LABORATORY GAS CHROMATOGRAPHS

214.2.840.039UM "Chromatec-Crystal 5000"

214.2.840.075UM "Chromatec-Crystal 9000"

INSTALLATION INSTRUCTIONS

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1 INTRODUCTION

Instructions marked by this symbol are necessary for carrying out in order to avoid injuries sustaining at working with chromatograph.



Instructions marked by this symbol are to be carried out when there is electron-capture detector (ECD) in chromatograph, which containing radioactive source Ni^{63}.



This symbol makes warning about danger of burn. It is painted on:

Top cover of the gas chromatograph (hereinafter the GC) (warning about hot surfaces of injectors and detectors).

Rear cover of the GC indicating: "**Hot air**" (warning about danger of burn at oven heating and cooling cycles.



Instruction marked by this symbol is warning about explosion risk.

There is a sign in the oven door:

Attention! Before GC turning on make sure that hydrogen lines are sealed or connected to the column.

Items produced by SDO Chromatec may contain updated parts following new developments or may be undergone to non-essential modernization, not specified in this user manual.

Two marking types of parts are used in this and accompanied documents:

XXX-XXXX – Part number or Cat. Number referred to ordering documents;

214.X.XXX.XXX(-XX) or simplified X.XXX.XXX(-XX) – Cross ID referred to internal manufacturer documents.

Both can be used for ordering parts.

2 PREPARATION FOR INSTALLATION

2.1 Safety precautions

Warning! Don’t start operating chromatograph without being acquainted with safety precautions stated in this Section and other documents listed below.

Don’t start operating chromatograph without being acquainted with installation instructions, GC User Manual and user manuals on auxiliary equipment.

2.1.1 Chromatograph dangerous sources are:

- Chromatograph current-carrying parts being alive;
- ECD detector beta-radiation source;
- High pressure gas lines;
- Hydrogen gas usage;
- Surfaces of GC heating zones, having high temperature, and hot air venting from oven exhaust.

Chromatograph and its auxiliary equipment that have power circuits should be grounded. Grounding is done with the help of network plugs and additional grounding. Contacts "⊥" of network sockets (mains) for connection of chromatograph components should be grounded (connected with external grounding mat) by copper wires of section at least 1,5 mm^2.

Additional grounding of auxiliary equipment including computer system unit, is performed by additional grounding terminals connection of these parts with grounding mat (by grounding cables from Shipping kit). Detector MSD, monitor and computer printer are allowed not to be grounded additionally.

Repair and maintenance of chromatograph should be carried out at power supply being off and gas lines being shutoff (except causes when power supply is required).

2.1.2 At mounting, installation, checking and maintenance of the GC the following current documents should be observed:

- “Rules of Electrical Installations Design” (PUE),
- “Rules for Consumer’s Electrical Installations Operation” (PTEEP),
- “Interindustrial Rules for Labour Protection (Safety Regulations) at Electrical Installations Operation” (POT RM-016-2001),
- “Rules for Pressure Vessels Design and Safety Operation” (PB3-576-03),
- “Basic Sanitary Regulations for Radiation Safety Provision” (OSPORB-99, SP2.6.1.799-99),
- "Sanitary-Epidemiologic Requirements to Radio-isotopic Instruments Treatment and Design" (SanPiN 2.6.1.3287-15),
- Radiation Safety Codes” (NRB-99).

2.1.3 Personnel requirements

For chromatograph mounting, installation, checking and maintenance as per PEEP and POT RM-016-2001 rules only competent persons having at least second skill category and having learnt Safety Regulations for chromatograph operation and also having passed medical examination should be admitted.

Operator of the GC (a person who performs chromatographic and mass-spectrometric analyses) shall have experience in working with chromatographic equipment, mass-spectrometers, computer, as well as be acquainted with safety rules at operation with the GC and having medical permit to work according to GC using company rules.

2.1.4 Use of hydrogen

A hydrogen generator is the hydrogen source allowable for premises, to use with gas chromatograph. Hazard sources and safety provisions at hydrogen generator operation are described in corresponding User Manual.

At hydrogen use, conducting analysis of combustible, harmful and deleterious substances fire safety provisions as per GOST 12.1.004 and measures provided in special regulations developing by consumers (in accordance with peculiarity of applied substances) on the basis of GOST 12.1.007 should be observed.

2.1.5 Use of gases in pressurized cylinders

Follow directions of “Rules for Pressure Vessels Design and Safety Operation” PB3-576-03, when using gases under high pressure up to 15 MPa (150 atm), typically supplied in gas cylinders 40 L.

It’s recommended to install carrier gas cylinders outdoors – in metal boxes. Gas sampling from gas cylinders should be done through regulator intended for this kind of gas. On operation completion valve on the gas cylinder should be tightly shut off.

If the gas cylinders are mounted outdoors, keep in mind that some unwilling defects may appear, such as, probability of contaminations ingress into gas stream at using long tubes of inappropriate quality, possible gas leaks and hereupon exaggerated gas consumption for GC operation, gas lines and pressure regulator frosting over at winter period.

The rules PB3-576-03 allow inert gas cylinders location in premises (except hydrogen and oxygen cylinders):

Extract from PB03-576-03:

1.1.1. Rules for Pressure Vessels Design and Safety Operation, establish requirements for engineering, design, manufacturing, reconstruction, adjustment, montage, repair, diagnostics and operation of vessels, tans, barrels, cylinders, altichambers operating under excess pressure.

6.1.2. It is allowable to mount vessels in workrooms if provided by sectoral safety provisions.

6.1.4. The way of vessels montage must exclude tumbling.

6.1.5. The way of vessels montage must allow observation, repairing and cleaning from all sides.

2.1.6 Fire safety

GOST 12.1.004 "Fire safety. General requirements" establish general requirements for fire safety to different objects.

Extract from GOST 12.1.004:

1.6.Classification of objects by fire safety and explosion-fire hazard must be provided depending on allowable level of their fire risk (required level for fire safety provision), criterions and values of such classification (including estimated probability of fire and explosion risks) must be calculated taking into account weights of combustible and hardly-combustible substances and materials, being in the object, explosion and fire hazard areas created at emergency and possible harm for people and capital equipment.

2.1.7 Hazard points in the GC are marked with relevant symbols and signs.

At oven cooling hot air flow is emitted through oven vent. Thus, distance between chromatograph rare wall and premise wall should be at least 200 mm; surface of premises wall shall be flame-proof if distance is less than 500 mm. On the way of direct hot air flow any equipment placing (electrical cables, accessories etc.) should be removed.

2.1.8 Using an ECD detector with a radionuclide source



At completing GC with electron capture detector (ECD) containing radioactive source, the radiohazard mark is applied on external surface of chromatograph.

The chromatograph with the ECD detector is referred to radio-isotope devices (RID) of 2-nd group of radiation hazard, in accordance with sanitary rules and standards SanPiN 2.6.1.3287-15 "Sanitary-Epidemiologic Requirements to Radio-isotopic Instruments Treatment and Design" (СанПиН 2.6.1.3287-15 "Санитарно-эпидемиологические требования к обращению с радиоизотопными приборами и их устройству "), Appendix 1.

Installation, operation and decommissioning such chromatograph should be carried out according to SanPiN 2.6.1.3287-15 and OSPORB-99.

Construction and operation features of the GC referred to radioisotope devices are specified in GC User Manual.

2.2 Site requirements

Operation of the GC is carried out in closed laboratory premises, provided that combustible gases and highly inflammable liquids may be present in volume insufficient for creation of explosive– or fire-hazardous mix.

The rooms shall be equipped by combined supply and exhaust ventilation, fire-extinguishing means, personal protection equipment providing safe operation conditions in laboratory.

Extract from GOST 12.1.004:

1.4. Objects related to fire safety categories should have cost-beneficial fire safety systems according to engineering technological regulations for determination of explosion and fire safety categories of premises.

Table 2.1 – Environmental conditions

Parameter	**Conditions**	
	Required	**recommended**
Temperature	10 – 35 °C	20 – 27 °C
Relative humidity	Not more than 95%	Not more than 80%
Atmospheric pressure	84 -107 kPa (630 – 800 mm Hg)	

If mass-spectrometric detector (MSD) is supplied with the GC, environmental temperature shall be within 15 – 31 °C.

Impurity content in premises air shall be normal, regulated by GOST 12.1.005.

Chromatograph operation at recommended conditions should provide its optimal functioning and enlarge its service life.

GOST 12.1.005 requirements cover working zone air of enterprises. Standard defines common sanitary-hygienic requirements to criteria of environment and maximum allowable concentration (MAC) of harmful substances in working zone air.

Standard gives maximum allowable concentration of harmful substances in working zone air considering their influence on human body. MACs are extended to working places independently on their disposition (in working premises, in mines, outdoor places, in vehicles etc.

In a number of cases during normal operation of chromatograph toxic or harmful substances – analyzed sample components or products resulted at its burning can be emitted from sample vent channel and detectors vent.

In such cases it's recommended to install chromatograph into laboratory exhaust hood provided that other operations are not carried out in it and reactive chemicals and solvents are not stored there.

At oven cooling hot air flow is emitted through oven vent. Thus, distance between chromatograph rare wall and premise wall should be at least 200 mm; surface of premises wall shall be flame-proof if distance is less than 500 mm. On the way of direct hot air flow any equipment placing (electrical cables, accessories etc.) should be avoided.

2.3 Chromatograph location requirements

Chromatograph is located on the laboratory desk in order convenient for operation. When laboratory desk choosing, weight of the equipment placing on it should be considered. Recommended schematic layout of gas chromatograph with thermal desorber and PC on the desk is shown below – * The width of the chromatograph with valves mounted on the bracket on the left is 620 mm.

** Printer dimensions vary by model.

Figure 2.1.

Space above the GC should be free, not equipped with shelves and overhanging constructions which eliminate access to the upper part of chromatograph. Some samplers are located directly on the GC; in this case it's necessary to consider additional space.

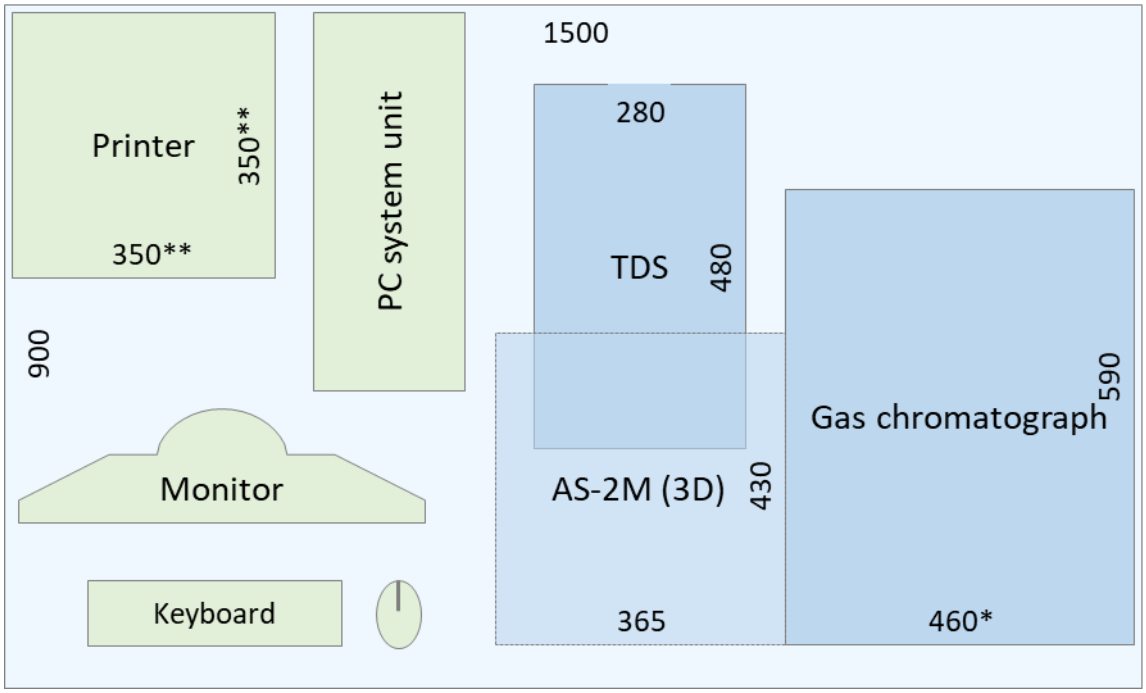
Location requirements for the GC with MSD are specified in cl. 4.1.4 of User Manual "Mass spectrometric detector 214.2.840.083UM".

Totally laboratory desk of 80cm in depth, 180 cm in width is recommended for location of the GC and its components. It may be wider depending on auxiliary devices.

The distance between rear wall of the GC, rear wall of MSD (if available) and premises wall shall be not less than 200mm.

It's recommended to locate compressor out of desk to avoid its vibrations effect at chromatograph operation.

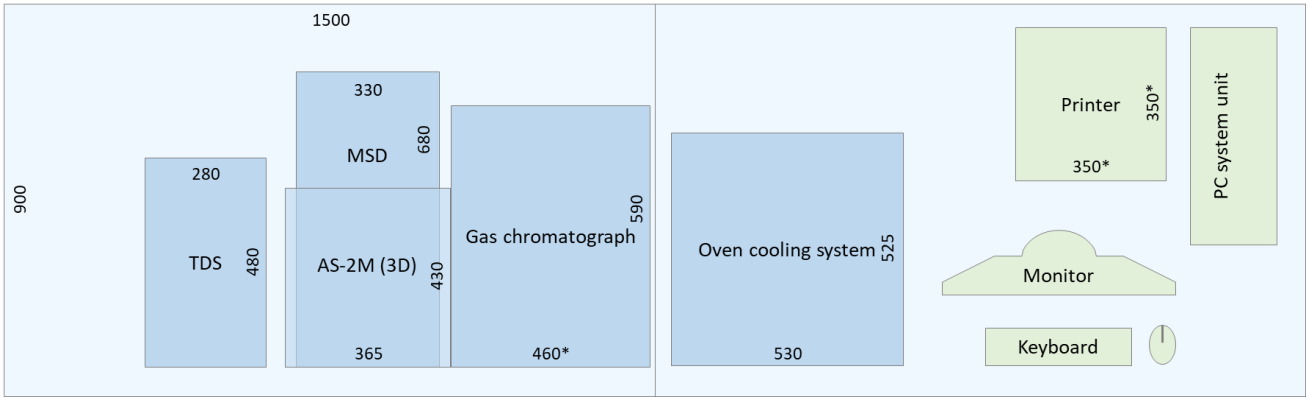
At implementation of CRT– monitor (cathode-ray tube) distance from chromatograph housing up to monitor housing should be at least 50 cm. For monitors with LCD display there's no limits for location.



* The width of the chromatograph with valves mounted on the bracket on the left is 620 mm.

** Printer dimensions vary by model.

Figure 2.1 – GC location on the desk



* Printer dimensions vary by model

Figure 2.2 – GC and other equipment location on two desks.

Two desks should stand close to each other and have the same height.

The following automatic liquid samplers can be installed directly on the chromatograph at the same time:

- One AS-2M 3D 214.2.508.006-05 and one AS-2M 214.2.508.006-02.
- One AS-2M 3D 214.2.508.006-06 and one AS-2M 214.2.508.006-02.
- Two AS-2M 214.2.508.006-02.

• One AS-2M 214.2.508.006.

Table 2.2 – Dimensions, weight of the GC and auxiliary devices

Device	**Width, mm**	**Depth, mm**	**Height, mm**	**Weight, kg**
Gas chromatograph "Chromatec-Crystal 5000"	460 (620)*	590	480	(48)**
Gas chromatograph "Chromatec-Crystal 9000"	460 (620)*	590	480	(48)**
Mass spectrometric detector (is connected from the left of the GC)	330	680	440	45
Hydrogen generator	230	540	440	20
Compressor	220	560	420	25
Autosampler AS–2M***	135	365	420	5,0
Autosampler AS–2M (3D) (is located from the left of the GC on assy bench)	390 (430)****	440	530***	13
Autosampler AS–2M (3D headspace) (is located from the left of the GC on assy bench)	390 (430)****	440	530***	17
HeadSpace Sampler (is located from the left of the GC on assy bench)	250 (250)****	320	210	5,4
Catalytic purifier 20.0	210	150	320	4,0
Mixer for syringes	120	230	150	2,5
Thermal desorber TDS-1 (2-stage) (is located from the left of the GC)	270	500	480	20
Thermal desorber TDS-1 (1-stage)***				
– Power unit	150	140	90	0,30
– heating column	35	75	135	0,16
Pyrolytic inlet***:				
– Power unit	113	185	123	1,7
– Inlet 6.13	110	27	87	0.1
Computer including:				
– system unit	200	500	420	–
– monitor (22'')	520	200	430	

Device	Width, mm	Depth, mm	Height, mm	Weight, kg
– printer (laser)	400	400	300	

* The width of the GC including gas valves located from the left on bracket.

** Specified weight of the GC is referred to model with isolating transformer

*** Device is located on the GC.

**** Assembly bench size

Dimensions and weight of computer depend on its model.

2.4 Electrical requirements

2.4.1 General

The area of mounting should be provided with:

- Single-phase alternating current network, 220 V, 50 Hz, at least 3,5 kW (for GC-MS – at least 6 kW);
- External grounding line;
- Euro standard (Schuko) electrical sockets (generally 6-8 pieces are enough for the GC and supplied equipment) with grounding in accordance with electrical safety rules.

Typically, power cords for the GC and supplied equipment have 2m length, so electrical sockets should be located within apprx.1,5m from the equipment.

For instance, use one socket for GC and one for MSD, the others may be used for PC and any low consuming devices. But do not connect GC and MSD to the same socket or power supply filter (with 5-6 sockets). Power supply filter has on/off switch and protective device, limiting exceeding of current rate. Accident switching or triggering of protective device may lead to damage of MSD or its turbo-molecular pump.

Make sure that total power consumption of the GC and equipment to be installed doesn’t exceed allowable 3,5kW (or 6kW for GC-MS systems). Table 2.3 contains data about power consumption levels for the GC, MSD, computer and some auxiliary devices.

Power supply quality is very important. Power supply should be stable and be in accordance with requirements specified in this Section. Check power supply quality in the area to avoid problems in future.

Power supply quality improvement is a complex challenge, it’s better to engage a firm or consultant specializing in this sphere for its solving. Bad quality of power supply reduces chromatograph features and reliability.

When using uninterruptible power system (UPS) follow instructions "Recommendations at UPS connection".

Table 2.3 – Power consumption

Equipment	**Power consumption, W**
Gas chromatograph "Chromatec-Crystal 5000"	2500[1] (700)[2]
Gas chromatograph "Chromatec-Crystal 9000"	2500[1] (700)[2]
MSD (with fore-vacuum pump)[3]	1440
Computer IBM PC (with printer)	400
Hydrogen generator 6.140, 6.400, 10.140, 10.400	140
Hydrogen generator 16.600, 25.600	300
Hydrogen generator 10.400 hpm, 16.600 hpm, 25.600 hpm	400
Compressor	140
Autosampler AS-2M	50
Autosampler AS-2M (3D)	100
Autosampler AS-2M (3D Headspace)	300
Thermal desorber TDS-1	90
Thermal desorber TDS-1 (2-stage)	700
Vacuum sampler	15
Pyrolytic inlet	250
Catalytic purifier 20.0	100
Mixer for syringes	12

[1] The Maximum power consumption (at heating up to T(inl1) = T(inl2) = T(det1) = T(det2) = T(oven) = 300 ˚C).

[2] Average power consumption (at keeping mode T(inl1) = T(inl2) = T(det1) = T(det2) = T(oven) = 300 ˚C).

[3] The Maximum power consumption (including all additional options – two turbomolecular pumps, chemical ionization option, Direct probe system option (DPS)) – 1,8 kW. Maximum power consumption (one turbomolecular pump 250 l/s, EI ionization, no DPS) – 1,0 kW.

Examples of bad quality power supply are given below:

- Harmonic excitations cause noises in power supply lines that results in apparatus performance degradation. Harmonic excitations are radio frequency interferences which can affect the GC. These interferences appear as distortions of base sine curve. Total harmonic excitations should not exceed 6%;
- Power supply drop is a constantly underrated from nominal voltage, that results in improper system performance or its shutting off;
- Slow changes – gradual, long-term deviation of relatively standard voltage level with duration more than 2 seconds;

- Overvoltage is a constantly increased voltage that results in overheating and components failure. Overvoltage and drop are slow deviations of relatively standard voltage levels with duration from 50 ms till 2 s;
- Short-term interferences lasting only few microseconds cause electrical appliances failure and sufficiently shorten their service life. Short-term interferences (or pulses) are very short voltage surges – up to some thousand's volts with duration less than 50 ms.

For chromatograph and MSD service life increase and expenses reduction for their repair and maintenance use uninterruptible power supply (UPS) especially if power line in premise is not in accordance with appropriate requirements, if short or long voltage drops in power supply network are possible.

In case of a short voltage drop in power supply network without availability of uninterruptible power supply it's necessary to transfer MSD and chromatograph in off mode. MSD, chromatograph and computer reset should be done at least in 10 minutes.

There are some UPS types, differ by their principle of functioning: On-Line, Off-Line и Line-Interactive. Most fully On-Line source type with double voltage transformation meets the requirements of power supply. It means that UPS transforms all (100%) entering it alternating voltage into direct voltage and then carries out inverse transformation. During first transformation stable direct voltage can be obtained from very bad external alternating voltage (bad shape, increased, reduced etc.) but at On-line UPC type outlet we always have sine curve voltage of proper quality because it generates it independently.

Uninterruptible power supply (UPS) of capacity 5000 VA is required for GC and MSD feeding.

2.4.2 Grounding

Don't switch-on without grounding!

All chromatograph components that have power circuits should be grounded. Grounding is done with the help of network plugs and additional grounding. Contacts "⊥"of network sockets for connection of chromatograph components should be grounded (connected with external grounding mat) by copper wires, section at least - 1,5 mm^2 .

Components additional grounding, computer system unit including (monitor and computer printer are allowed not to be grounded additionally), is performed by additional grounding terminals connection of these parts with grounding mat (by grounding cables from Shipping kit).

2.5 Gas requirements

2.5.1 Gas type

Carrier gas required for use depends on detector type and particular analysis methods. As a carrier gas most frequently such gases as: helium, nitrogen, argon, hydrogen are used. Recommendations for carrier gas and makeup gas application in dependence upon detector type and some analysis conditions are given below (Table 2.4). For flame detectors (FID, NPD, FPD) burning hydrogen and air are used.

Table 2.4 – Gases application depending on detector type

Detector	**Carrier gas**	**Makeup gas[1]**	**Note**
TCD[2]	Helium	Helium	Most frequently usable gas
	Hydrogen	Hydrogen	Maximum sensitivity
	Argon	Argon	These gases are used mostly for hydrogen and helium analysis. As for other components, much lower sensitivity is observed
	Nitrogen	Nitrogen	
CCD	Helium	Air	e.g. hydrogen determination in Helium
	Argon	Hydrogen	e.g. oxygen determination in argon
PID	Helium	Argon, or Helium, or Nitrogen	Argon shows the best sensitivity
	Argon		
	Nitrogen		
	Hydrogen[3]		
ECD	Nitrogen	Nitrogen	As make up gas nitrogen, or argon with additive of 5% methane vol.
	Helium[3]		
	Hydrogen[3]		
FID[4]	Hydrogen[3]	Nitrogen or Helium	Nitrogen is more preferable makeup gas
	Helium		
	Nitrogen		
NPD	Nitrogen	Nitrogen	At operation with capillary column makeup gas is obligatory
	Helium[3]		
FPD	Helium	–	At FPD operation with capillary column in single flame mode makeup gas application is not recommended. With helium as the carrier gas, higher sensitivity is obtained
	Nitrogen		
	Hydrogen		
	Argon		
MSD	Helium	–	MSD has better sensitivity with Helium contrary to Hydrogen
	Hydrogen		

[1] Makeup gas is used at operation with capillary columns.

[2] Makeup (reference gas) for TCD should be the same as carrier gas.

[3] Only for capillary columns is recommended as a carrier gas.

[4] At operation with capillary column FID detector design allows to function without makeup gas and at the same time sensitivity of detector is slightly lower (by 15-20 %).

2.5.2 Gases purity

Concentration of impurities in gases, being used for gas chromatograph operation, must be much lower than concentration level of components of interest. Insufficient purity of gases may lead to incorrect operation of the GC (too high detector signal and noise, deterioration and even damage of column, poor sensitivity, negative peaks on chromatogram).

Recommended qualification of applied gases purity.

Carrier gas:

- Gaseous nitrogen (purity grade of nitrogen is not less than 99,999 vol.%; content of oxygen not more than 0,001 vol.%; concentration of water steams not more than 0,005 g/m^3; content of carbon monoxide and dioxide is not rated);
- Gaseous argon (volume fraction of argon at least 99,998 %, volume fraction of nitrogen not more than 0,005 %, volume fraction of oxygen not more than 0,0007 %, volume fraction of hydrocarbons not more than 0,0005 %, water vapor volume fraction not more than 0,0009 %, content of carbon oxide and carbon dioxide is not rated);
- Gaseous helium (purity grade of helium is not less than 99,999 vol.%, content of nitrogen is not more than 0,005 vol.%, content of oxygen is not more than 0,0001 vol.%, content of carbon dioxide is not more than 0,0002 vol.%, content of hydrocarbons is not more 0,0001 vol.%, content of water steams is not more 0,0005 vol.%).
- gaseous helium of mark "60" (purity grade of helium is not less than 99,9999 %, content of nitrogen is not more than 0,000045 %, content of oxygen and argon in sum is not more than 0,000015 %, content of carbon monoxide and carbon dioxide is not more than 0,0001 %, content of methane is not more than 0,00001 %, content of water steams is not more than 0,0002 %) – at usage with MSD, PDD (PDHID).

When operating MSD, usage of helium of sorts "45", "50", "55" will lead to quicker gas traps saturation, shorter lifetime of filaments of ion source, possible appearance of contaminations in MSD. MCS performance cannot be guaranteed in this case.

Flame detectors supply:

- hydrogen (purity grade of hydrogen is not less than 99,99 vol.%; content of oxygen is not more 0,01 vol.%, content of water steams is not more 0,5 g/m^3 , carbon monoxide and dioxide are absent), or from hydrogen generator (models P/N 451-0101…09);
- zero air (or from air compressor purified with Catalytic purifier 20.0-01 or 20.0-03, or with other traps purified from organic impurities).

When using ECD detector, carrier gas must have low contents of oxygen and water traces. When using GC columns containing Polyethylene glycol (Carbowax, Wax, FFAP) as a liquid phase, it's important to use carrier gas with the lowest oxygen concentration in order to avoid liquid phase destruction.

2.5.3 Additional gases purification

Additional purification of air from volatile organic substances is performed with the help of Catalytic purifier 20.0-01 or 20.0-03.

Additional purification of gas – carrier from oxygen is performed with the help of Catalytic purifier 20.0-02 or 20.0-03.

Gases purification from moisture, carbon dioxide is obtained with the help of filters filled with molecular sieves. Removing hydrocarbons from gas flow is provided in active charcoal traps.

Various commonly used filter preventing gases from oxygen, hydrocarbons and water can be used.

2.6 Gas lines requirements

2.6.1 General requirements

At mounting, installation, checking of gas cylinders with compressed gases "Rules for Pressure Vessels Design and Safety Operation" should be observed.

Gas cylinders with compressed gases are attached to premise walls with the help of a clamp from a complete set of gas fitting.

Gas cylinders with gas located in premises should be at least at 1 m distance from heating radiators and other heating devices and furnaces; at least 5 m from heat sources with open fire.

Two-stage pressure regulators for gas cylinders are strongly recommended in order to eliminate pressure surges in gas lines.

At GC delivery with gas fitting set (P/N 455-0513), two-stage pressure regulator (e.g., P/N 455-0131) from the set meets these recommendations, except PDD detector. The pressure regulator can be used for feeding several GCs with carrier gas in total up to 500 ml/minute.

Another way for additional pressure reduction step is Filters block usage.

For stable operation of chromatograph gas controllers it is recommended that pressure differential between controller entry and outlet should be at least 50 kPa.

Recommended gases pressures at the entry of chromatograph:

- Carrier gas – from 0.36 to 1.25 MPa;
- Hydrogen – from 0.14 to 0.64 MPa;
- Air – from 0.17 to 0.64 MPa.

As a source of hydrogen, it is supposed to use hydrogen generator. Use of hydrogen generator (models P/N 451-0101…09) manufactured by SDO "Chromatec" is recommended.

As a source of air any oil-free compressor providing constant pressure at its outlet and sufficient productivity in range specified for GC. and thus having capacity necessary for chromatograph operation can be used. Compressor (P/N 451-0202) manufactured by SDO "Chromatec" is recommended.

2.6.2 Tubing preparation for gas lines mounting

For mounting of gas lines it is necessary to use only tubing carefully washed out and dried in a stream of pure gas.

Contaminants are present in all tubing of common purpose as a result of manufacturing process. Specially cleaned tubing for chromatographic purpose is free of contaminants.

Before gas lines mounting tubes must be carefully cleaned with solvent.

Nonpolar solvent, like n-hexane, is recommended for tubing cleaning. To clean tube, fill it with solvent and keep within about 30 minutes, then empty tube. It's recommended to repeat procedure until drops of poured solvent stain white paper or cloth.

Further roll the tube into reel. Using pure nitrogen, blow out tubes from rest of solvent. Do not use technological compressed air, since it may contain traces of oil.

Reeled tubes are to be located into heating oven and kept under 110°C within at least 2 hours.

After cooling ends the tube shall be sealed (or plugged), especially those which are supposed to be transported or stored until the next montage.

Do not use halogenated solvents for tubes cleaning. It may cause increasing of baseline noise and drift.

2.6.3 Tubing material

Stainless steel.
Stainless steel is the best choice for gas lines thanks to its resistance to physical impact and to oxidation of internal and external surface. Stainless steel tubing is recommended for important applications, when extremely low oxygen concentration in carrier gas flow is required therefore high level of impermeability. For tubing pieces connection outside of premises it's recommended to use welding.
For example, high impermeability requirements are made at operation with helium ionization detector (HID) and mass-spectrometric detector (MSD).

The same requirements are typical for capillary columns exposed temperatures to their maximum. In case of insufficient gas quality detector with high signal may decrease its level when purified gases connected, but capillary columns typically deteriorate its efficiency and low bleeding irrevocably.

Copper.
Copper tubing is cheaper than stainless steel one. For tubing pieces connection outside of premises it's recommended to use high temperature soldering.

Copper tubing is not allowed to use for hydrogen lines connected to compressed hydrogen gas cylinders, because copper is too soft material as a result scratches, cracks and other damages may appear on tube surface. Tubes of short length may be used for connection hydrogen lines between hydrogen generator and GC.
Keep in mind that internal copper surface may oxidize if it contacts with moisture and oxygen. Thus tubes connected to hydrogen generators (or air compressors) shall be immediately dried if these were exposed to moisture owing to devices failure.

Polymers.
Rubber tubing is not recommended for gas lines montage. Such tubes may cause carrier gas pollution.

Manufacturer doesn't guarantee GC technical specification data and its trouble-free operation if contaminated carrier gas is used.

Typical oxygen diffusion figures depending on polymer material are listed in table.
Gas – argon, pressure 10 bar., gas flow, tube length – 1m,
Tube size: outer diameter (OD) 6mm, wall thickness 1mm.

Material	**Oxygen diffusion, ppm**
Glass	0
Stainless steel	0
Copper	0
Neoprene	7
Polyethylene	11
Teflon (PTFE)	13
Polyvinyl	27
Rubber	40

Oxygen diffusion through Teflon tube of 3 mm OD, 1mm wall thickness, 1m length is about 2 ppm (0,0002 % vol.).
Teflon tube with length up to 3m, supplied by manufacturer, is permissible to use for gas lines to hydrogen generators, air compressors and also for carrier gas lines when oxygen diffusion influence is not highly relevant.

2.6.4 Tubing diameter

Safety measures of some companies may ban storing high pressure gas cylinders containing carrier gas in laboratories. One needs to consult with safety department in order to determine proper place of storing for gas cylinders.

At placing gas cylinders outside of premises these shall be protected from atmospheric precipitates.

At the best, cylinders shall be placed in immediate proximity to the GC. The best gas line is of short length with minimum connections. Never lay tubes places difficult of access, it makes difficulty for possible leaks seeking.

Gas line internal diameter (ID) depends on the distance between the GC ad gas cylinder. If one GC is used at distance from 3 to 10 meters from gas cylinder, 2mm ID for gas lines would be applicable.

When feeding several GCs from one gas cylinder at long distance, tubes of 4mm ID is recommended in order to eliminate influence in GC operation between each other.

2.7 Recommendation on choosing regulator for gas cylinder

Some commercial pressure regulators for gas cylinders may be found unsuitable for chromatography. Typically such regulators are designated for reducing gas pressure (for example, at welding operations). Nevertheless requirements for zero leak, zero oxygen diffusion the regulator membrane, accuracy of outlet pressure keeping do not meet to chromatography requirements.

To eliminate pressure fluctuation in gas lines, two-stage pressure regulators for gas cylinders are strongly recommended.

Two stage pressure regulator 5.882.003, supplied separately or in consist of gas fitting set (4.078.000) meets to GC requirements. Pressure regulator may be used for feeding several GC with the total carrier gas flow up to 500 ml/min.

For stable operation of gas flow regulators in GC, pressure difference between inlet and outlet of flow regulators shall be at least 50 kPa (0,5 atm.).

3 CHROMATOGRAPH INSTALLATION

3.1 General

Before starting chromatograph installation provide all necessary preparatory measures described in the previous section.

Chromatograph installation is performed by a trained service engineer of SDO "Chromatec" or its official representative.

The organizations, having their own skilled specialists, can perform chromatograph commissioning only by written permit of SDO "Chromatec ".

When working with MSD, take into account the requirements specified in chapter 4 of User Manual "Mass-spectrometric detector 214.2.840.083UM".

3.2 Chromatograph unpacking and compete set checking

At chromatograph receipt, first make sure that transport containers (package) are not damaged and have integrity of seals. If there are revealed signs of damages or seal is torn from container, it is necessary to notify transport agency about it and regional representative of SDO "Chromatec" and prepare statement on revealed damages with proper pictures attached.

Install containers with chromatograph components at a dry area with temperature at least 10°C. In a winter period you should hold containers without unpacking at least a day.

Open containers without strong impacts and shakings. Free it from a packing material.

Make external survey for lack of damages of the GC and its auxiliary parts, check complete set of equipment according to the sections "Complete set" specified in the Logbook and in service papers of products (according Operating documents sheet) with which the GC is accompanied.

If there are either signs of damages of the GC or its auxiliary devices, or discrepancy in specification, it’s suggested to notify manufacturer (supplier) or regional Chromatec representative and to prepare a statement (claim) describing revealed damages with appropriate pictures of damages (defects) or difference between specifications and delivery kit.

3.3 Chromatograph location

During the GC location it is necessary to consider requirements given in Section 2 of the present manual.

Gas chromatograph, PC and other chromatograph components are installed on laboratory desk in order convenient for operation.

At oven cooling hot air flow is emitted through oven vent. Thus distance between chromatograph rare wall and premise wall should be at least 200 mm; surface of premises wall shall be flame-proof if distance is less than 500 mm. On the way of direct hot air flow any equipment placing (electrical cables, accessories etc.) should be removed.

Compressor is recommended to place outside of desk in order to prevent GC from compressors vibration.

Location of chromatograph components should provide easy access to power sockets and connections of gas lines.

3.4 Gas lines mounting

3.4.1 Required materials

From chromatograph shipping kit:

- Filter 5.886.001(-05);
- Nuts 8.930.167(-04);
- Nuts 8.930.114(-04);
- Ferrules 8.658.038-03 (or other suitable ferrules 1/8” OD);
- fitting 8.658.195 (or other connection to gas cylinder regulator);
- wrenches (from set of tools 4.073.006);
- stainless steel tube of 1/8” OD;
- washer 3.

For connection copper tube use suitable brass ferrules.

Other equipment (if required):

- installation kit (P/N 455-0501 or 455-0502);
- two-stage pressure regulator P/N455-0131 (or other);
- filters block (e.g. P/N 455-0400);
- hydrogen generator;
- air compressor.
- catalytic purifier 20.0
- additional filters for gas purification.

T-joints (6.454.022-02) from GC shipping kit may be used for extension gas lines.

At mounting of chromatograph gas lines, it is necessary to consider requirements stated in subsection 2.6 of this manual.

When working with GC/MSD, take into account the requirements specified in chapter 4.1.4 of User Manual "Mass-spectrometric detector. 214.2.840.083UM".

3.4.2 Installation of gas regulator on gas cylinder and leaks testing

Before installation of gas regulator the gas cylinder's valve should be closed, gas cylinder's output fitting should be clean and have no damages.

Follow instructions in corresponding User Manual to connect pressure regulator to gas cylinder and tube to regulator's outlet. Typical description of pressure regulator connection to gas cylinder is given below.

Actions:

- Install regulator on the gas cylinder. At turning a connecting nut regulator's crank isn't allowable;
- unscrew regulator's valve counter-clockwise against stop;
- open gas cylinder's valve;

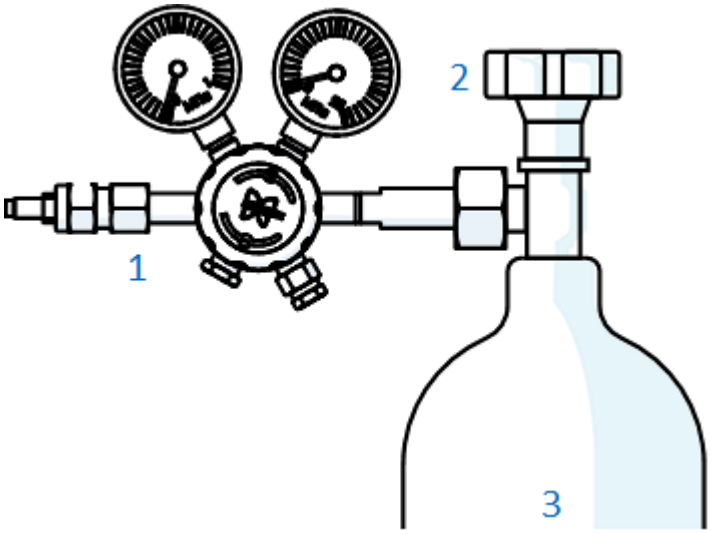
with the help of a soap liquids test joint for leaks

At regulator's valve soaping and output fitting bulbs formation should not allowed.

The regulator on gas cylinder should not leak through the valve at releasing its control spring (as a rule at full regulator control screw unscrewing counter-clockwise).

The pressure regulator (P/N 455-0131 and similar) testing is performed as follows (Figure 3.1):

- Seal the regulator with 6.432.002 plug from gc shipping kit;
- Set pressure on regulator output gage (0.4±0.04) mpa;
- Release regulator control spring. It may lead to insignificant pressure decrease (up to 0.05 mpa);
- Check gas pressure change on the output gage for 4 hours. Gas pressure change is not allowed.



1 – Pressure regulator, 2 – regulator's valve, 3 – gas cylinder

Figure 3.1 – Pressure regulator checking

Pressure increase on output gage testifies to regulator failure due to gas overflow through control valve of the regulator itself. This regulator derangement can result in errors at leakage testing and to flow controllers valves failure at chromatograph operation, due to gas leakage.

Gas pressure decrease on output gage testifies regulator leakage. This derangement can result in increase of gas flow rate.

3.4.3 Tubing connection

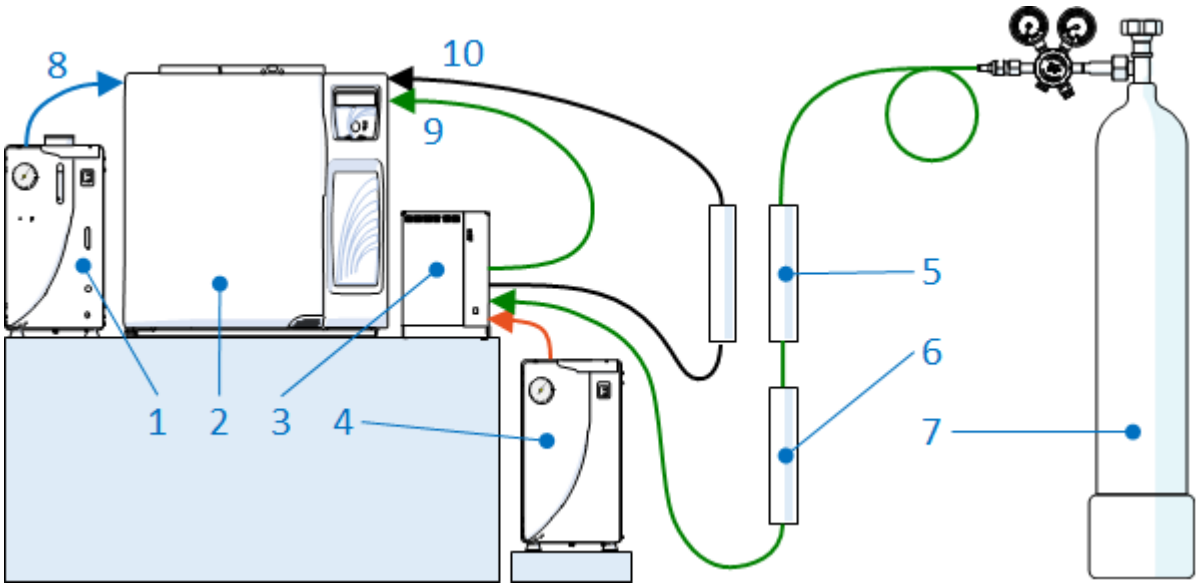
Gas lines supplying to the GC under working pressure over 0,2 MPa shall be sealed metal ferrules. Rubber ferrules usage is not admissible in order to prevent occurrence of leakages or connections breakups.

When gas lines connection, metal tubing connected to one GC is convenient to stretch as a spiral, it will give flexibility to it and will allow to shift the GC if necessary without gas lines disconnection.

Gas lines connection from hydrogen generator and compressor to chromatograph is performed similar with the help of screw nuts 8.930.167 and suitable metal ferrules. If working pressure in line is not over 0.2 MPa, use of 8.220.272-01 rubber ferrules are allowed.

If gas purification after gas source is required (for carrier gas, air or hydrogen) additional filters (catalytic filters like Catalytic purifier 20.0 or adsorption traps) shall be installed in lines before the GC.

Typical gas connection diagram is shown on figure below:



1 – hydrogen generator, 2 – chromatograph, 3 – catalytic purifier 20.0, 4 – compressor, 5 – moisture traps, 6 – hydrocarbon traps, 7 – gas cylinder, 8 – hydrogen outlet, 9 – carrier-gas outlet, 10 – air outlet.

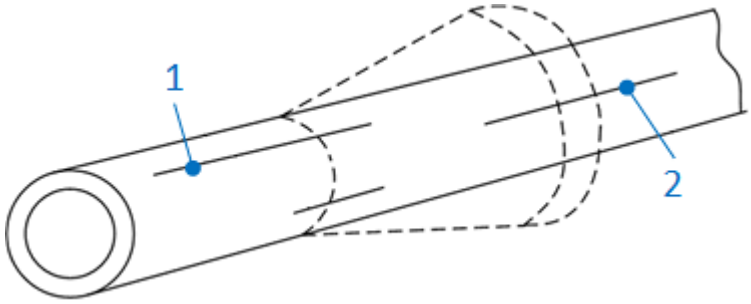
Figure 3.2 – GC gas connections

Traps 5 and 6 are independent from shipping kit or as parts of Filters block. Catalytic purifier 20.0-03 or other model connected as per its User Manual instructions.

3.4.4 Connection (sealing) of pipelines

Preparation of sealing elements

- Tubes should be carefully washed, tubing surface shall be smooth without mechanical defects. Additional treatment of external tubing surface, particularly polishing, is allowed. When polishing, ingress of any solid particles inside tubing should be eliminated. After treatment tube shall be thoroughly blown out with pure gas flow from possible solid particles.
- Scratches are not admissible on the surface.



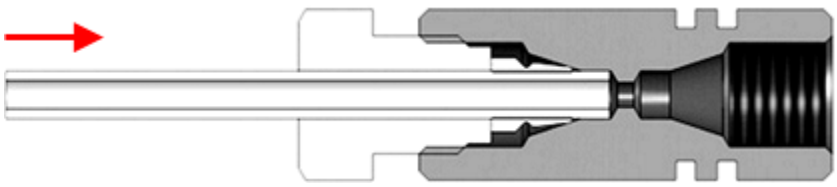
1 – leak, 2 – leak may not appear

- Ends of the tube must be even. For this use special roll cutter to prepare tube of required length.
- Tubes with an oval cross-section that are difficult to fit into nuts, ferrules and fittings must not be used.
- Scratches, dents, cracks and chips are not allowed in the cone hole of the fitting.

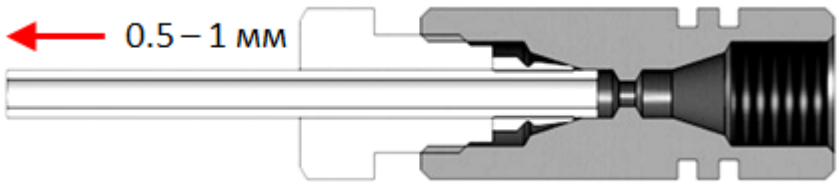
Order of sealing of metal ferrules

When sealing metal pipelines with a metal ferrule, the following sequence of actions must be followed:

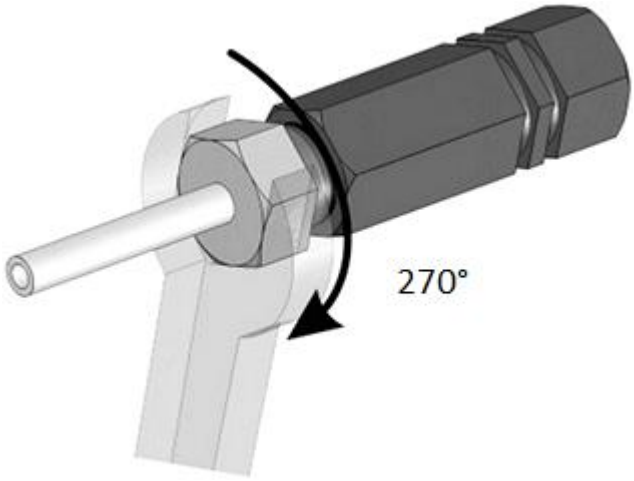
- The tube with the ferrule and nut planted on it is inserted into the fitting until it stops in the side, then the nut is manually tightened until it stops.



- For convenience, you can mark the tube with a marker at the end of the nut.
- The tube is removed by 0.5-1 mm.



- Holding the body of the fitting in a fixed position, the nut is tightened with a 3/4 turn wrench (270°). If necessary, a second key should be used to protect the fitting from scrolling.



- If a leaky connection is detected, the nut is tightened with a wrench for another 1/6 turn (60°). If the leak has not stopped, the part of the sealed tube with the ferrule is cut off and a new ferrule is installed.

When re-sealing, the nut is manually tightened until it stops and tightened with a key by 60 degrees.

Order of sealing of rubber ferrulles

Rubber ferrules are allowed to be used (at a pressure below 200 kPa, if the diffusion of components from the air does not affect the operation of the detectors and the result of the analysis.

- The tube with the ferrule and nut planted on it is inserted into the fitting until it stops in the side, then the nut is manually tightened until it stops.
- Holding the body of the fitting in a fixed position, the nut is tightened with a 1/6 turn wrench (60°). If necessary, a second key should be used to protect the fitting from scrolling.
- If a leaky connection is detected, the nut is tightened with a wrench for another 1/6 turn (60°).

3.5 GC turning on and initial operability check

Turn the GC on. For this turn on power on/off switcher on rear panel, then push on/off button on right wall.

Once the GC has been turned on:

- On the front panel the LED “Power” lights, cooler starts working in rear part of the GC;
- Then within a few seconds flash memory control and “Initialization” state run, at which display shows corresponding notice. During this states hardware identifies detectors, gas regulators, auxiliary devices and internal auxiliary units connected to GC mainboard.
- Once “Initialization” state finals successfully, LEDs “Not ready” and “Cooling” get lighting on the front panel and message “Control” with menu for current parameters overview will appear on display.
- Keep it within approximately 2 minutes.
- Turn the GC off.

The GC is considered to be accepted successfully on test “operability at delivery”, if above-listed LEDS got lighting, “Control” status displayed and cooler turned on. At this initial operability check conducted by Customer is terminated.

Further checks of GC operation are to be conducted by Manufacturer (Supplier) authorized person during commissioning procedure according to terms of agreement between Manufacturer (Seller) and Customer (Buyer).

3.6 Feeding gas lines check for leaks

When using soap liquids for leaks checking, there is a potential danger of electric shock.

In order to prevent this danger at such checks it is necessary to turn GC and connected devices off and disconnect the main power cords.

Leaks test of feeding gas lines (outside GC) is provided as follows by soap liquids:

- Before checking make sure that all gas lines are connected and tightened in a proper way;
- set working pressure in gas lines for testing;
- leakproofness should be tested by soap liquids wetting of tubes connection points. Leakages should be removed by tightening of corresponding fittings and, if necessary, by replacement of sealing elements;
- after leakage test places of wetting should be wiped by wet napkin for removal of soap liquids remnants;
- upon termination of testing gas lines should be blocked.

When operating MSD, soap liquids usage for leak test is not allowed in order to avoid contamination of the system.

Instead of soap liquid it is recommended to use available commercial items instead of soap liquid (for example, Swagelok snoop Liquid Leak Detector, Agilent P/N 9300-0311; Agilent Flow Tracker 2000, Leak Mode, Restek Leak Detective II™ Electronic Leak Detector and others). Performing leak test follow procedure recommended for used items.

Leakproofness of carrier gas lines can also be tested by pressure-gage quality control in accordance with GOST 25136-82. Allowable gas leakage is 0.02 ml*MPa/s.

3.7 Gas supply pressure setting

Pressure setting at chromatograph entry depends on the following factors.

Pressure should be sufficient for obtaining the most high gas flow rate necessary for device operation. Pressure/ flow rate proportion depends on the chromatograph column and applied chromatograph devices.

For stable gas flow controllers and chromatograph pressure it is necessary pressure differential between the entry and output of controller should be at least 50 kPa.

Maximum allowable chromatograph inlet pressure in gas – carrier lines 1.25 MPa, hydrogen and air – 0.7 MPa.

Recommended gas pressure rates for operation:

- Carrier gas: (0.36-0.64) MPa;
- air (in detector): 0.2 MPa;
- hydrogen (into detector): 0.14 MPa.

If filters block is applied, recommended pressure rate at its inlet is from 0.5 to 0.7 MPa.

3.8 Connections to the GC

3.8.1 Computer connection

A personal computer (PC) is connected to the chromatograph using a standard Ethernet cable (patch cord) to the LAN connector.

To connect the chromatograph and mass spectrometric detector in the computer, it is desirable to install a separate network card.

Recommended Board: PCI Express d-Link DGE-560T adapter.

The network adapter integrated into the motherboard of the computer can be used to connect to the local network and the Internet. The imposition of a GC and MS on a single network adapter allows you to avoid disconnections.

GC to PC connection settings are described in section 3.7.10 part 1 GC User Manual and also in section 2 Chromatec Analytic SW User manual.

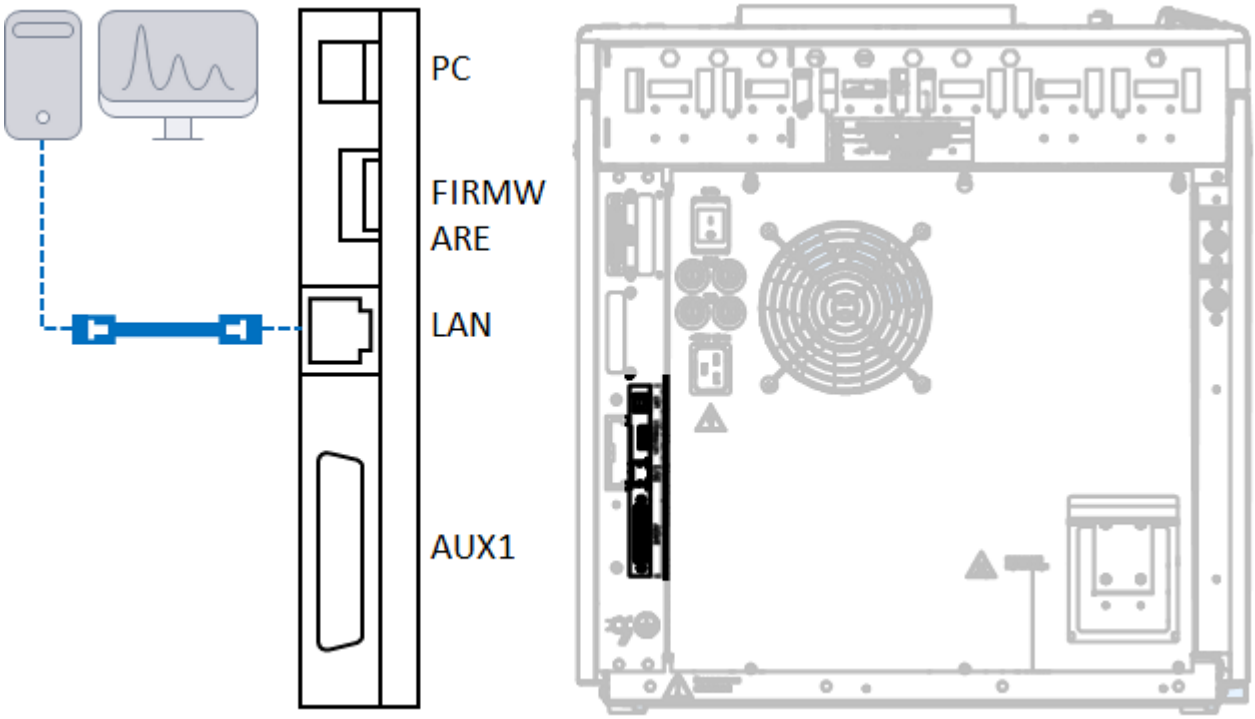
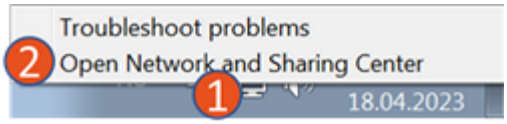
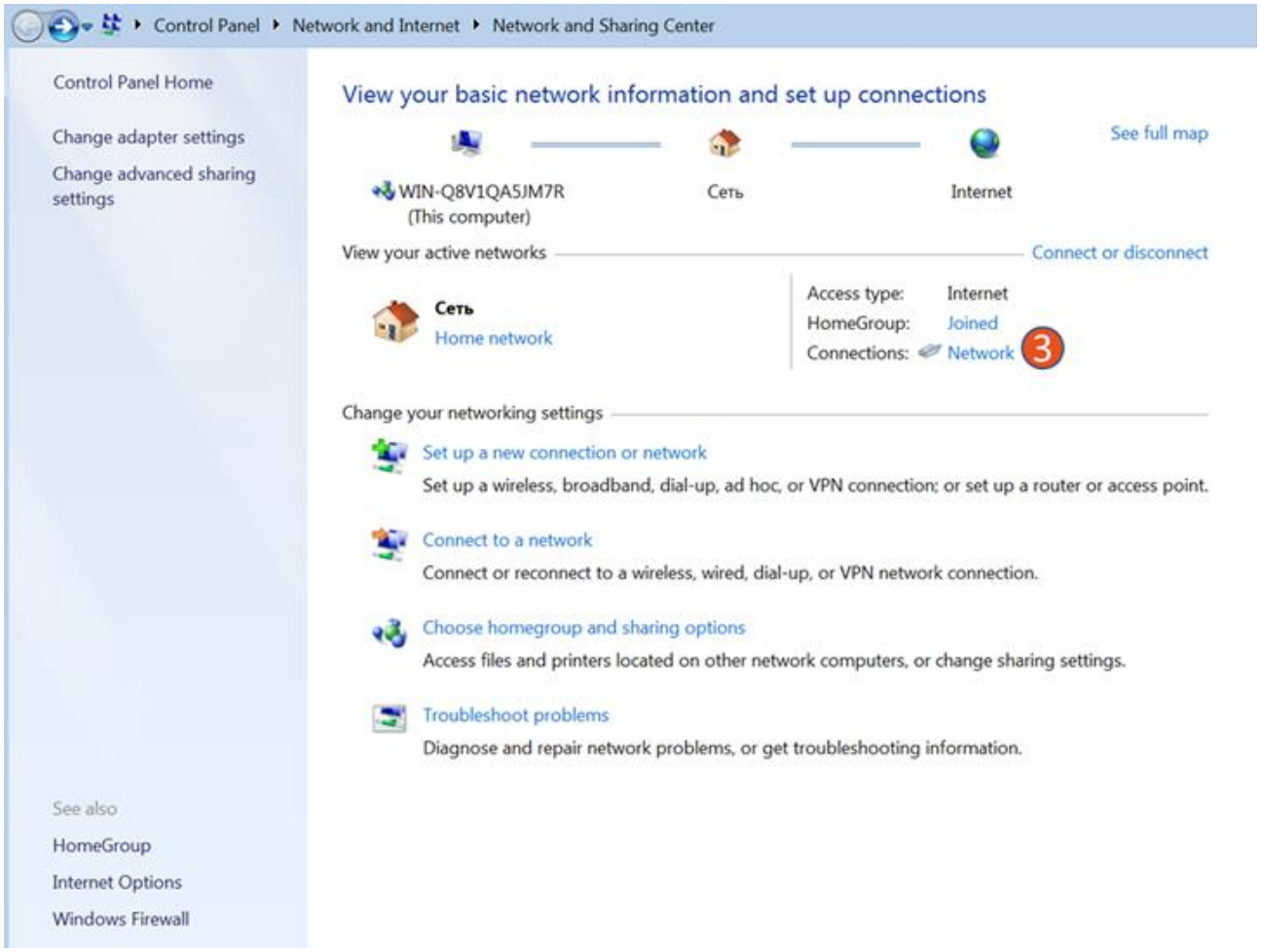


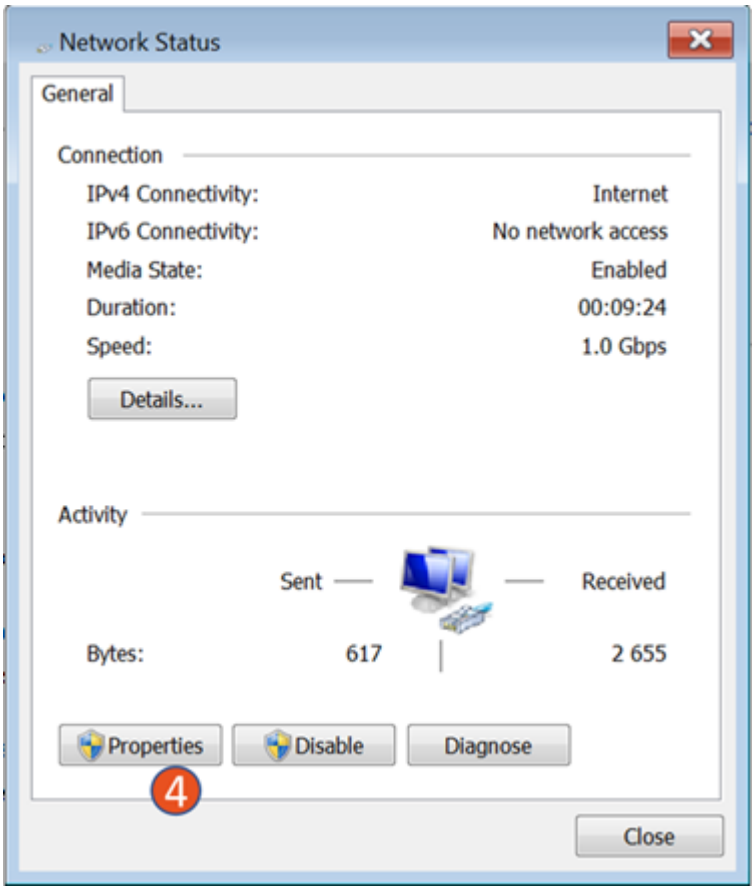
Figure 3.3 – Cable connections to the GC

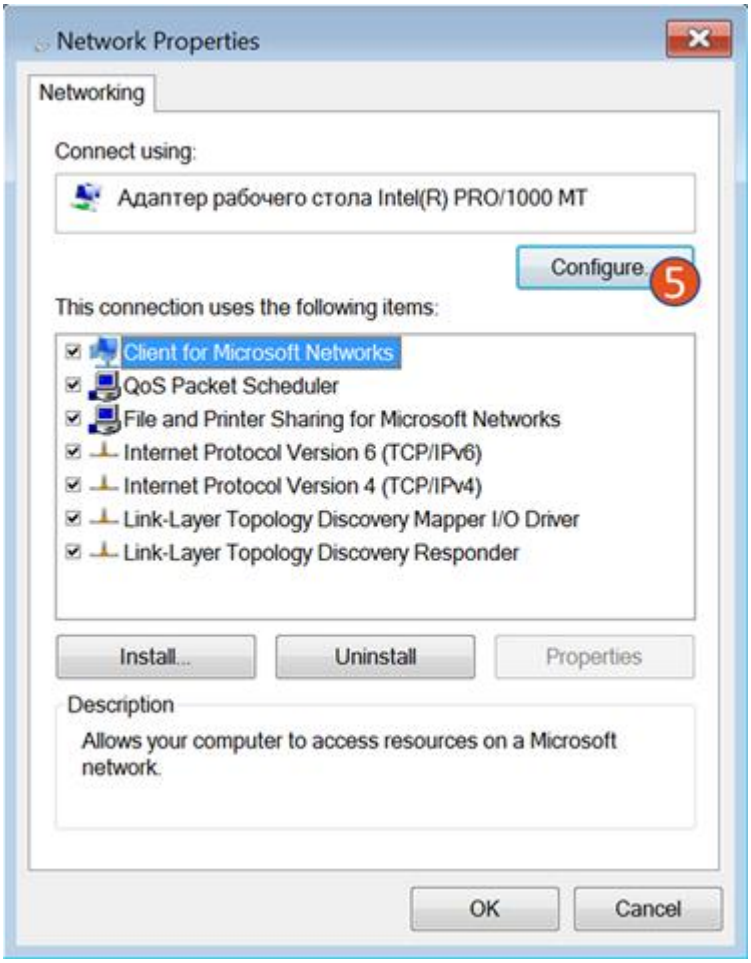
RS-232 connector is installed in the chromatograph by a separate order.
If your computer does not have a separate network adapter for the GC, follow these steps:

1. In the lower right corner of the screen, right-click the Network icon.
2. Select Network and Sharing Center.
3. Select a connection.
4. Click the Properties button.
5. Click the Configure button.
6. Switch to the Link Speed tab.
7. Expand the Speed and Duplex list.
8. Select a value - 10 Mbps Full Duplex.
9. Go to the Power Management tab.
10. Turn off the Energy Efficient Ethernet option.
11. Click OK on all open windows.




Control Panel ▸ Network and Internet ▸ Network and Sharing Center
Control Panel Home
Change adapter settings
Change advanced sharing settings
View your basic network information and set up connections
See full map
WIN-Q8V1QA5JM7R
(This computer)
Сеть
Internet
View your active networks
Connect or disconnect
Сеть
Home network
Access type: Internet
HomeGroup: Joined
Connections: Network
3
Change your networking settings
Set up a new connection or network
Set up a wireless, broadband, dial-up, ad hoc, or VPN connection; or set up a router or access point.
Connect to a network
Connect or reconnect to a wireless, wired, dial-up, or VPN network connection.
Choose homegroup and sharing options
Access files and printers located on other network computers, or change sharing settings.
Troubleshoot problems
Diagnose and repair network problems, or get troubleshooting information.
See also
HomeGroup
Internet Options
Windows Firewall


Network Status
General
Connection
IPv4 Connectivity: Internet
IPv6 Connectivity: No network access
Media State: Enabled
Duration: 00:09:24
Speed: 1.0 Gbps
Details...
Activity
Sent
Received
Bytes: 617 2 655
Properties
Disable
Diagnose
4
Close



3.8.2 Recorder connection

Slot for recorder connection is mounted optionally.

- Connect cable from shipping kit to slot “A out” of the GC;
- Lugs on other end of the cable connect to recorder. Recommended recorder scale is – 10 mV;
- Provide recorder grounding, then turn the recorder on according to supplied User Manual.

3.8.3 Auxiliary devices connection

Auxiliary (external) devices are to be connected to the GC:

- Autosampler AS-2M and its modifications;
- Headspace sampler;
- Thermal desorber TDS-1 (two-stage);
- Pyrolytic inlet;
- Oven cooling system.

Auxiliary devices connected to the GC are synchronized between each other and are controlled by means of Chromatec Analytic software.

Connection is carried out to slots "AUX1", "AUX2".

If device is connected to the GC properly, it will be automatically identified in software and GC at instruments turning on.

3.8.4 Mass spectrometric detector connection

MSD detector, operating with the GC, shall be synchronized by Start channel.

Connect cable 6.644.146 from MSD shipping kit to “Start MS” socket which is located on rear panel of the GC.

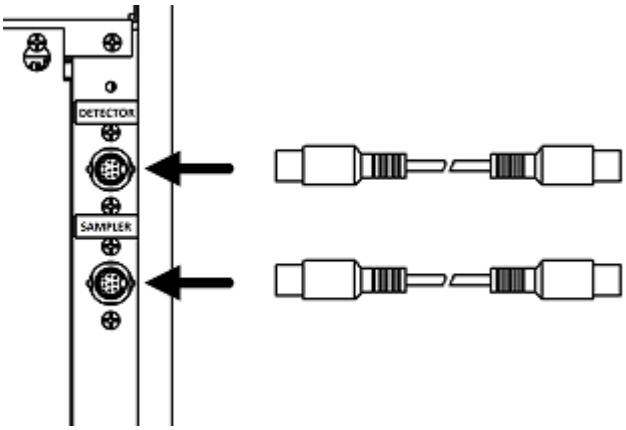


Figure 3.4 – MSD connection to the GC

3.8.5 External keyboard connection

External keyboard (control panel 5.285.034) of the GC is to be connected to “Keyboard” socket, located on the right side panel of the GC.

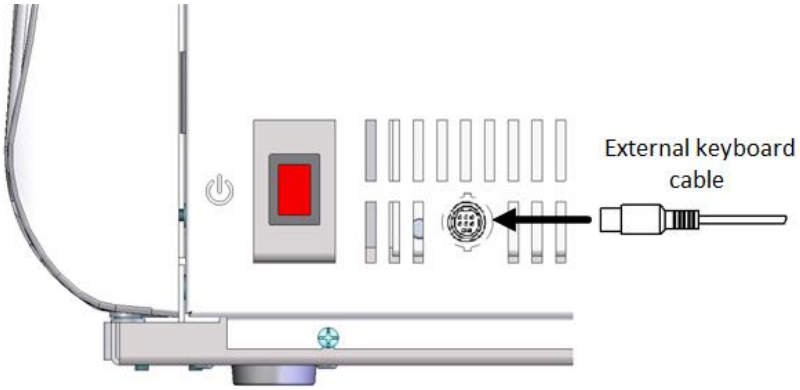
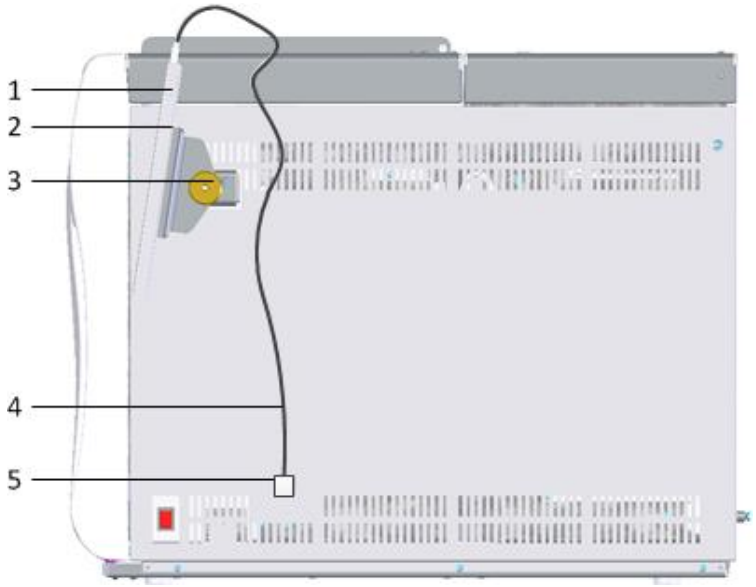


Figure 3.5 – External keyboard connection

3.8.6 Connection of # 8'' Touch Screen Control Display

If option # 8'' Touch Screen Control Display (P/N 150-6112, hereinafter the Control Display) supplied, the GC, the PC and the Display) are to be connected to local network using Wi-Fi-router. Use wireless connection into the same network for the Control Display.

Power unit of the Control Display is located in electronic right side part of the GC. The Control Display is connected to power with USB cable.



1 – Standby button; 2 – Control Display; 3 – holder 1.E-8181; 4 – USB cable; 5 – USB slot for power connection.

Figure 3.6 – Control display connection to the GC

Connect Ethernet cable (Patching cord UTP) from GC shipping kit to LAN slot on the rear cover of the GC. Other and of this cable to be connected to one of slots in rear panel of Wi-Fi router (marked 1 – 4).

Connect Wi-Fi router with PC using vacant slot in the router and cable from router kit (Figure 3.7).

Set Wi-Fi router as described in User Manual “Chromatec Analytic” Software. Part 1. Control Panel".

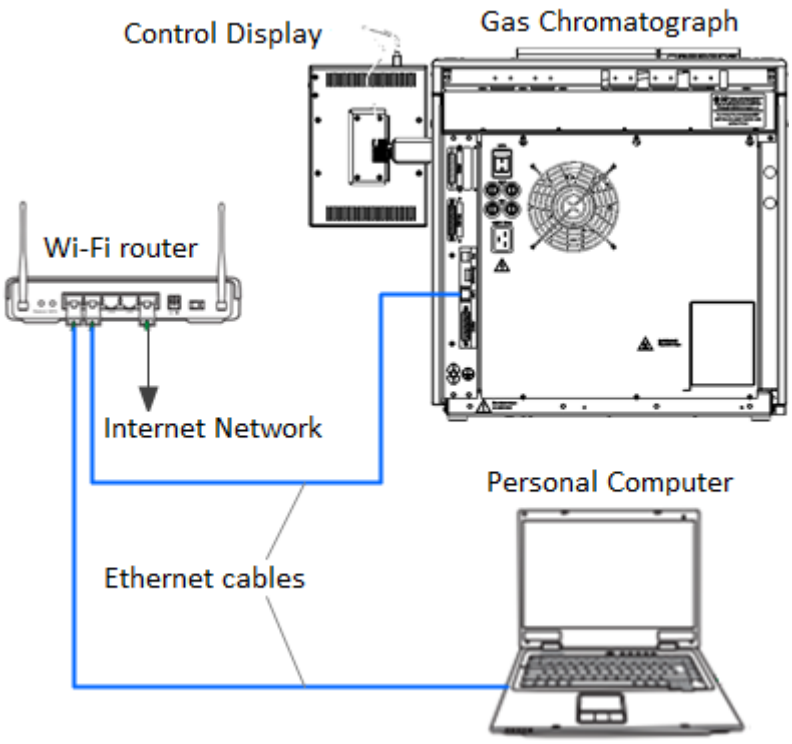


Figure 3.7 – Wi-Fi router connection

4 TURNING ON AND CONFIGURATION SETTING

Based configuration parameters for built-in units are set at manufacturing. Nevertheless, at installation of the GC, some configuration data could be changed depending on chromatographic columns property, particular GC mode, applied test method etc.

Groups of parameters adjusted at configuration setting are described below (Table 4.1). Detailed description is given in corresponding sections of Part 1 UM.

Table 4.1 – Configuration setting. Main operations

Setting parameter	**Need to perform in case**	**Section in UM, detail description**
Setting of connection to PC	First connection to PC or replacement	section 3.7.10 part 1 UM; section 6.1 Chromatec Analytic SW UM
Built-in units' parameters setting (gas controllers, detectors, inlets, valves; oven and chromatographic columns; start synchronization for automatic auxiliary devices etc.)	Replacement or change of position of units, columns, optimization of the GC operation	section 3.7.7 part 1 UM
Expert configuration parameters	Language choosing (Ru/En), setting of power board, gas board, amplifiers	section 3.7.8. part 1 UM
Hardware updating	GC hardware updating	section 3.7.9. part 1 UM
Additional service setting	Activation code input, maintenance, operation optimization	section 3.7.11 part 1 UM