



# CRYSTAL GROWTH PROCESSES AUTOMATION



Weight, kg	0.000	Pressure, Torr	0.00e+00	Temp, °C	0.0	Flow, gpm	0.0	Heat, J	0.0
Height increasing, mm	0.000	Deep Vacuum, Torr	0.00e+00	Heater 1	0.0	0.0	0.0	0.0	
Height increasing, cm	0.000	Mechanical Air	Closed	Heater 2	0.0	0.0	0.0	0.0	
Basic Weight, kg	0.000	K1	Closed	Cover 1	0.0	0.0	0.0	0.0	
Heating		K2	Closed	Cover 2	0.0	0.0	0.0	0.0	
Stage Command, V	0.000	K3	Closed	Rad	0.0	0.0	0.0	0.0	
Voltage Fact, V	0.000	Diffusion pump	OFF	Bottom	0.0	0.0	0.0	0.0	
Power Command, kW	0.000	Mechanical Pump	OFF	Chamber 1	0.0	0.0	0.0	0.0	
Power Fact, kW	0.000	Gate	Unknown	Chamber 2	0.0	0.0	0.0	0.0	
Start, A	0.000	Diffusion pump	OFF	Screen	0.0	0.0	0.0	0.0	
Distance, mChm	0.000	Mechanical Pump	OFF	Diffusion Pump	0.0	0.0	0.0	0.0	
Locking		Manual Control Mode		Power Supply 1	0.0	0.0	0.0	0.0	
P1				Power Supply 2	0.0	0.0	0.0	0.0	
P2				Cooling Water	0.0	0.0	0.0	0.0	
Rod									
Retracting Speed, mm/sec									
Position, mm									
Retracting Speed, mm/sec									

UKRAINE

**Design and manufacture  
of automated Crystal  
Growth Systems (CGS)**

**Automation control system (ACS) CGS sapphire**

**ACS CGS silicon carbide**

**Practical implementation  
of new technologies**

**Crystal mass management**

**Multi-zone heating of the crucible**

**The development of  
innovative  
electric-efficient power  
supplies CGS**

**Power inverters**

**Multi-channel power inverters**

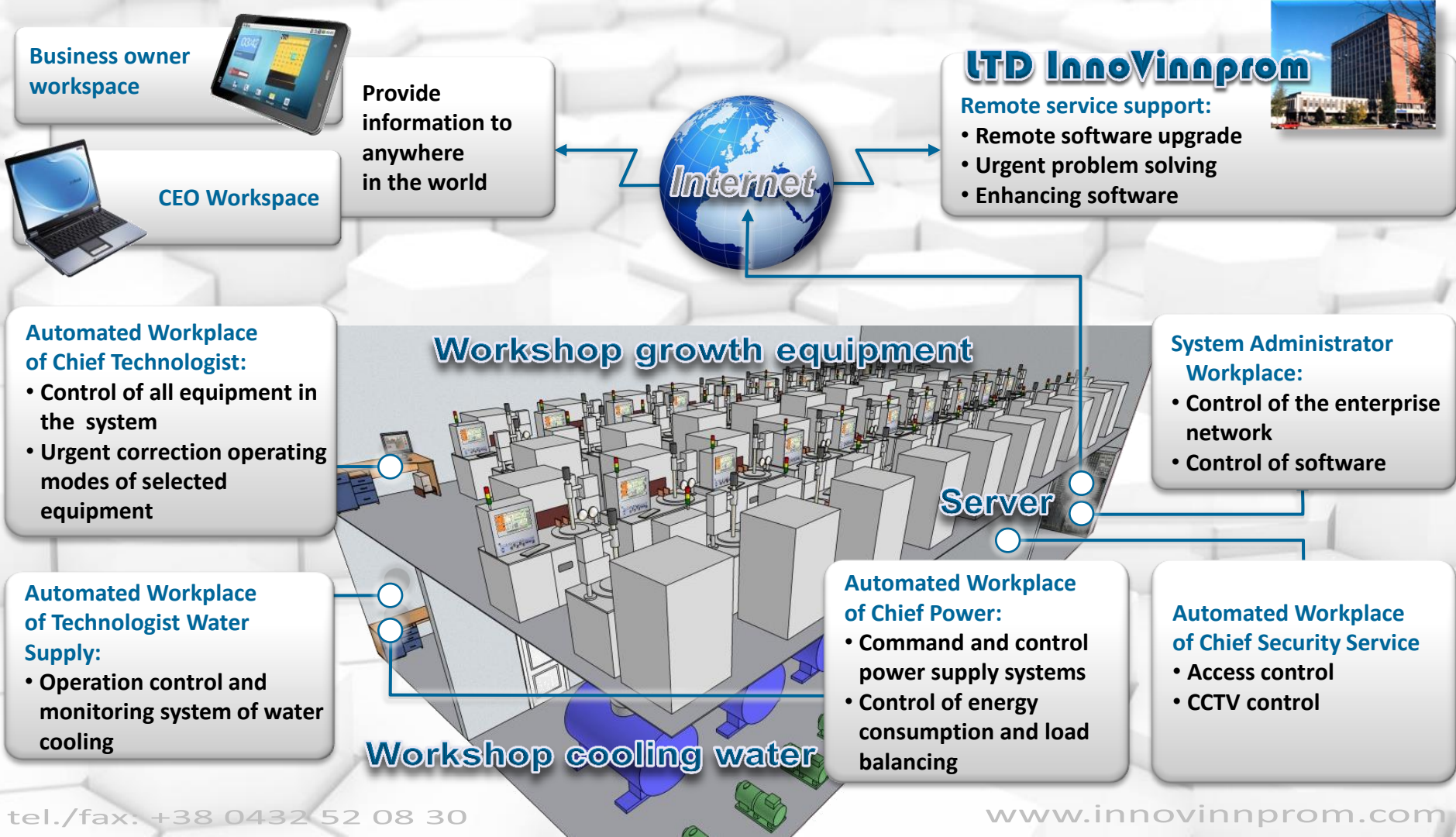
**Automation of industrial  
complexes**

**ACS CGS of factory**

**ACS water cooling system**

The control of system industrial complex enterprise for crystal growing enables full process automation businesses, including the operation of the systems of power supply, water cooling and ventilation.

All equipment merged into a internal network that provides access to full and accurate information about technological processes at the plant in accordance with the user permissions.



**The acquisition server:**

- reception and-or formation of data;
- data processing;
- service of queries about access to data;
- service of queries about updating of data.

**The server of archiving:**

- archiving of data of SCADA-system;
- service of queries about access to contemporary records;
- import/export of archives.

**The journaling server:**

- archiving of messages of units of SCADA-system;
- service of queries about access to archival messages;
- import/export of archives.

**The alarm server:**

- represents a task or group of tasks carrying out functions of the server of recording concerning a narrow category of messages of the signal system.

**The operator working place:**

- granting of the user interface for the control over a condition of technological process;
- granting of an opportunity of formation of operating influences;
- granting of an opportunity of studying and the analysis of history of technological process;
- granting of toolkit for generation of the reporting documentation.

**The engineer working place:**

- granting of toolkit for manipulation with system functions of system;
- granting of toolkit of a workplace of the operator;
- granting of toolkit for manipulation with architecture of SCADA system as a whole (distribution of functions between stations, creation/removal of stations...).

**The chief working place:**

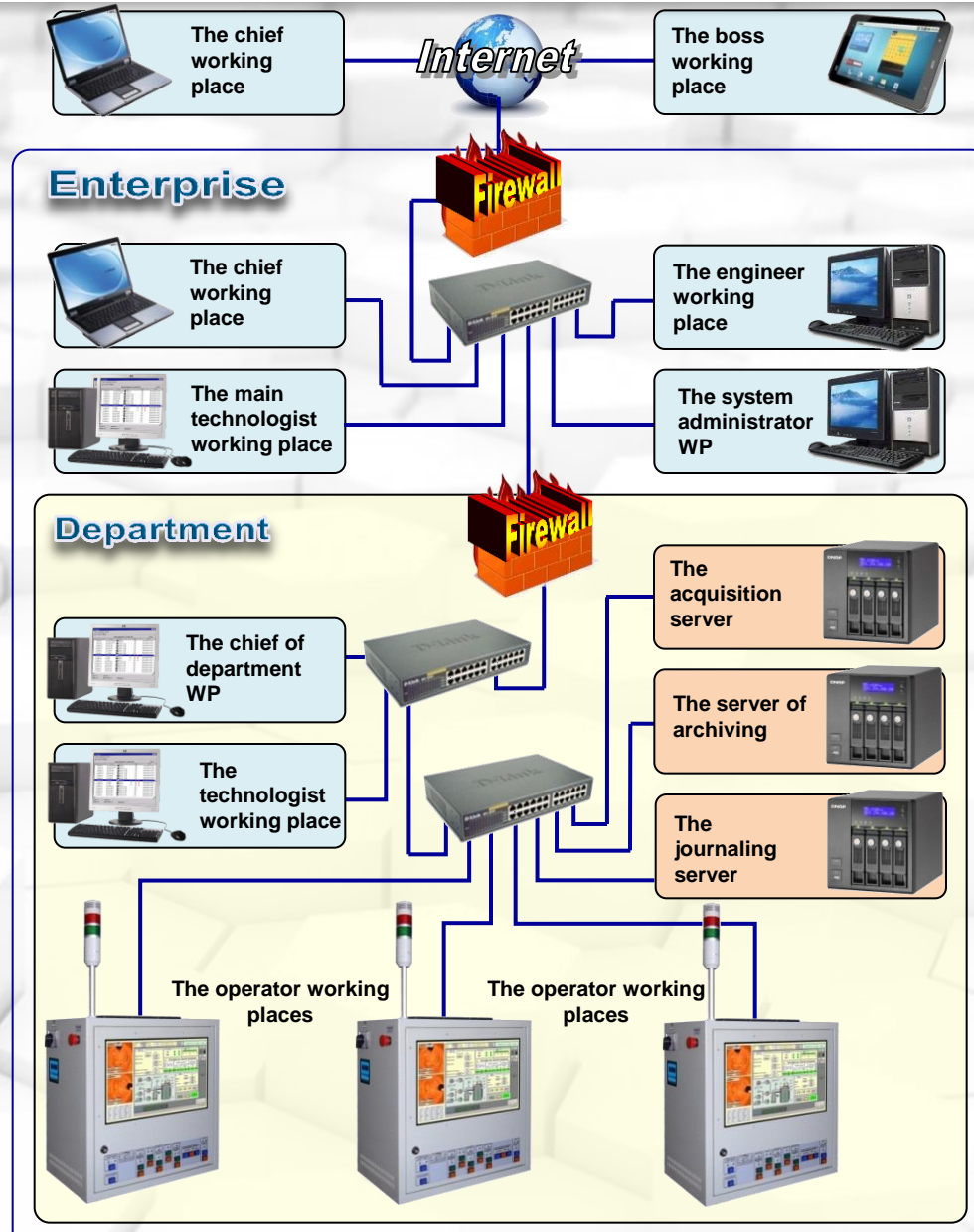
- granting of the user interface for the control over a condition of technological process;
- granting of toolkit for studying and the analysis of history of technological process as is direct from an active server, and on the basis of separate archives;
- granting of toolkit for generation of the reporting documentation.

**The technologist working place:**

- completely includes functions of a workplace of the operator plus model of technological process.

**The work planner working place:**

- completely includes functions of a workplace of the technologist plus toolkit for creation of models of technological processes.

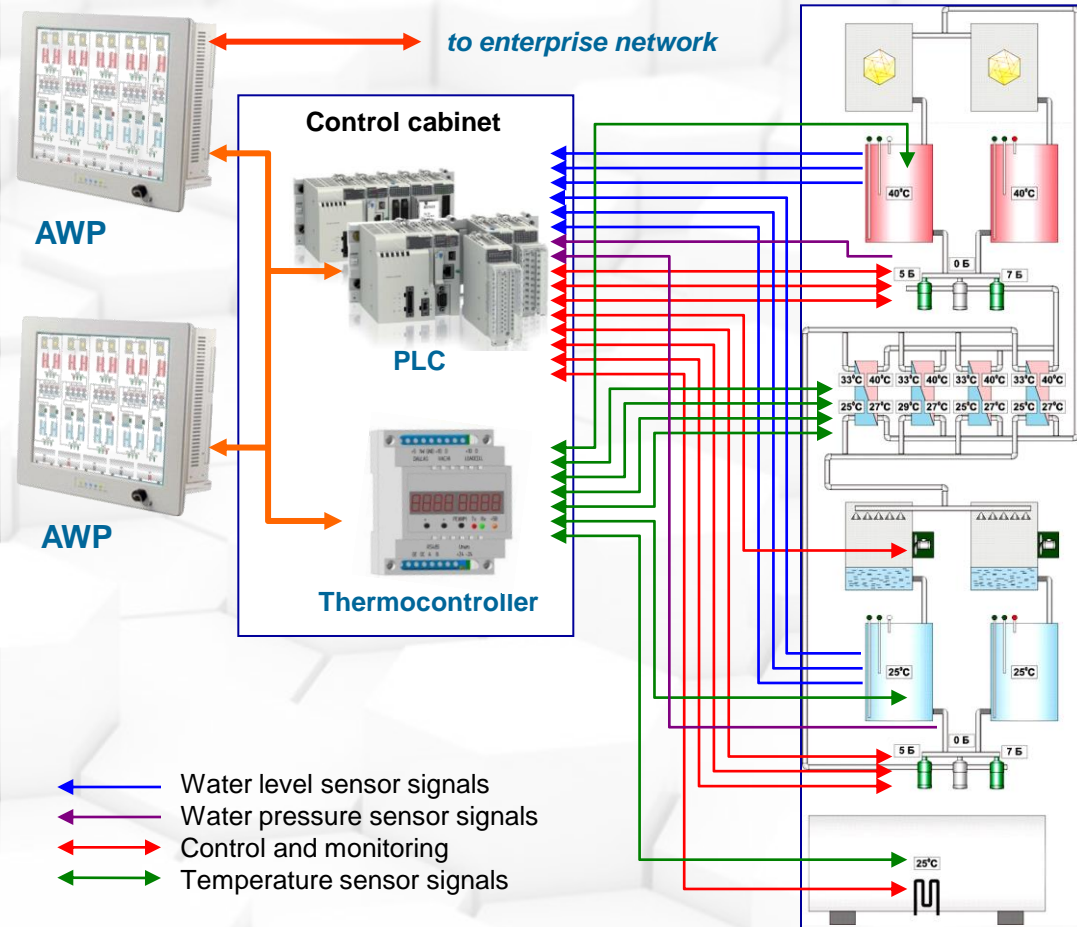


## ACS cooling system is designed to:

- ✓ level control, temperature and pressure of the cooling liquid in the cooling system;
- ✓ controlling temperature conditions by cooling systems by automatic, semi-automatic control aggregates of the cooling system;
- ✓ maintaining databases of measurements and logging operations;
- ✓ providing visual and print reports of controlled parameters, including remote access over the Internet

## System Functions:

- ❖ automatic measurement and display of level, temperature and pressure of cooling liquid;
- ❖ enabling the user to select objects of measurement, settings of measurement parameters, algorithms of switching on devices and mechanisms of cooling systems;
- ❖ automatic, semi-automatic temperature control of cooling systems;
- ❖ emergency switching on and off pumps and fans;
- ❖ automatic maintenance of the water flow and temperature in the cooling system;
- ❖ display information about the level of cooling liquid temperature and pressure and current technological processes;
- ❖ maintaining statistics complete with ability to review previous measurement and storing measurements in a database system;
- ❖ creating and printing of reports on the status of controlled objects and general information, such as the maximum and minimum values of parameters, the dynamics of change, serviceability and stock of system's resource;
- ❖ GSM transmission emergency alerts
- ❖ remote access over the Internet to the information about technological process flow and condition of the whole system;
- ❖ diagnostics of the system over the Internet.



- ✓ Automatic logging process of crystal growth
- ✓ Management of vacuum equipment
- ✓ Precision control of the energy parameters
- ✓ Motor control of crystal movement and rotation
- ✓ Flow control of gases
- ✓ Measurement of weight of the crystal during the growth
- ✓ Temperature control in the cooling circuit
- ✓ Maintain databases of measurements
- ✓ Automatic logging of actions performed by the operator
- ✓ Alarms and automatic emergency blocking
- ✓ Generating of visual and printed reports of system parameters
- ✓ Remote control of the system via the Internet



In order to avoid failure the technological process of crystal growth and destruction of the thermal unit was implemented a multi-level fault-tolerant architecture of ACS.



## 1. Industrial PC

- ✓ setting parameters for the technological process
- ✓ visualization and archiving of data
- ✓ the possibility of hot-switch to control the other PC



## 2. PLC

- ✓ management of technological
- ✓ regulation of technological parameters
- ✓ maintenance of the system parameters in the case of PC failure



## 3. Relay circuit

- ✓ management of vacuum equipment
- ✓ saving modes of vacuum equipment
- ✓ in case of emergency situations



## 4. Meter-regulator

- ✓ maintaining heater parameters within limits with high precision
- ✓ saving heater and crystal in case of software failure
- ✓ PID control system parameters of energy



# Software ACS CGS

As the management of technological process software we have implemented the SCADA-system on a platform with operating system GNU / Linux.

MDI interface software provides complete information about technological process, device status, easy process control, setting permissions, and generates all required reports and graphs.

Software provides the ability to manage recipes of technological processes, loading from the database and automatically save the current recipe, providing tools to view and analyze the data.

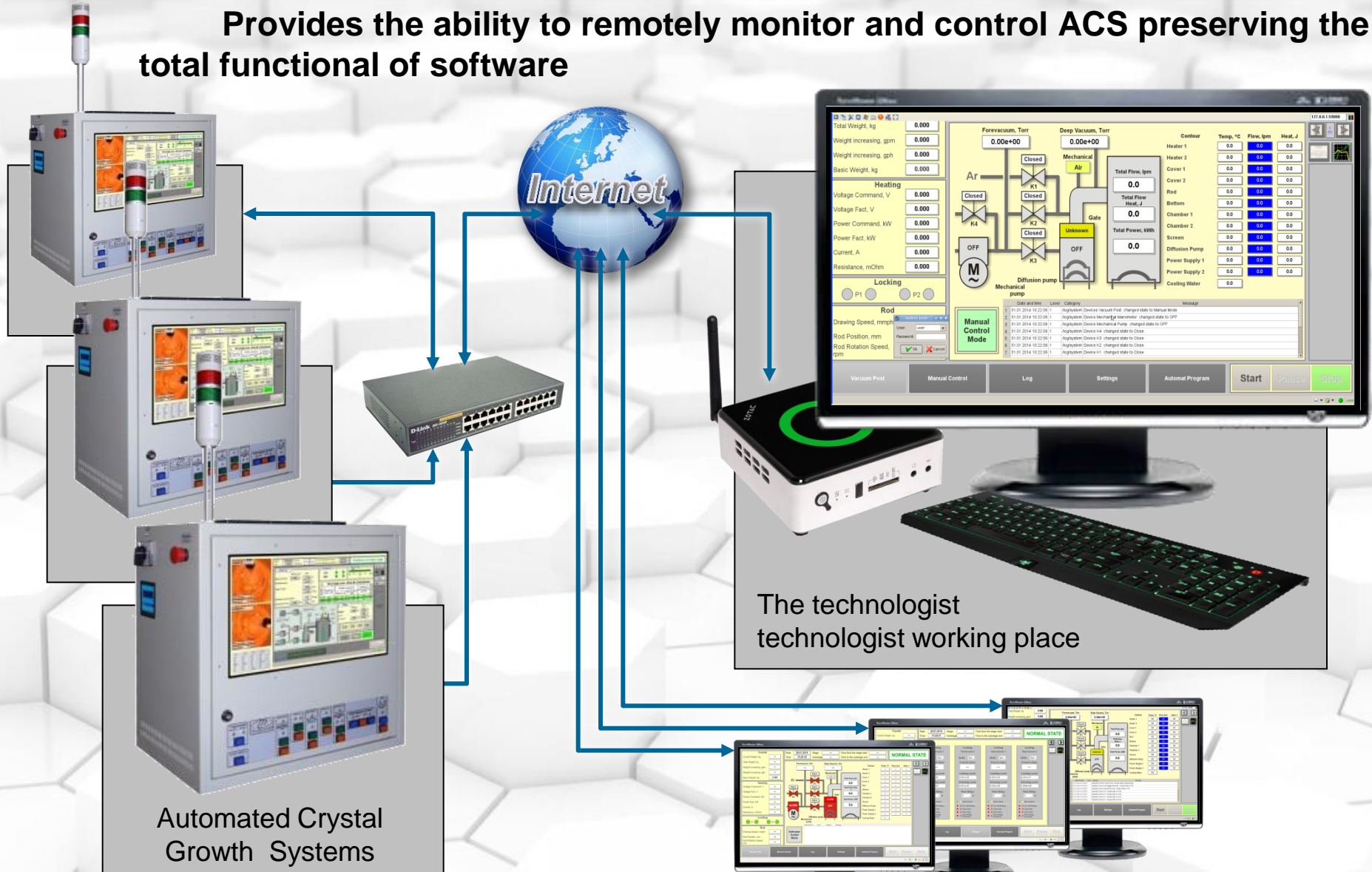
The screenshot displays a comprehensive SCADA interface for the ACS CGS system. It includes several key components:

- Control Panels:** On the left, there are panels for 'Heating' (Voltage Command, Power Command, Current, Resistance), 'Locking' (P1, P2), and 'Rod' (Drawing Speed, Rod Position, Rod Rotation Speed).
- Process Diagram:** A central schematic shows the vacuum system with components like Forevacuum, Deep Vacuum, Mechanical pumps, Diffusion pumps, and various valves (K1-K4, Gate).
- Data Table:** A table at the bottom left lists system events:
 

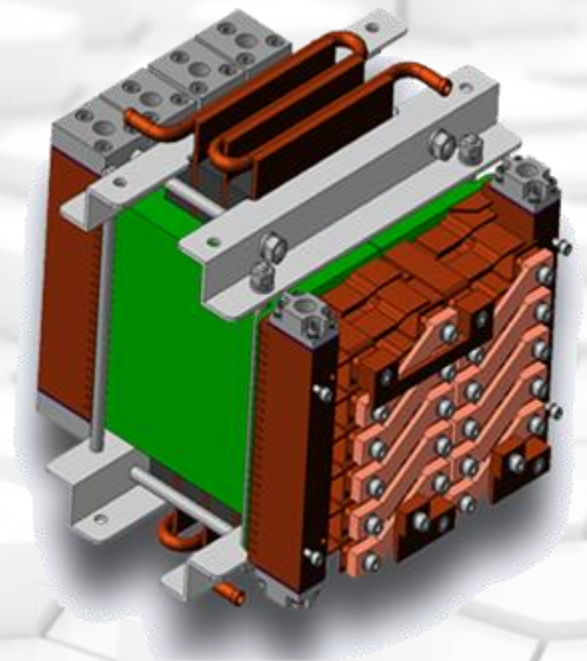
Date and time	Level	Category	Message
31.01.2014 10:22:06	1	/log/system	Device K4 changed state to Close
31.01.2014 10:22:06	1	/log/system	Device K3 changed state to Close
31.01.2014 10:22:06	1	/log/system	Device K2 changed state to Close
31.01.2014 10:22:06	1	/log/system	Device K1 changed state to Close
- Graphs and Status:** On the right, there is a 'NORMAL STATE' indicator, a 'Crystal' weight graph, and a 'Heating' power graph. A 'Contour' table shows real-time data for various sensors.
- Locking Controls:** A foreground panel shows detailed locking settings for Forevacuum 1, Forevacuum 2, Deep Vacuum 1, and Deep Vacuum 2, including units, current values, locking/unlocking levels, and time delays.



Provides the ability to remotely monitor and control ACS preserving the total functional of software



To improve the efficiency of crystal growth systems, load distribution over the phases of industrial networks, reduce network interference from working machines, our specialists together with Vinnytsia National Technical University scientists have developed a unique system of power which is based on the inverter.

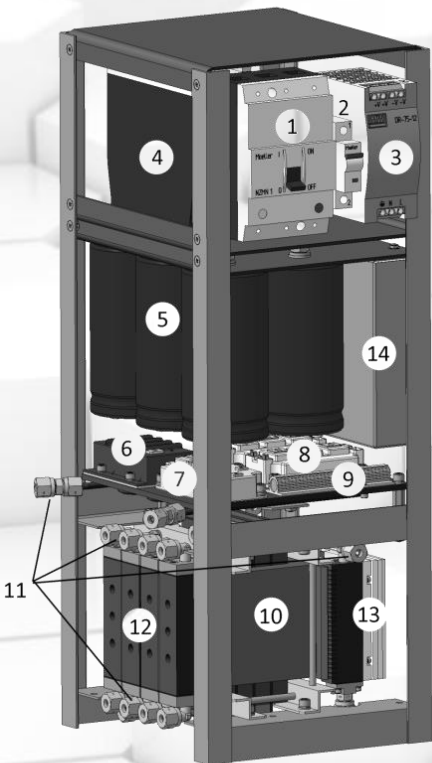


## The components of the inverter:

- ❖ Microcontroller Control System;
- ❖ Input rectifier;
- ❖ power bridge on IGBT transistors;
- ❖ High Frequency Transformer.

The basis of the schemes is a specially designed high impedance matching transformer with unique design which allows to give 98% of power and as a result has almost eliminated reactive losses, improve the reliability of the device, and in some cases reduce the size of equipment.

With the power of 150 kW induction generator dimensions are only 643x256x238 mm.



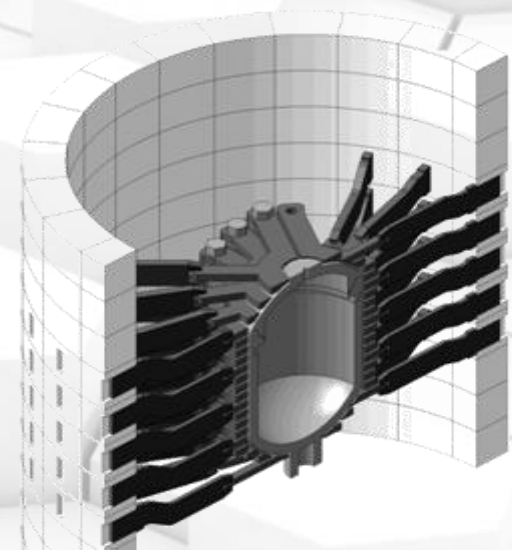
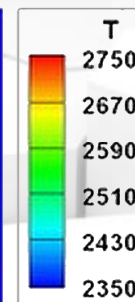
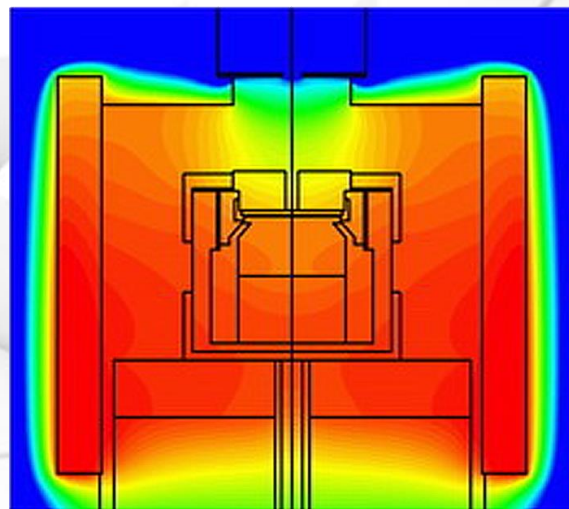
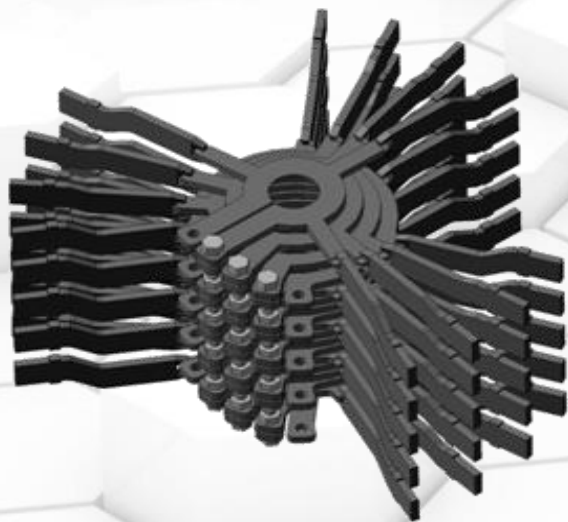
To improve the accuracy of the formation of the thermal field in the zones and improve the energy performance of equipment developed a system of managed multi-zone heating crucible.

The design of the heater represents the number of independent sections with low-resistance carbon graphite bushings, which are held consoles fitted to the shell of growth chamber. Power supply is carried out in each section of the resonance mode of a single channel inverter. Management of a thermal field produced an integrated microprocessor module.

As the resistivity of the material of the crucible and heater are same, then 50% of the power supplied to the crucible in induction mode, and 50% - in the heating of the inductor in resistive heating mode.

Increased system operating voltage to 150 - 200V achieves lowering operating current, which entails a reduction of losses in the inlet fitting.

The calculated efficiency of the system is 95%.



## Omega DM300 Omega PG350



**Pryroda LTD**  
<http://www.pryroda.org>

## Delta-K



**Kvadrat-D LTD**  
<http://kvadrat-delta.com>

## PromCrystal-S2



**UIS Krystal LTD**  
<http://www.uis-crystal.com>

## Project of Plant of Growing Crystals

**Vinnitsya Project Institute**  
<http://vpiplus.com.ua>





**LTD IVP InnoVinnprom**

**e-mail: [info@innovinnprom.com](mailto:info@innovinnprom.com)**

**14, Kyivska Str.**

**Vinnitsya, Ukraine, 21100**

**tel./fax: +38 0432 52 08 30**

**<http://innovinnprom.com>**



# Pryroda LTD

Business Partner



The main kind of activity - design and manufacturing equipment for growing and cutting into wafers polycrystal corundum (sapphire), silicon and other materials. Design and manufacturing control systems and software for them.

The equipment manufactured by our company has a contemporary level, high-performance, original design solutions and high reliability.

Currently Equipment of Pryroda Ltd. works in Russia, Ukraine, China, Taiwan, Korea and other countries.

## Pryroda LTD

2b, Tsymlyans'ka str.,  
Lugansk city, 91033,  
Ukraine

tel/fax +380(642)922542

E-mail: [pryroda@pryroda.org](mailto:pryroda@pryroda.org)

<http://www.pryroda.org>





### **Head Office:**

Regent House. 316, Beulah Hill,  
London, UK , SE19 3HF

Tel.: +3725 777 2 888

e-mail: [office@kvadrat-delta.com](mailto:office@kvadrat-delta.com)

Company No. 08287616

### **Ukrainian Branch:**

01103 Ukraine, Kyiv

10/10 Podvysotskogo Str. Of. 60

Tel.: +380 44 223 10 37

e-mail: [office@kvadrat-delta.com](mailto:office@kvadrat-delta.com)

Creation of the Company "Kvadrat-D " was due to the needs of the growing market for LED based on sapphire substrates.

The equipment used for the single crystal sapphire growth was designed and developed in early 70-ies of the last century. At present it is out-dated and does not meet the sapphire producer's requirements.

The dissatisfaction with outdated equipment and desire to upgrade quality of the grown single crystals has united designers and technologists to synergize their efforts for the new solutions.

Technology of single crystal growth by Kyropoulos method supplemented the practical years of experience. At the moment the range of growth equipment presents series of "Delta-30" (38-kg crystals growing) and series "Delta-K" (80-kg crystals growing).

The dozens of innovative solutions were applied and patented for the creation of new single crystals growth equipment.

However, our team is in constant creative research, strives to improve the technology and quality of single crystals produced on our growing equipment.

<http://kvadrat-delta.com>