100 Gas Analyzer. The **DX6100 Vision II** has the simple interface and does not demand the User's special knowledge.

The **DX6100 Vision II** software is delivered with the DX6100 Gas Analyzer.

The following consideration involves Analyzer control based on using the **DX6100 II Vision** software.

To run the **DX6100 Vision II** software, your system must meet or exceed the following hardware and software requirements:

- Intel Pentium class computer with Windows 95/98/2000 operating system
- Free COM port
- 16 MB of RAM (32 MB recommended)
- 6 MB free hard drive space
- CD ROM drive
- Mouse or compatible pointing device

The use of **DX6100 Vision II** software does not demand the user wide experience. And on the contrary, the manual method of Analyzer operating control requires of careful study of Analyzer's commands set.

This way can be recommended only for experienced users.

But if nevertheless you want to use this way of sensor controlling you must be acquainted with some standard communication programs, such as the Hyper Terminal for Windows OS, for example. You must also be able to perform some simple tunings of communication program.

Be guided by Chapter 4 of this Manual when controlling the sensor manually.

Irrespective of a method of sensor control it is necessary at first to do some hardware preparations.

Hardware Preparation

Turn the DX6100 Analyzer by the face side to yourself. From this side you will see the following elements (Fig. 5.1):

- Power supply input connector,
- RS–232 connector,
- Analog output connector,
- Two–color LED indicator,
- Inlet gas port,
- Outlet gas port.

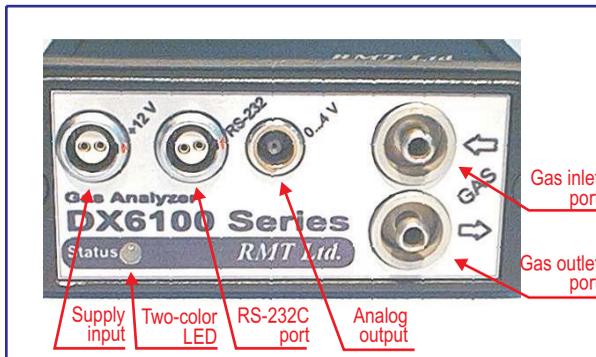


Fig. 5.1. Output Connectors of DX6100 Gas Analyzer

Now you may start preparation to begin working with the Analyzer. Try to keep to the following order of operations:

1. Turn off the sensor if it was ON.
2. Using the DX6100–C–03 cable connect the DX6100 Analyzer to COM port which you are going to use for Analyzer driving (Fig. 5.2).

3. Connect the supply cable to Power Supply Input (Fig 5.3).

You can use the standard AC/DC adaptor from the DX6100 Kit. Also you can use any other suitable power supply with 6 to 15 V DC output. In that case you can use the DX6100-C-02 cable which is also in the DX6100 Kit.



*Fig. 5.2. RS-232
Interface Cable
Connection*

4. Insert a plug of the adaptor into a socket of ~50/60 Hz 220 V supply line. (Or turn on the DC power supply if you use your own power supply).



*Fig. 5.3. Power Supply
Connection*

5. Turn on the sensor.

Now the Analyzer is ready for operation.

Program Installation

The **DX6100 Vision II** software is supplied on a CD.

Insert the CD into the appropriate drive and start the Setup program.

Pass all the steps of the installation procedure sequentially according to directions of the installer.

When selecting the logic disk you must keep in mind that the program requires not less than 5 Mb of hard disk space.

Program Launch

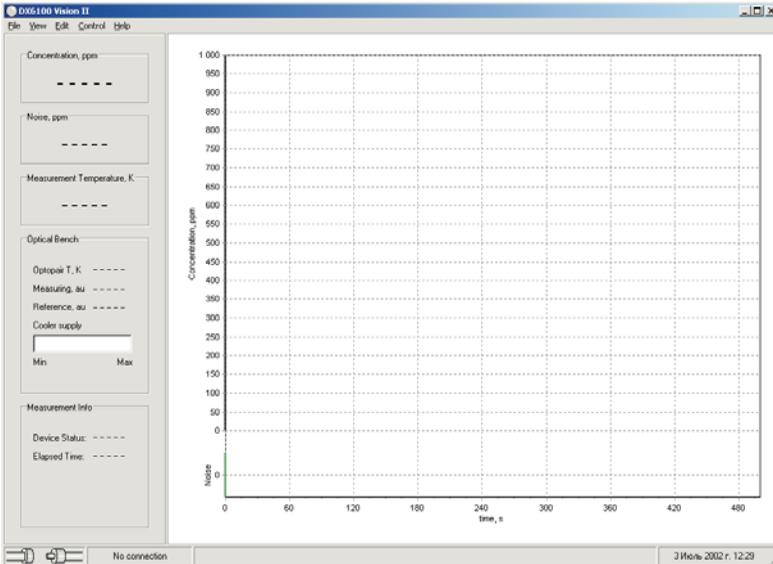
Select the «DX6100 Vision II» programs group from the list and click the mouse button on «DX6100 Vision II». The program will determine automatically whether computer is connected to the gaz analyzer. If the device is found, the program reports the following



In the case of no connection with the computer the following message appears:



After an attempt of connection with the device the main window of the program will be loaded. If the device was found successfully by the program, the program is ready to work.

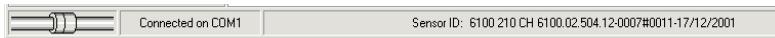


Otherwise it is necessary to be convinced that

- the Analyzer is connected to the device,
- power is ON and the LED indicator is blinking,
- the communication port is not shared with any other program.

Try connecting again by choosing «Edit >> Connection >> Reconnect» from the menu.

In case of successful connection the appropriate acknowledgment will appear in the status bar.



Parameters of Analyzer Adjustment

The **DX6100 Vision II** program allows the parameters of Analyzer adjustment to be edited. But before editing it, please, study the device description thoroughly.

To open the parameters editor choose «Edit >> Sensor >> Parameters» from the menu.

DX6100 Parameters Edit

Preset parameters

Measuring cycle (JB)

1000	Warning level, ppm
2000	Alarm level, ppm
50	Repeating rate of data output, 0.01xsec
0	Number of measurements cycles
1,00000	Normalization factor of analog signal
0	Delay time before autostart, 0.01xsec

Read Write Save Restore

In the parameters list choose the parameters group you are going to edit. The information fields of the editor window will be filled with the current data extracted from the Analyzer's EEPROM.

Use the «Read» button to read the data from the EEPROM. To store the data in the EEPROM use the «Write» button.

The «Save» button copies the current data into the temporary buffer. In case of a mistake at data input the current data may be retrieved from the buffer with the «Restore» button.

Analyzer Controlling

The Analyzer is in the Stop Mode after connection establishing. To start the measurements choose «Control >> Measurements >> Start» from the menu or type «Ctrl+S».

The status indicator view will change:

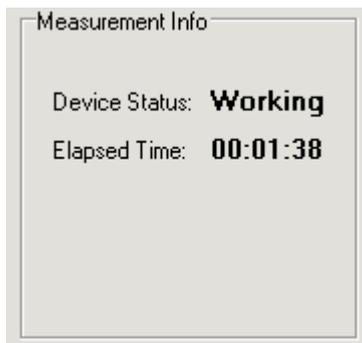


It means the start of the Analyzer preparation process.

The device preparation consists of two stages:

- The measurement temperature definition for selecting the optimal calibration data block.
- Waiting until thermostabilization transient processes are died out. (60 sec approx.).

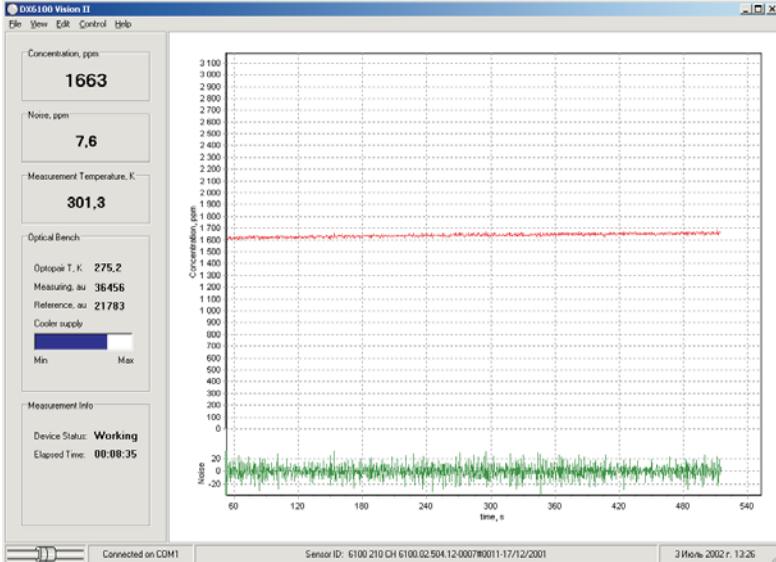
After the second stage is passed, the Analyzer begins the gas concentration measurements:



To stop the Analyzer choose «Control >> Measurements >> Stop» from the menu or type «Ctrl+T».

The device will be stopped, and the program will suggest storing the results.

DX6100 Vision II Window



There are the following items within the Main window of **DX6100 Vision II**:

- Menu bar
- Information fields
- Concentration and noise charts

Charts

Four charts in **DX6100 Vision II** are available:

- Main chart
- Noise chart
- Total chart
- LOG chart

The **Main chart** and the Noise chart are open on default. The **Noise chart** is always displayed in conjunction with the **Main chart**.

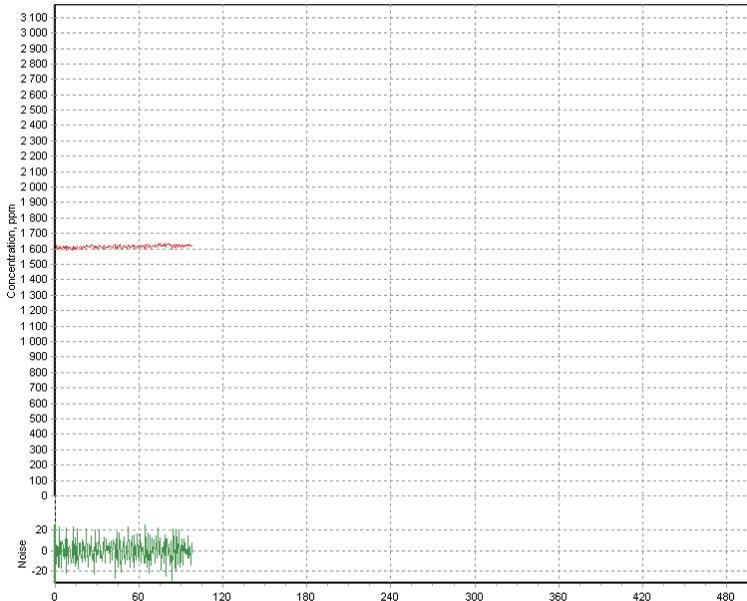
Main Chart

The **Main Chart** displays the results of gas concentration measurements in real time.

The readouts of the last 500 sec can be represented in the chart. On the 500th sec expiration the plot area cleans itself and begins to be filled again.

For previous results viewing hold the right mouse button pressed inside the chart's plot area and move it across the chart.

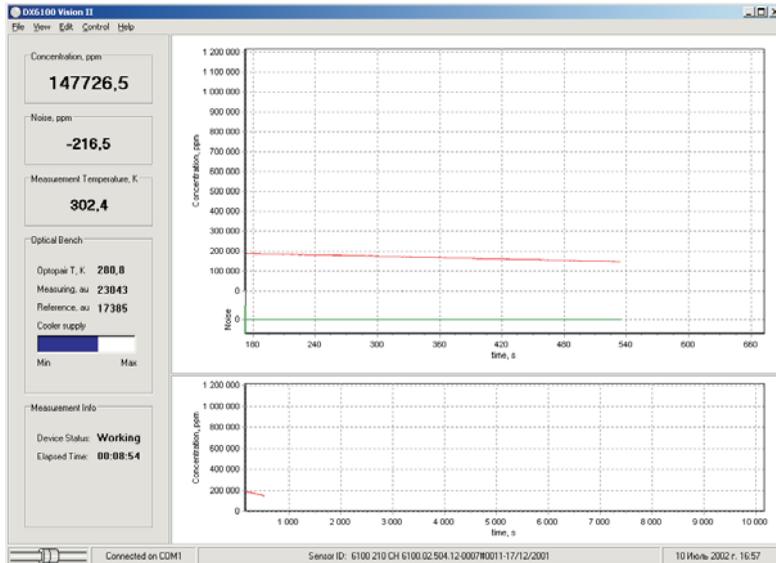
The **Noise chart** is placed at the bottom part of the **Main chart**.



Total Chart

Choose «View >> Total» from the menu. The **Total chart** will appear in the bottom of the program window. The readouts of the last 10 000 sec can be represented in the chart.

For previous results viewing hold the right mouse button pressed inside the chart's plot area and move it across the chart.

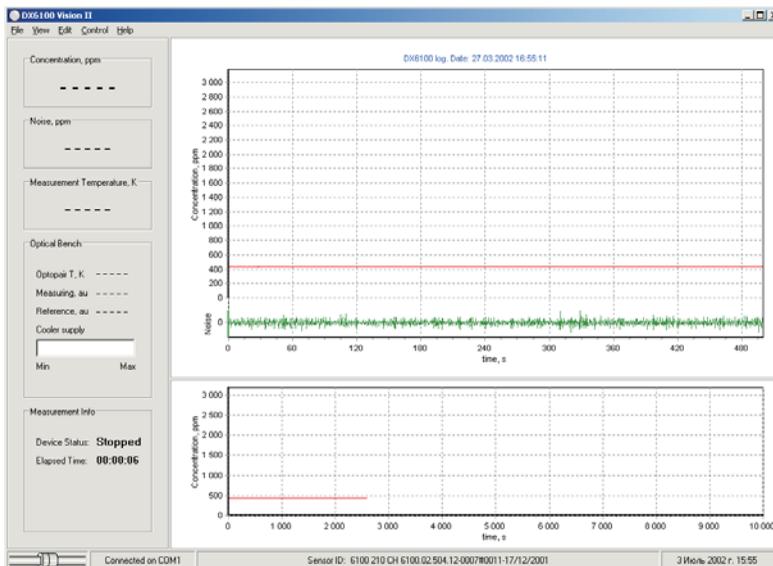


LOG chart

The Log chart is intended for displaying the content of files with the stored measurements results.

The Analyzer should be stopped before the Result File loading.

To load the Result file choose «File >> Open» from the menu. The Result file content will be represented in Main chart. The data collection date and time will be displayed above the chart.



Information panel

The Information panel consists of five fields:

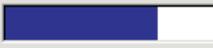
- **Concentration**
- **Noise**
- **Measurement**
- **Optical Bench**
- **Measurement info**

The first three fields assignment is obvious and does not demand any explanations.

The Optical Bench field indicates some auxiliary parameters. These are the Optopair temperature, the signals of measuring and reference channels and the cooler supply.

The signals of channels are represented in ADC units, marked as **au**.

The Cooler supply voltage is displayed in the graphic form as a colored bar. The bar length is proportional to the voltage

Concentration, ppm	1624,5
Noise, ppm	1,1
Measurement Temperature, K	300,4
Optical Bench	
Optopair T, K	275,2
Measuring, au	36476
Reference, au	21769
Cooler supply	
	Min Max
Measurement Info	
Device Status:	Working
Elapsed Time:	00:01:38

supplied to the cooler. The bar color is blue normally. If the voltage reaches the critical value the bar color changes to yellow. It serves as a warning that the control of temperature management can be lost and the measurement results may be not valid.

The **Measurement Info** field shows the Analyzer status and the time the measuring has been carried out.

Adjustment of Visual Parameters of the Program

The **DX6100 Vision II** program allows some visual characteristics of data representation to be changed by the user. First of all it is referred to the program window.

The program window can be considered as three areas:

- The area of the **Main chart** and the **Noise chart**.
- The area of the **Total chart**.
- The area of the **Information panel**.

To open or close the **Information panel** choose «View >> Info» from the menu. To display the **Total chart** choose «View >> Total» from the menu. The **Main chart** and the **Noise chart** are displayed permanently.

Some adjustments are allowed in DX6100 Vision II program for **Main chart** and **Total chart** parameters. These are the plot color, the plot background color, plot axis format, animated zoom and so on. To adjust these parameters choose «Edit >> Settings >> Charts >> Main».

For **Total chart** parameters adjustments choose «Edit >> Settings >> Charts >> Total».

6. Calibration

Preparation

First of all User should prepare the set of calibration gases.

The number of calibration gases should be at least two more than the desirable polynomial order (See Chapter 2). In turn the order of a polynomial determines accuracy of approximation, and hence the measurement accuracy.

The following close to optimum set of calibration gases can be recommended (in percentages to upper concentration of measurement range):

Extended Kit	Standard Kit
0	0
1	1
5	5
10	10
15	–
30	–
50	50
65	–
100	100

Any other sets of standard samples User can apply according to own reasons. But be sure that the samples are within specified measurement range and the customer standard gases provide accurate calibration.

As a “zero” gas one can use any standard pure gas. Argon (Ar) or Nitrogen (N₂) are quite suitable.

As other concentrations, the mixture of measured gas with “zero” gas is usually used.

Prepare some portions of plastic tubes for gas bottles connection with Analyzer’s gas inlets.

Now the Analyzer and appropriate software should be prepared:

1. Connect the DX6100 Analyzer to computer using the RS–232 cable.
2. Connect Power supply to the Analyzer.
3. Run the **DX6100 Vision II** program.
4. Run the Calibration routine.

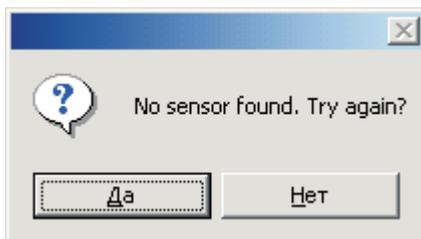
All the other steps of calibration procedure must be performed under the guidance of Calibration routine from **DX6100 Vision II** software programs set.

DX6100 Calibration Window

Select the «DX6100 Vision II» programs group from the list and click the mouse button on «Calibration». The program will determine automatically whether computer is connected to the gas analyzer. If the device is found, the program reports the following



If there is no connection with the computer the following message appears:



In this case the program will suggest trying connection again.

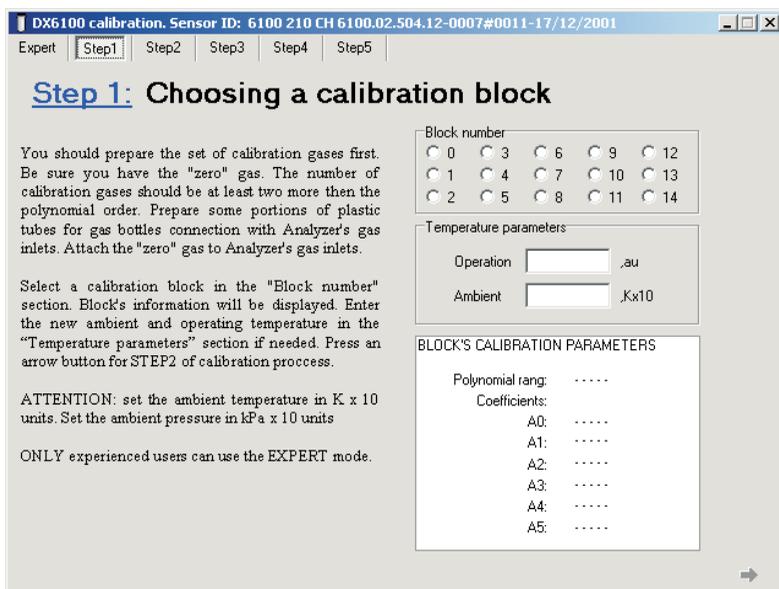
At first check whether

- the Analyzer is connected to the device,
- power is ON and the LED indicator is blinking,

- the communication port is not shared with any other program.

Then click the mouse button on «Yes».

After the successful connection with the device the window of the calibration program will be loaded.



The calibration program will propose that the sequence of 6 consecutive stages should be performed. Each stage contains the description of actions necessary to execute.

Stage 0. Expert Mode

The **Expert mode** is necessary only for experienced users. At this stage the Analyzer parameters adjustment can be performed.

By default the Calibration program starts with Stage 1. To launch the program in Expert mode the following command string should be entered from via the keyboard

“calibration.exe -expert”

Stage 1. Calibration Block Select

DX6100 calibration. Sensor ID: 6100 210 CH 6100.02.504.12-0007#0011-17/12/2001

Expert | Step1 | Step2 | Step3 | Step4 | Step5

Step 1: Choosing a calibration block

You should prepare the set of calibration gases first. Be sure you have the "zero" gas. The number of calibration gases should be at least two more than the polynomial order. Prepare some portions of plastic tubes for gas bottles connection with Analyzer's gas inlets. Attach the "zero" gas to Analyzer's gas inlets.

Select a calibration block in the "Block number" section. Block's information will be displayed. Enter the new ambient and operating temperature in the "Temperature parameters" section if needed. Press an arrow button for STEP2 of calibration process.

ATTENTION: set the ambient temperature in K x 10 units. Set the ambient pressure in kPa x 10 units

ONLY experienced users can use the EXPERT mode.

Block number
 0 3 6 9 12
 1 4 7 10 13
 2 5 8 11 14

Temperature parameters
 Operation .au
 Ambient .Kx10

BLOCK'S CALIBRATION PARAMETERS

Polynomial rang: 3
 Coefficients:
 A0: -113539.6346
 A1: 241669.0170
 A2: -180910.2699
 A3: 52687.8413
 A4: 0.0000
 A5: 0.0000

➔

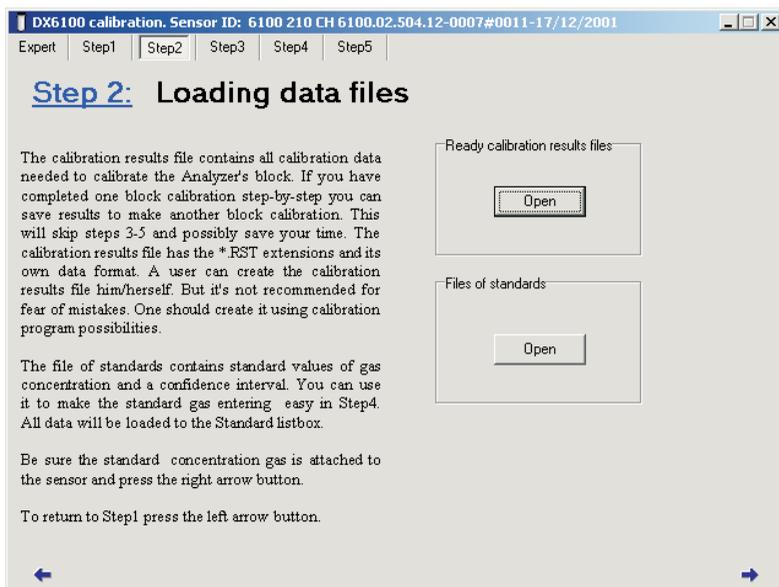
Select the calibration block by clicking on one of the radio buttons from the «Block number» group. The current temperature parameters of the selected block will be displayed in the «Temperature parameters» field. These are the working temperature and the ambient temperature.

The polynomial rank and polynomial coefficients will be shown in the «Block calibration parameters» field.

Redefine the temperature parameters, if necessary.

Click on the blue arrow to move to the next stage.

Stage 2. Loading Auxiliary Data



Two kinds of files are used by the Calibration program: the Results files and the Gas Standards files. The Results file can be saved after the calibration procedure and then retrieved for a new calibration.

The use of a Results file can reduce greatly the time of the same calibrations realization.

The Gas Standards file contains the data on the gas standards used in the calibration procedure and confidential intervals for realization of calibration.

To load the Results file click on the «Open» button in the «Ready calibration results files» field.

To load the Gas Standards file click on the «Open» button in the «File of standards» field.

Stage 3. Inputting Data Points

DX6100 calibration. Sensor ID: 6100 210 CH 6100.02.504.12-0007#0011-17/12/2001

Expert | Step1 | Step2 | **Step3** | Step4 | Step5

Step 3: Inputting data points

Wait until the chart area begins to fill with measured values. The red chart series shows the measured values. In case of possible noise the blue average chart series is available. After the chart begins to fill, wait until the chart curve reaches the saturation. You can zoom in and zoom out the chart line using sidebar at the chart bottom.

Everytime you attach the gas to the sensor wait until the chart reaches the saturation. Then press the "Get D ratio" button. Wait until the current signal is calculated and placed to the D Ratio editbox. Then set a gas concentration value (or select it from the Standard combobox if the file of standards is loaded) and enter a confidence interval to the Interval editbox (1% of the standard concentration values is set automatically). Press "Add point" button. The point data will be added to the point data field. Repeat procedure with another gas standard.

To delete a point select it from the points field and press right mouse button. Then select "Delete" from dropdown menu.

1,73
1,725
1,72
1,715
1,71

600 650 700 750 800 850 900

— Data
— Average

Data Average

Get D ratio
D ratio
Standard
Interval
Add point

At Stage 3 of the calibration procedure the accumulation of data points for calibration execution is made. After Stage 3 starts, the measured signal values begin to fill the plot area of the chart.

Attach now the bottle with the standard gas to the Analyzer and wait for the signal to become stable. Then click on the «Get D Ratio» button. The signal value will be displayed in the «D Ratio» field.

Enter the standard gas concentration into the «Standard» field or, if the Gas Standards file had been loaded, select it from the drop-out list. Enter now the confidential interval value into the «Interval» field . (1% of the concentration value is the default value). Click on the «Add point» button.

Repeat the actions described above for every standard gas and move on Stage 4.

Keep in mind that both signal level (red plot) and average value (blue plot) are outputted into the chart.

The points that were entered may be observed by clicking the right mouse button on the plot point and choosing «Delete» from the drop-down list.

Stage 4. Polynomial Rank Selecting

DX6100 calibration. Sensor ID: 6100 210 CH 6100.02.504.12-0007#0011-17/12/2001

Expert Step1 Step2 Step3 **Step4** Step5

Step 4: Choosing polynomial rang

Select the polynomial rank from the "Rank" editbox using up/down arrows. The trend line will be plotted on the calibration chart. The RMS value will be displayed in the "RMS value" section.

You can delete points if it's needed. To do this press the mouse right button on the point and select "Delete" from the drop-down menu. To add new points go back to the Step4.

Using up/down arrows in the "Rank" section select the optimal trend line and press the right arrow button to follow to Step6.

Or the left arrow button to return to Step4.

Rank: 2 RMS value: 2,1E+01

TChart

X	Y
0	1,000
100	1,022
200	1,028
300	1,040

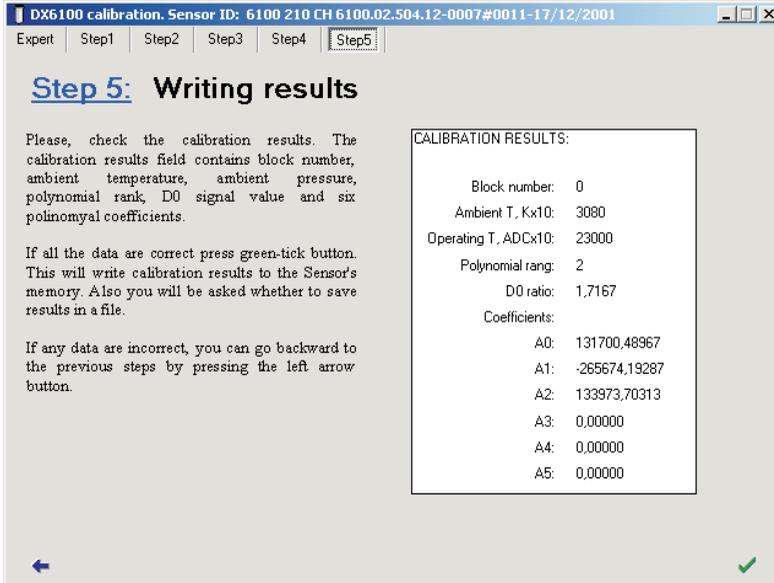
At Stage 4 the approximation of accumulated data is performed. The plot area fills with the curve representing the approximation polynomial.

The buttons with arrows in the «Rank» field serve for polynomial rank selection.

The «RMS» field indicates the standard deviation value.

After the suitable polynomial rank is selected, you should go to Stage 5.

Stage 5. Writing Results



At Stage 5 the calibration program outputs the results and writes it into the Analyzer's EEPROM.

Click on the button with green tick to save the calibration results into the EEPROM. The Results file will be saved simultaneously.

The button with a blue arrow allows to return to the previous stages of calibration procedure in case the calibration parameters were entered wrong.

After the results are saved, the Calibration program will suggest beginning another block calibration or quitting the program.

Zero Adjustments

To ensure the high measuring accuracy, the zero adjustment should be made. It may be done with Calibration program launched in **Expert mode** (See the Calibration program description).

Flow up any "zero" gas through the Analyzer.

Click the left mouse button on the terminal window of Stage 0. Type the <Enter> with keypad and enter the command

GC+Block#

Type <Enter> again to send the command into the computer. Wait while the measurement information appears in the terminal window. Wait 1–2 more minutes while the signal reaches saturation, type <Enter>, enter the command

ZE

and type <Enter> again.

Wait now until the Analyzer begins to output measuring information again. The zero adjustment has finished.

To perform the zero adjustment for another block, type <Enter>, enter the command

ST

and type <Enter> again.

Point to another block number and repeat operations described above.

Re – Calibration

In standard option, the DX6106 Gas Analyzer is delivered with one calibration data. The calibration is made at optimal operating temperature.

User can make re – calibration at any time. It is possible to do this at other operating temperatures, with larger set of reference gases (larger order polynomial) and to replace stored data by the new one.

According to customer demands the re – calibration could be done by Manufacturer on request.

On – board memory can contain itself additionally 13 data blocks for more calibrations. Totally up to 14 different calibrations could be done.

The polynomial coefficients A_j depend on the design of the Optical Unit's optical scheme. It is not necessary to make re – calibration often.

It is recommended to perform re – calibration annually.

7. Maintenance

Optics Cleaning

If necessary optics cleaning should be performed.

Assuming the Analyzer was outdoors at low temperature, maintain it indoors not less than 4 hours before diagnostics.

Cleaning of optics execute with the help of the suede and the special optic clearing fluid.

For optics cleaning the DX6106 Optical Unit must be disassembled.

Remove screws from each end face of the Optical Unit. Remove the covers (Fig. 7.1).

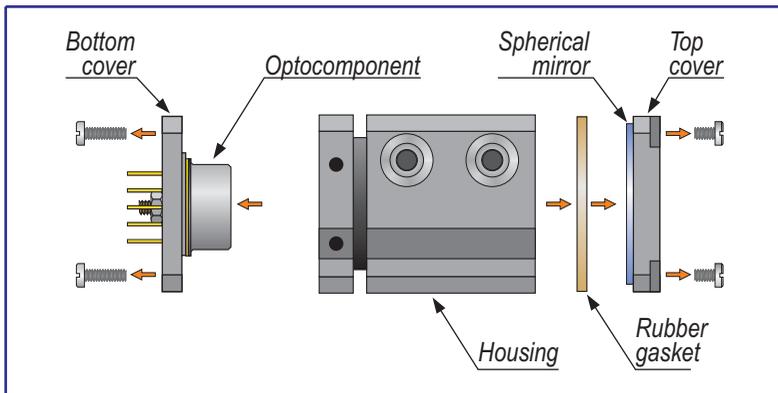


Fig. 7.1. DX6106 Optical Unit disassembling illustration

The Optical Unit after disassembling is shown in Fig. 7.2.



Fig. 7.2. DX6106 Optical Unit with the covers removed

***The spherical mirror is glued to the top cover.
Do not try to rip it off.***

Clean now

- the window of the optopair,
- spherical mirror,
- internal mirror (with a hole) from both sides.

Wait some minutes and assemble the Optical Unit in the reverse order.

8. Standard Kits

DX6100

#	Item	Code	Q-ty
1	Gas Analyzer	DX6100	1
2	Power supply cable	DX6100-C-02	1
3	RS-232 cable	DX6100-C-03	1
4	Analog interface cable	DX6100-C-04	1
5	AC/DC adaptor		1
6	DX6100 User Manual		1
7	DX6100 Vision software CD		1



DX6100 OEM

#	Item	Code	Q-ty
1	Gas Analyzer	DX6100	1
2	Optical Unit	DX6106	1
3	Controller module	6101-x.xx	1
4	Optocomponent Mating module	6102-x.xx	1
5	Power supply cable	DX6100-C-12	1
6	RS-232 cable	DX6100-C-13	1
7	Analog interface cable	DX6100-C-14	1
8	Module interconnection cable	DX6100-C-15	1
9	Module interconnection cable	DX6100-C-16	1
10	Mounting Base	DX6100-M-01	1
11	DX6100 User Manual		1
12	DX6100 Vision software CD		1



9. Specifications

Common

Type	NDIR gas analyzer
Detector	Lead selenide with TE cooler

Measured gases

Carbon Dioxide	CO ₂
Carbon Monoxide	CO
Hydrocarbons	C _m H _n
Water vapor	H ₂ O

Timing

Output Repeating Rate ⁴⁾	0.01...20 Hz
Average Time Constant ⁴⁾	0.1...60 sec

Alarms

Light	Two color LED
Sound	> 85 dB

Supply requirements

Supply voltage	+6 to +15 V DC
Supply current	300 mA (max)

Interfaces

Digital	RS-232C
Analog	0...4,095 V

Operation conditions

Moisture protection	IP65
Temperature range	-10° to 50°C
Relative humidity	5 to 100%

Mechanical

Dimensions	60 × 80 × 122 mm
Weight	310 g (max)

Carbon Dioxide (CO₂) Sensor

Concentration range ¹⁾	0...1000 ppm	0...5 % vol	0...20 % vol
Noise level ^{2,3)}	< 3 ppm	< 0.15 %	< 0.15 %
Accuracy ³⁾	10 ppm	0,5 %	0,5 %
Zero drift ³⁾	0.02 %		

Hydrocarbons (C_mH_n) Sensor

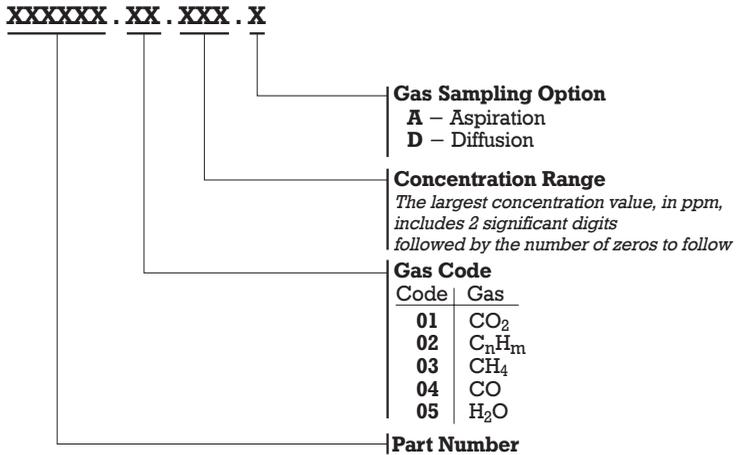
Concentration range ¹⁾	0...1000 ppm	0...5 % vol
Noise level ^{2,3)}	< 2 ppm	< 0.1 %
Accuracy ³⁾	10 ppm	0,5 %
Zero drift ³⁾	0.02 %	

1) *Optional ranges up to 100% vol. are available.*

2) *At Averaging Time Constant = 0.2 s.*

3) *If value in %, then it means relative units $\Delta X/X$*

10. Ordering Guide



Example:

DX6100.01.504.A

[DX6100]	DX6100 Series,
[01]	CO ₂ Gas Option,
[504]	0...5.0·10 ⁴ ppm (0...5%) concentration range,
[A]	aspiration type gas cell,

RMT Ltd. Leninskij prosp. 53, Moscow 119991 Russia
phone: 095-132-6817 fax: 095-135-0565
e-mail: rmtcom@dol.ru <http://www.rmtltd.ru>
