Cutting-edge solutions for automation of aviation industry test facilities

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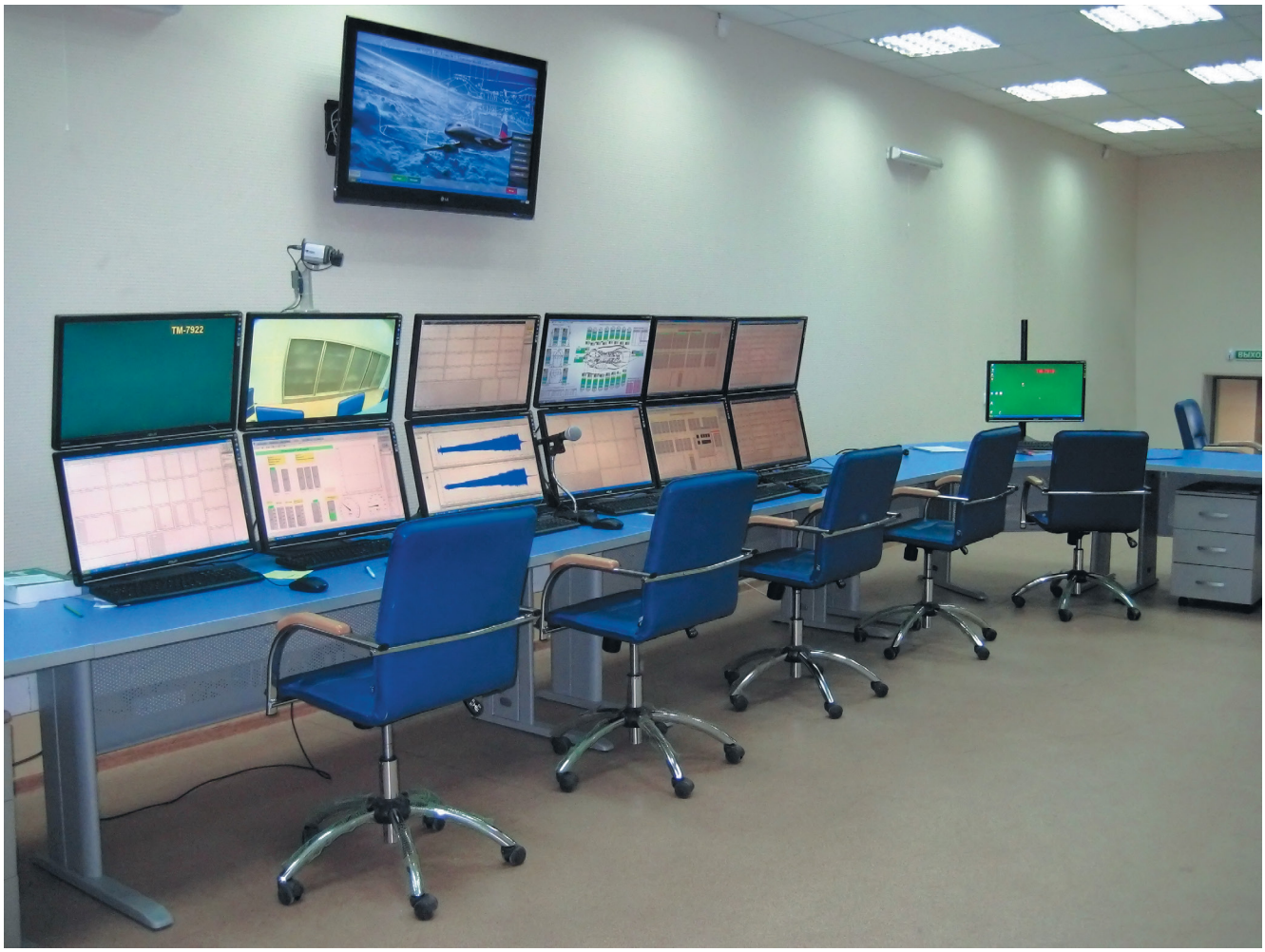
Contents

Advanced benches for comprehensive testing of modern gas turbine engines



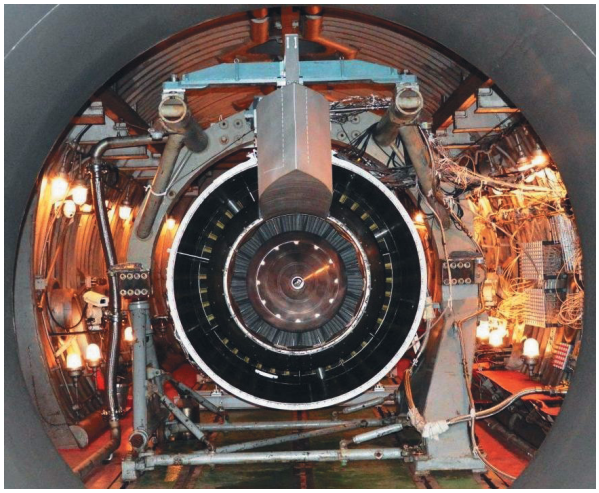
MERA holds leading positions among Russian developers and manufacturers of automated information-measuring and control systems for test benches. We use the most reliable components, which are developed by our company or the world famous companies.

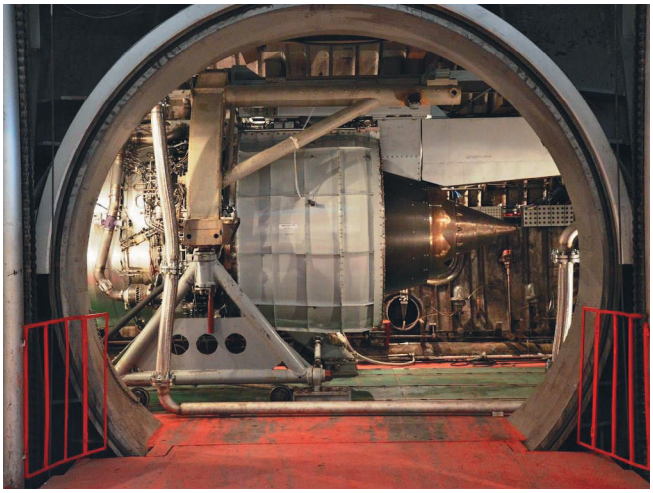
The test bench hardware is delivered to the customer fully assembled and ready for operation ("plug and play").

Engine test facilities are composed of the following subsystems:

- Thrust measurement and calibration system;
- Lifting platform embedded into the floor of the test box. Platform equipped with power supply, control and locking systems and provide access to the mounted engine;
- APCS consisting of control panel, fly-by-wire engine control system (TCL), monitors, operator station, power supplies, meteorological station, measuring equipment, local TV and communication systems;
- Fuel feed system with fuel handling, flow measurement, and an emergency power supply subsystems;
- Engine oil supply system;
- Power supply system;
- Compressed air starting system for preparing and controlling the air supply;
- Engine compressor washing system;
- Pollutant emission measurement system;
- Engine preservation system;

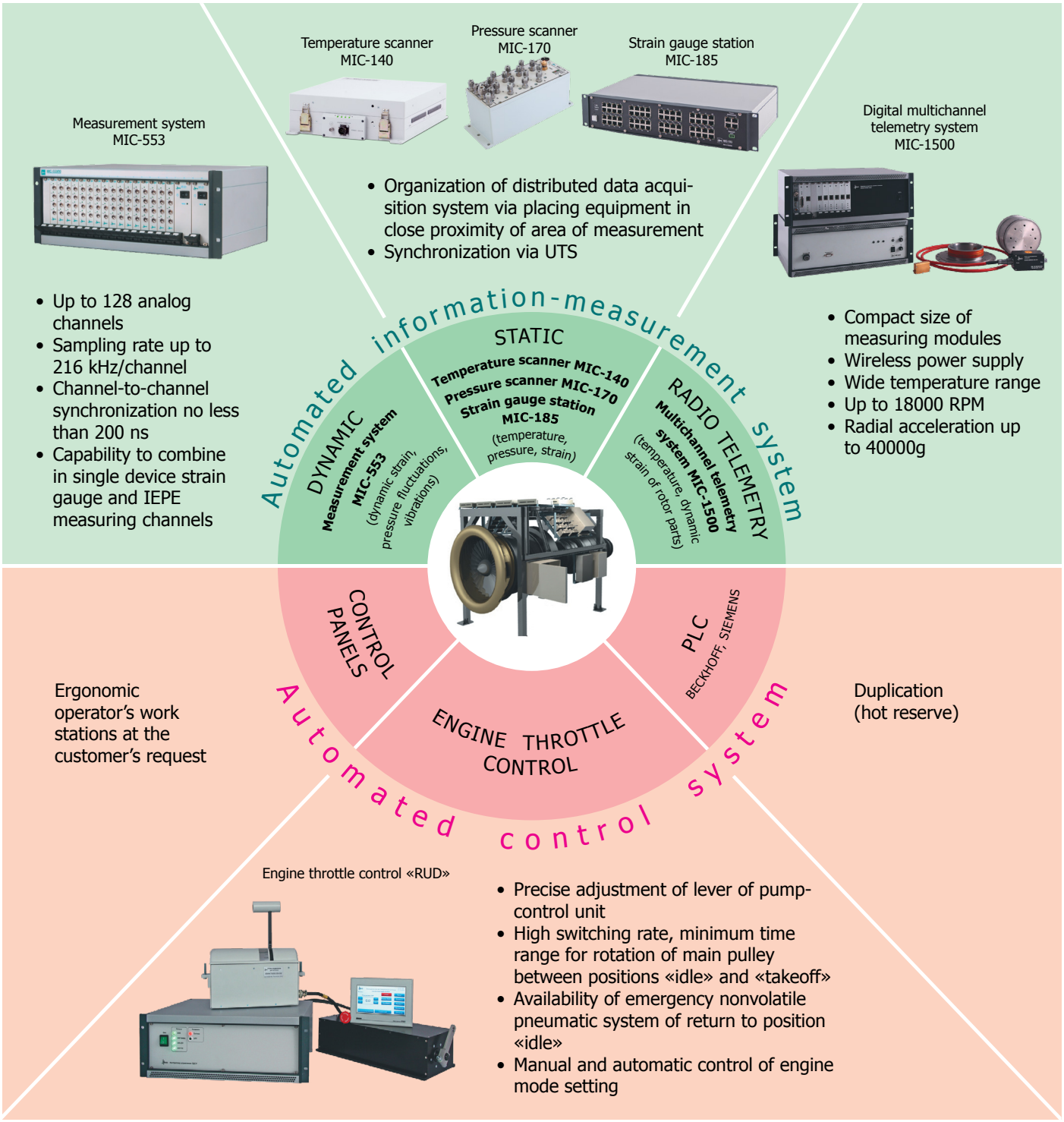
- System for hydraulic pumps and electric generators loading;
- Equipment for installing an engine in thrust measurement system (monorail with a telpher) and self-propelled swivel truck;
- Cart for storing and transporting a cowled engine with adapter and output flow measuring collector (OFMC);
- Underhood fire fighting argon system;
- Engine adapter including upper platform, spring beam, locks for FMS, quick release couplings, pylon tailpiece simulator, fuel and air supply connections, measuring equipment connections;
- Engine dome including OFMC, cowls and nozzle heads
- Cart to store and transport the adapter with domes





The test bench APCS includes:

- Engine control system enabling steady-state and non-stationary operation of the engine and switching from manual to automatic mode
- Panel for monitoring, configuration, and display of engine performance parameters
- Control system for test bench systems (fuel, oil, etc.) that sends control signals to actuators
- Engine control system that generates warnings when parameters exceed threshold levels, monitors engine housing vibrations, warns if emergency modes and emergency situations in the engine and test bench systems occurs, and controls the gas temperature past the turbine
- System for measuring and recording engine parameters providing a common data format for low and high-frequency measurements.

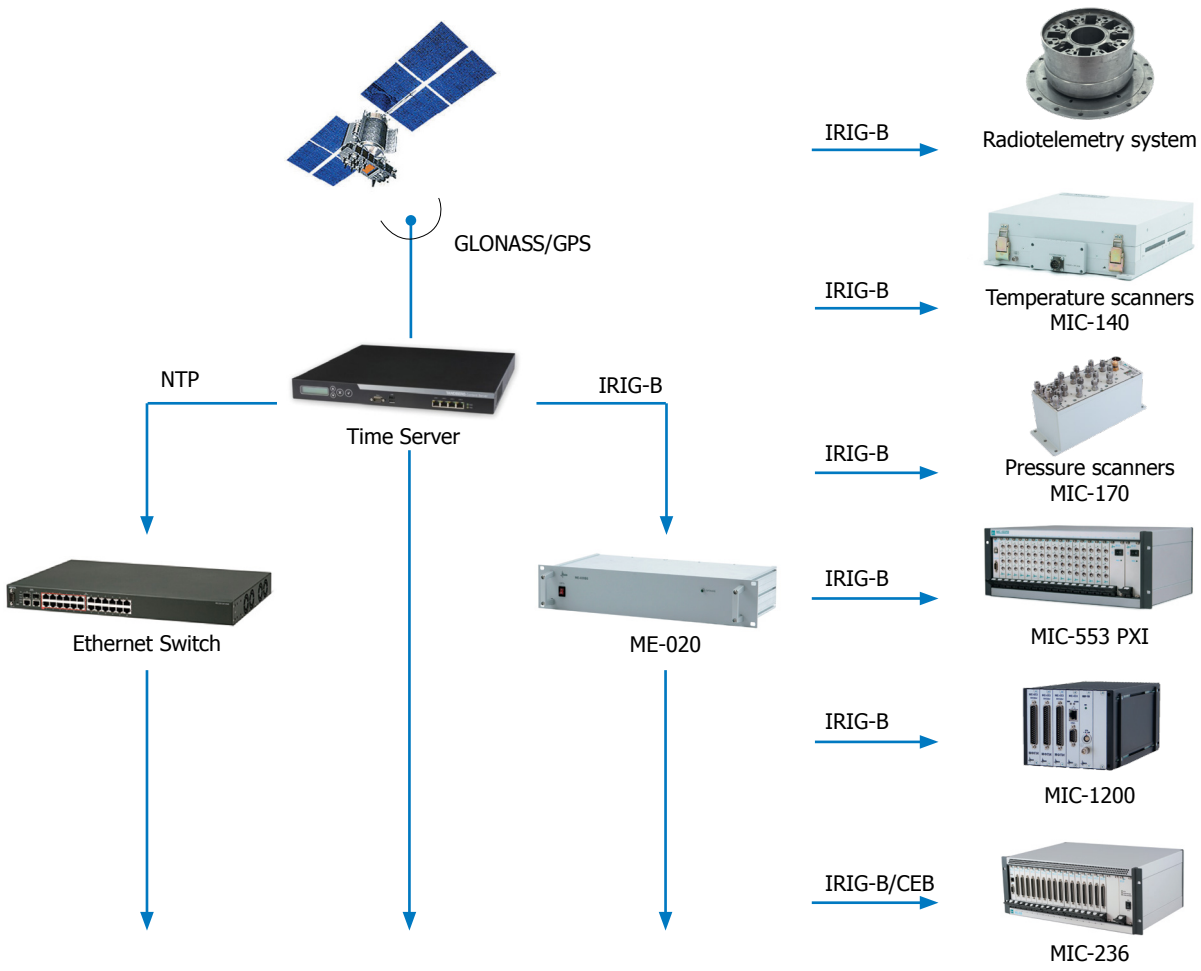


Standart test bench automation capabilities

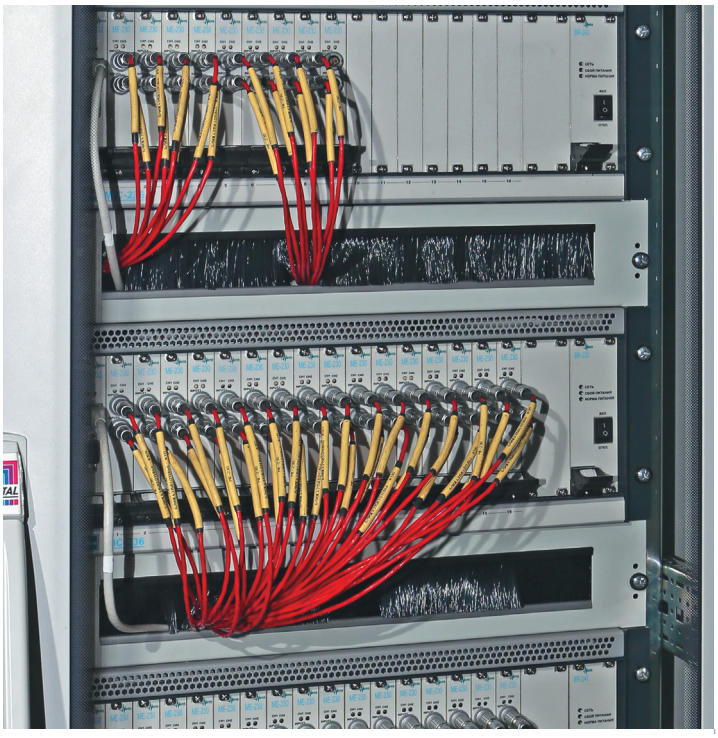
Using the high speed data transfer channel everyone test engineer can get easy access to comprehensive set of experimental data. Researchers can access any information including single readings, fragments of raw data files, operating instructions, technical documentation, results of gas-air channel inspections (photo and video files).

All subsystems are integrated into a single hardware and software solution.

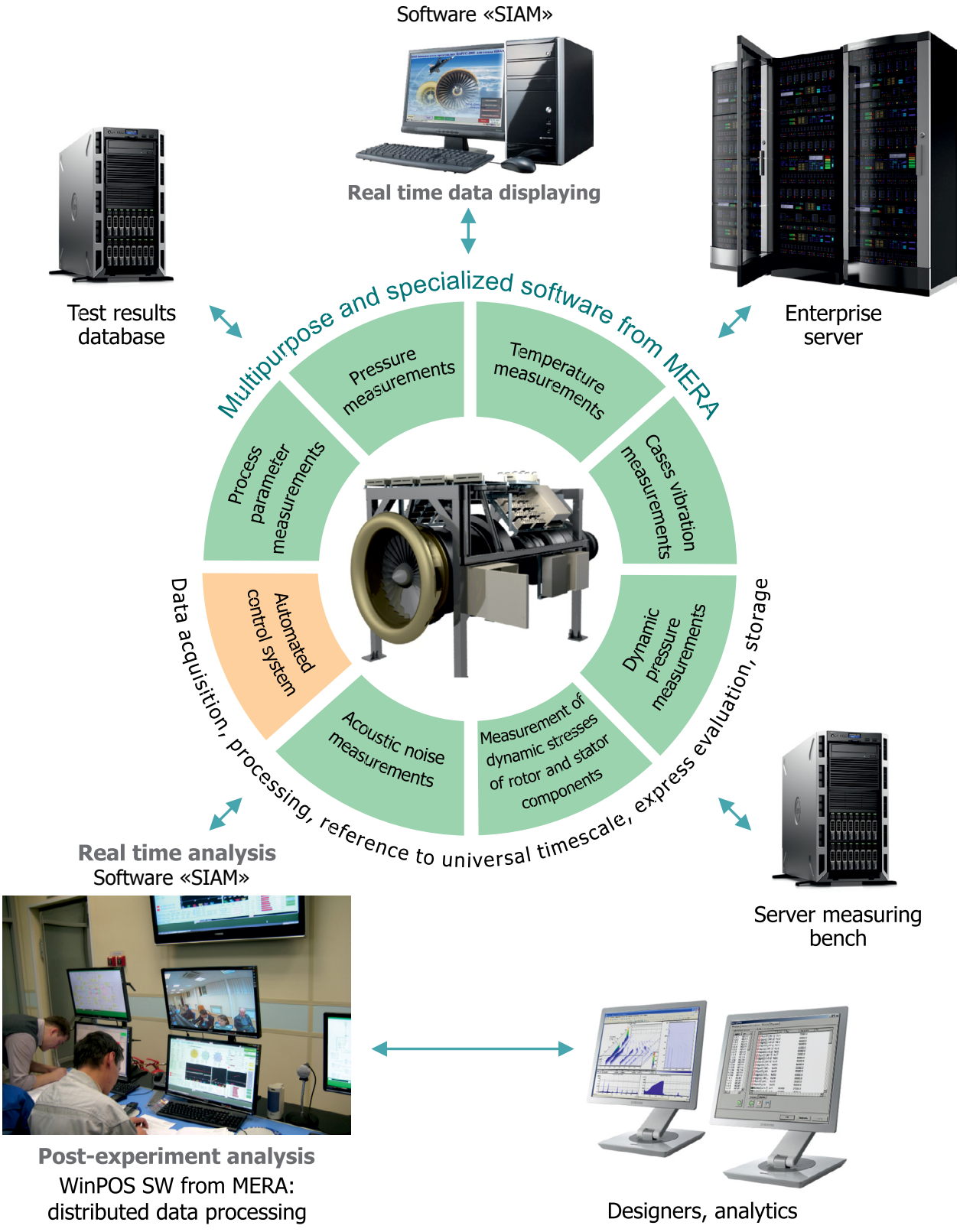
Measurement channels of the automated test bed are synchronized by the universal time system according to the IRIG standard. Support of synchronization with GLONASS/GPS time.



All equipment developed by MERA based on proven components and state-of-the-art technical solutions for monitoring and control using reliable computer hardware, advanced methods and approaches to designing data acquisition systems, actuators, power supply layouts, etc.



MERA has developed specialized multilevel-architecture software intended for data acquisition, processing and test results storage. The top-level software «SIAM» is intended for managing the test processes, measuring and displaying data at the test tempo, preparing a report on the test results. On the lower level synchronous data acquisition is carried out using Recorder and MR-300 software.

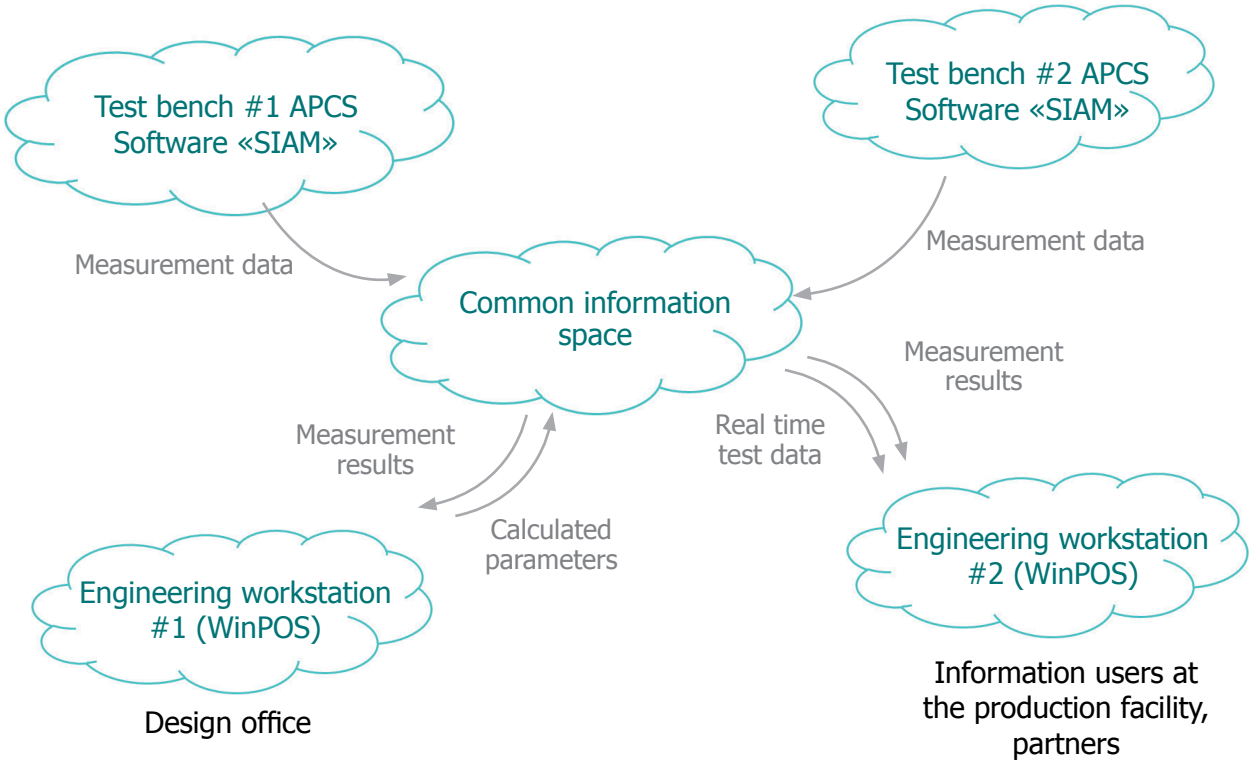


Software architecture, example of project implementation at Aviadvigatel JSC

A WinPOS signal processing suite is used for post-experiment test data analysis. The software may be used locally at an individual workstation or as a distributed client-server system.

Client-server technologies is allow to make a resource-intensive operations on a dedicated server, while computation results are received and analyzed at a client workstation Client-server data processing scheme minimizes resources requirements for user workstations and reduces the load on the LAN. It also provides an efficient processing of large amounts of data using any WinPOS algorithms.

To transfer the test results in an enterprise network the customers can create a common information space. This environment provides the data exchange with remote users via a single database.



Concept of the common information space, example of project implementation at Aviadvigatel JSC

Data acquisition systems developed by MERA for test benches are delivered ready for certification according to GOST R 8.596 2002 and OST 101021-93, and meet all requirements of General Specifications (OTU) 2006.

Parameter name	Total measurement error, %
Measured engine thrust	± 0.3 of measured value (MV)
Torque	± 0.5 of MV
Fuel consumption	± 0.3 of MV
Fuel mass flow rate	± 0.5 of MV
RPM	± 0.1 of MV
Customer bleed air flow from GTE	± 0.1 of MV
Oil circulation	± 0.1 of MV
Oil consumption	± 0.2 of MV
Air (gas) pressure in GTE flow path	± 0.3 of MV
Air (gas) temperature in GTE flow path	± 0.3 of MV
Air pressure at the GTE inlet (for forced flow tests)	± 0.4 of MV
Ambient air temperature at the GTE/flow measuring collector (FMC) inlet	± 0.3 of MV
Temperature of process fluids (fuel, oil, hydraulic fluids)	± 0.1 of the upper limit of the rated value (UL RV)
Difference between full pressure at the FMC inlet and static pressure in the FMC metering cross section	± 0.3 of MV
Relative humidity at the FMC inlet	± 2.0 of UL
Temperature of GTE housings and components	± 1.0 of UL RV
Transient pressure in the GTE flow channel	± 1.0 of UL (amplitude)
Vibration speed (vibration acceleration) of GTE cases and components (for vibrations at RPM frequencies)	± (1.0–12.0) of UL (amplitude)
Static and dynamic strains of GTE housings, components, and assemblies	± 10.0 of UL RV
Fluid pressure (oil, fuel, hydraulic fluids)	± 1.0 of UL RV

MERA is ready to include the works on the test bench measuring system certification in our package of services.

Below you can see a description of the full-scale reconstruction of test benches projects implemented by MERA. To perform this works we have studied the test objects, coordinated technical project with customer, developed a working design documentation, produced hardware and software and complete system of OEM equipment. In addition, we organized the installation, commissioning, technical support and warranty services.

High-altitude test bench reconstruction

Objective

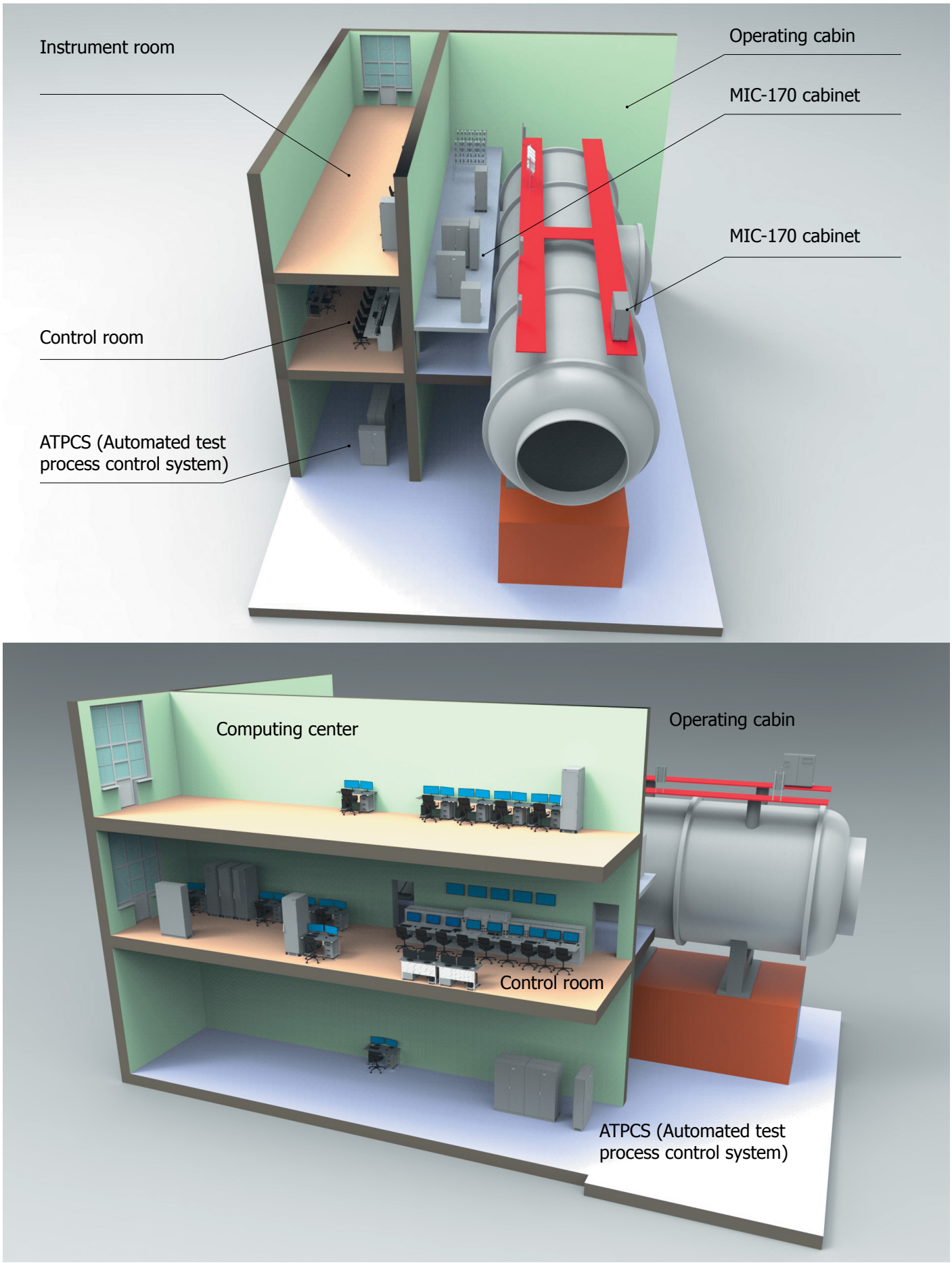
The aim of the project was a retrofitting and upgrading the test bench. The test bench is designed to perform research, development and certification tests of air-breathing engines in ground and altitude-velocity conditions (with steady-state and transient operating modes of engine and the test bench). There is the possibility of implementing modes that simulate the flight conditions of the aircraft along the trajectory of its application. The test bench can be using for power plant parts, aircrafts and other equipment.

The reconstruction works includes development of an automated test process control system (ATPCS) for the test bed to enable:

- Automated real time control of the test bench and object under test operating modes during standard and special tests
- Automated measurement, processing, acquisition and display of parameters of the test article and test benchs in steady-state and transient conditions
- Automated regulation of air pressure and temperature at the object inlet, exhaust pressure in the thermal vacuum chamber, and pressure difference for the object
- Automated control of process system parameters
- Regulation of the ratio of gas-air flow pressures at the inlet and in the thermal vacuum chamber in transient modes of the engine
- Regulation of the water content in the airflow, flow speed, and humidity
- Keeping test logs, etc.

Key Features

- Tests of full-scale 4th and 5th-generation aircraft gas turbine engines with thrust up to 25 tonnes, various instrumentation volumes. Simulation of altitude-speed conditions in a wide range of altitudes and Mach numbers with steady-state and transient modes of operation.
- A large number of measured parameters: pressure, temperature, gas and liquid mass flow rates, forces, vibrations, dynamic pressure, dynamic strains, RPMs, linear and angular displacements, radial and axial gaps, humidity, water content, etc.
- Ability to measure more than 1000 test bench and engine parameters in a wide frequency range (from 1 Hz to 100 kHz through individual channels).
- High precision measurements of basic and operating parameters: 0.1 – 0.5% of the upper range limit.
- Wide range of parameter measurements, e.g., pressure at the engine inlet may be changed by 80 times.
- The main feature of project is large-scale control system development. In addition to the control system for processes and engine subsystems, a hardware and software suite was developed intended to control the thermal vacuum chamber, the shutoff and regulating elements of the gas-air circuit, and the force measuring system (FMS).



General scheme of the test bench main equipment location

Solution

Components of test bench:

Component	Purpose
Static AMIS	Transient processes and system-wide parameters measuring
Dynamic AMIS	Automated measurement, recording, reproduction, processing, and display of test object and test bench process parameters.
APCS	Automate operating control of test bench operating modes, display of test object and test bench process parameters Pre-emergency and emergency values of test object and test bench parameters tracking, Pre-emergency and emergency alarms, emergency shutdown of the engine, automatic regulation the air pressure and temperature at the engine inlet.
Force measuring system	Engine thrust measuring
Video surveillance system	Video surveillance of the test procedure, with the option to record and archive the data
Control panel designed	allocate the following automated workstations: AMIS, lead test engineer, engine control, throttle control lever (TCL), altitude compressor plant (ACP) and gas-air circuit (GAC) control, water system and automatic regulation system (ARS) control, main and auxiliary controls.
Hydraulic system	Control shutoff and regulating elements
Power supply system	Provide uninterrupted stabilized power for the test bed
Audio communication system	Communication with test bench staff

All measurement channels, as well as AMIS and APCS control nodes (including the video and audio subsystem), are integrated into LAN and synchronized using the universal time system (UTS) with accuracy at least 0.01 second.

1. Automated measuring and information system

Due to the requirements to the number of measured parameters (up to 200 high-frequency and more than 1,000 low-frequency channels) it is advisable to separate AMIS into Static and Dynamic subsystems groups.

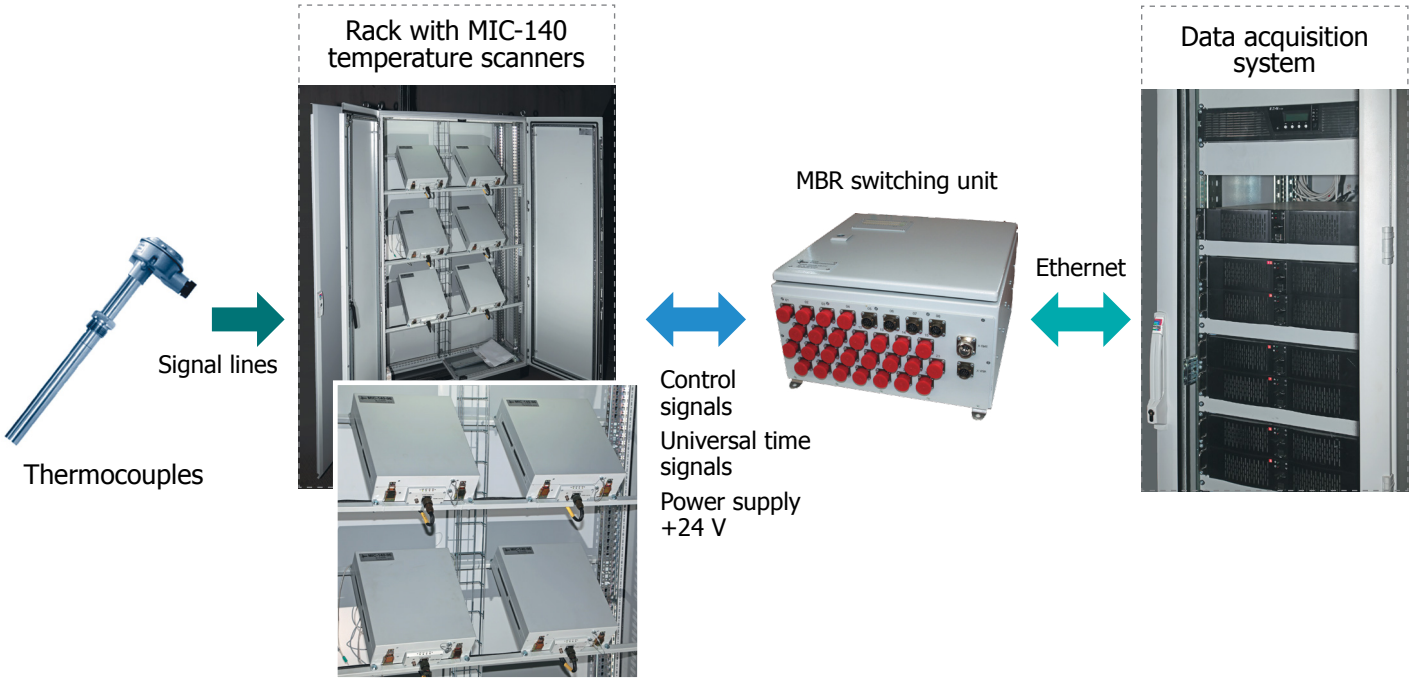
1.1. Static subsystem

Static subsystem include the following measurement channels:

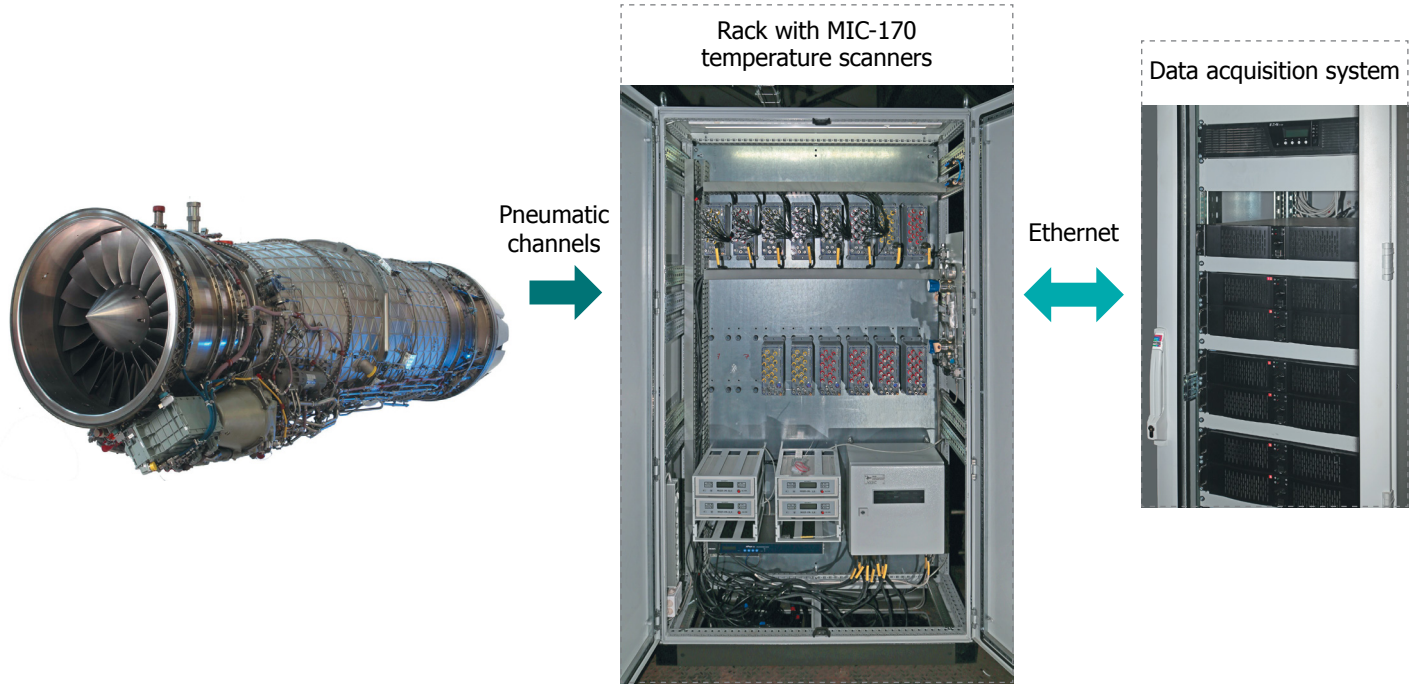
- Air and gas pressure
- Fluid pressure (fuel, oil, hydraulic fluids)
- Temperature (thermocouples, resistance thermometers)
- RPMs
- Fluid flow rate (fuel, oil, water)
- Engine thrust
- Rotation angle
- Displacement
- Relative humidity, water content
- Discrete input/output
- Analog output
- ARINC-429 serial interface.

Hardware

In order to receive signals from thermocouples and to process measurement data, the Static subsystem includes MIC-140 highway-module temperature measurement systems (temperature scanners). MIC-170 multi-channel pressure transducers (pressure scanners) are used to measure steady gas flow pressure in the engine and thermal vacuum chamber. Scanners of physical parameters are designed to operate under high temperatures, humidity, impacts, and noise exposure.



Static subsystem. Temperature measurement channels

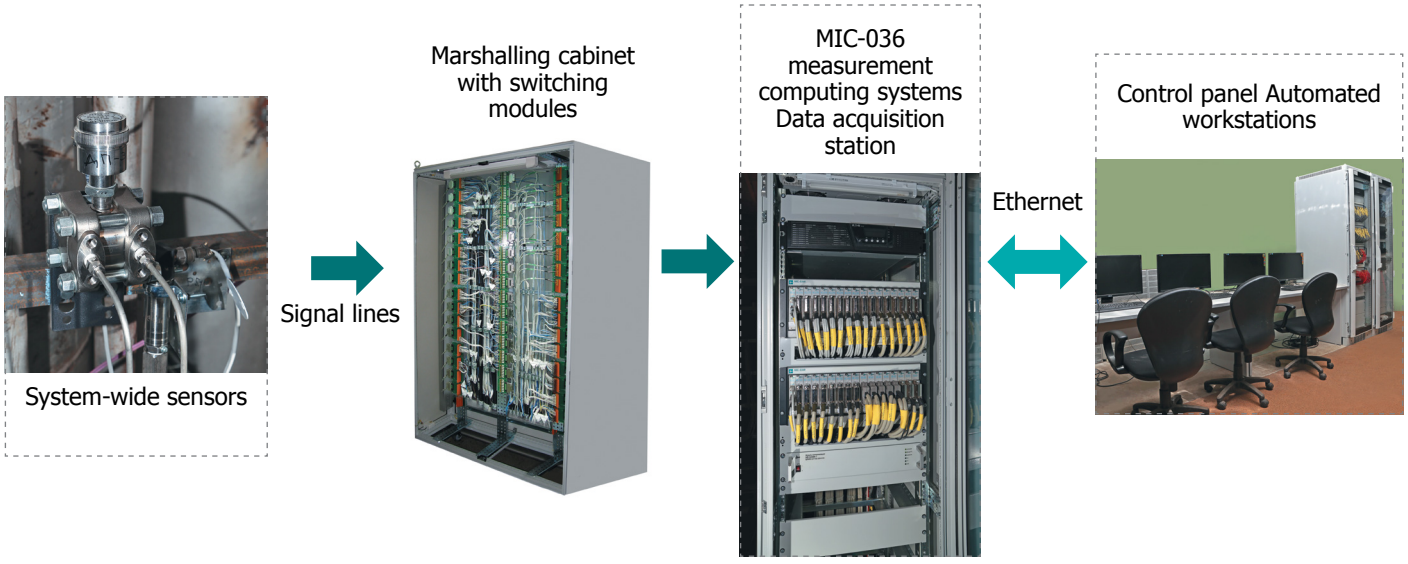


Static subsystem. Pressure measurement channels

Using the distributed system architecture allows to reduce the total length of wired and pneumatic channels, as well as to minimize the cable connection cost and increase the reliability of a large number of low-frequency measurement channels. All the temperature and pressure scanners with the appropriate protection are arranged on special racks in the operating cabin of the test bench near the thermal vacuum chamber, and are synchronized with the universal time system.

The subsystem for measuring general system parameters is designed to monitor the state and measure parameters, of various devices incorporated into the test bed and maintaining the required test modes.

The subsystem uses MIC-036 measurement computing systems that collect, convert, and transmit data to LAN.



Static subsystem. General system channels

1.2. Dynamic subsystem

The Dynamic subsystem combines software and hardware tools for measuring vibrations, dynamic pressure, dynamic strains, and RPMs.

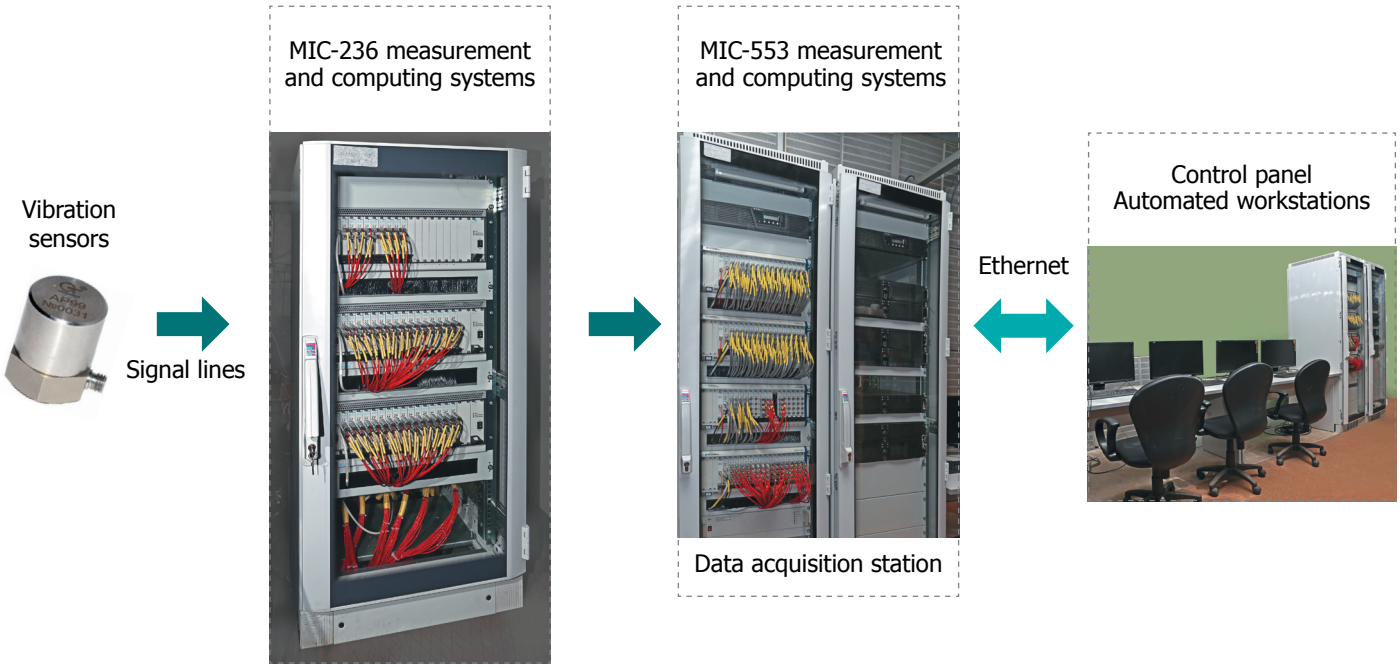
Hardware

The Dynamic AMIS incorporates several data acquisition stations (DAS) that function as an automated workstation (AWS) for measuring and monitoring dynamic pressure pressure, vibrations, and strain gauging.

DAS are built on unified software and hardware facilities of MIC series based on the PXI open standard and advanced SCADA systems. Each DAS consists of an MIC-553 mainframe with installed programmable DAQ modules and an industrial computer. All system components are synchronized with each other with respect to the universal time source using the IRIG-B protocol.

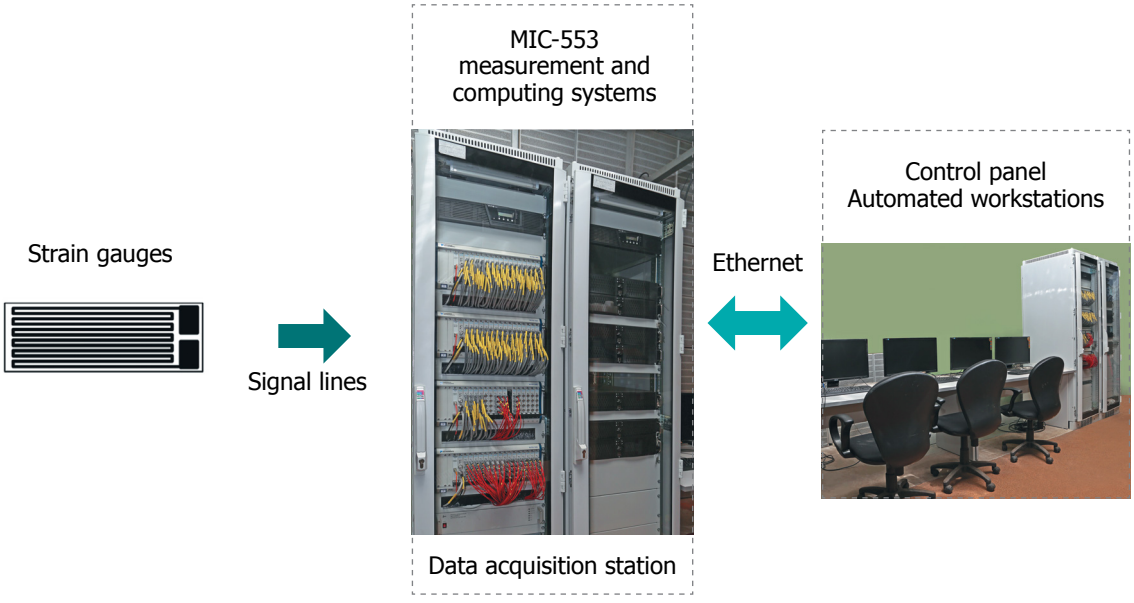
Vibration sensors installed directly on components and structures are connected to ME-230 modules located in slots of MIC-236 systems. ME-230 modules acts as piezo-sensors signal amplifiers.

Amplified signals enters to the input channels of MX-224 DAQ modules that incorporated into MIC-553 dynamic signal measurement systems. The MIC-553 systems are connected to the data acquisition system via an optical link.



Dynamic subsystem. Vibration measurement channels

The subsystem for measuring mechanical stresses and strains includes strain gauges installed on components and structural elements of engine. Strain gauges connected to inputs of MX-340 modules of MIC-553 mainframes, which have controllers for interfacing with data acquisition system via LAN.



Dynamic subsystem. Dynamic stresses and strains measurement channels

Measurement results recorded by data acquisition stations is transmitting to automated workstations (AWS) and the test database server using Ethernet.

Software

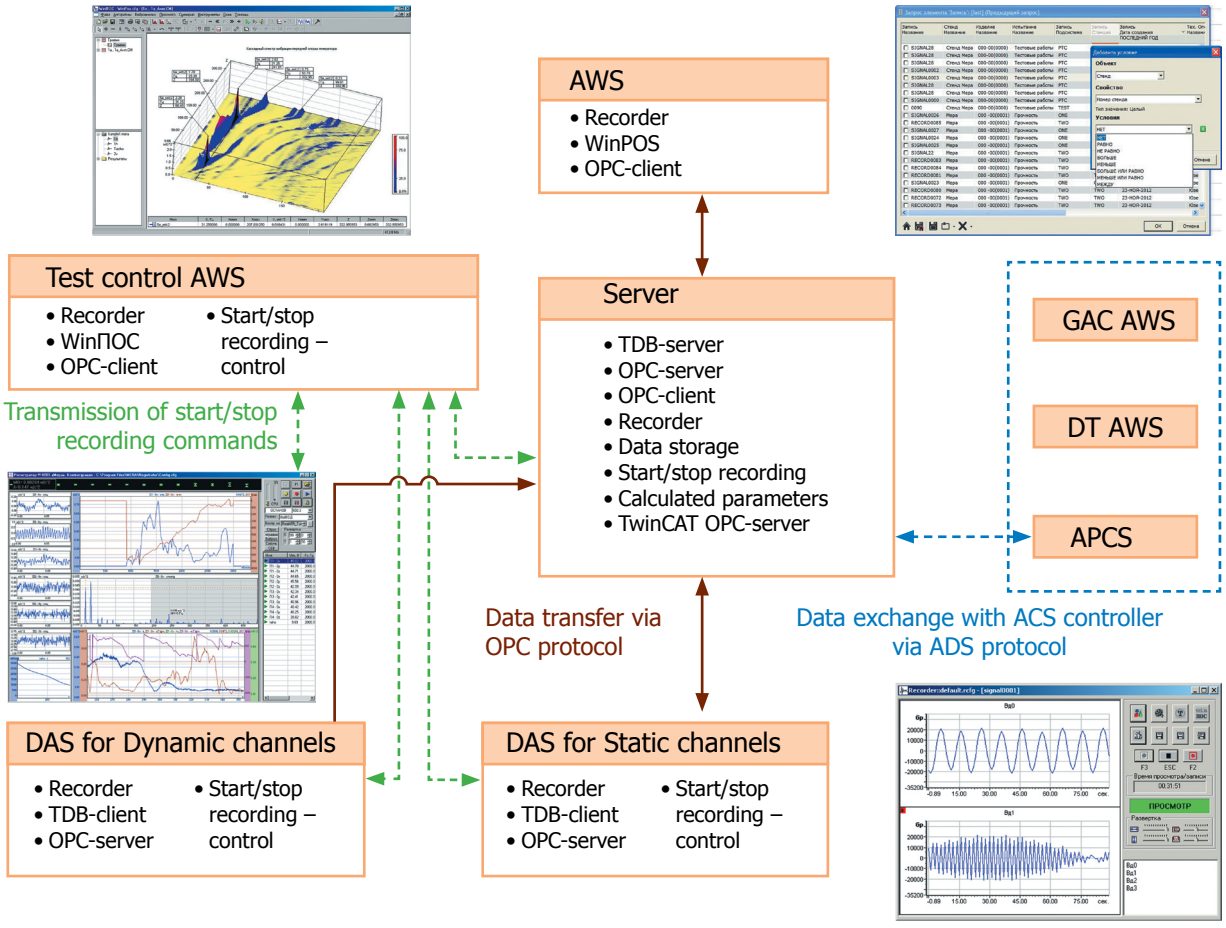
Splitting the channel groups into subsystems allows the use of specialized software which enables to validate, calibrate and tune channels, and to record and display the measurement data.

Targeted data acquisition and processing, and display of measurement results for the Static channel group is controlled by Recorder SW installed on a computer connected to MIC-140, MIC-170 and MIC-036.

This software is also used for configuring data acquisition, processing and display modes, for monitoring the system status.

The specialized MR-300 software installed on DAS used for modules control, data recording and real-time signals analysis in Dynamics subsystem.

WinPOS software is used for post-processing and extensive analysis of data recorded both Static and Dynamic subsystems.

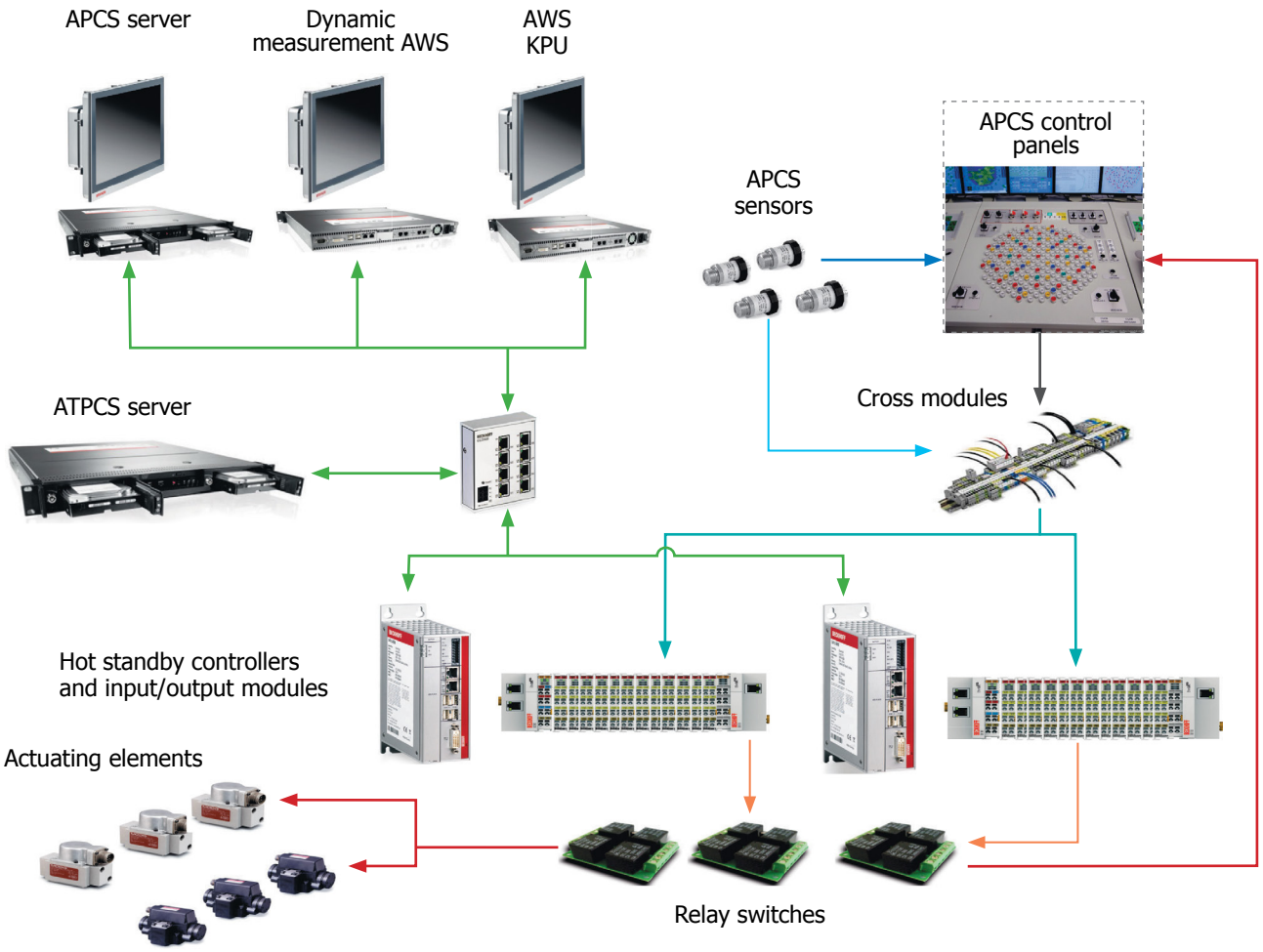


AMIS software architecture

1.3. APCS

Main technological controlled parameters of the test bench operational process are:

- Total air pressure at the engine inlet
- Stagnation air temperature at the engine inlet
- Static exhaust gas pressure in the thermal vacuum chamber (outside the jet stream from the engine nozzle)
- Total air pressure blown into the combustion chamber of the engine
- Flow water content (when simulating icing conditions)
- Airflow speed before the test object (when simulating icing conditions) when the engine is blown from wind tunnel.



APCS structure flowchart

Air supply schemes for different test types are implemented by opening/closing the corresponding shutoff and shutoff and regulating elements.

Test bench flow chart elements to be automated include:

- Thermal vacuum chamber (TVC) where the test object is placed
- Pipelines, quick-acting regulating elements, hot and cold air mixer and receiver that make up the main air supply system for the test object;
- Test support systems:
- Compressed air supply systems from 9 atm. and 25 atm. collectors
- Hydraulic control system for regulating elements
- Air supply system for the ejection circuit of the jet nozzle and for cooling of the afterburner and components
- Systems for suppling and heating compressed air and water to nozzles of the water-spray collector
- ystem for water supply and status control of the cooling system of gas chillers of the test bench, and cooling system of TVC and input receiver
- System for supplying process air from a high pressure cylinder battery
- Industrial air supply system
- Fire suppression systems for test bench and TVC rooms
- TVC process ventilation system.

All of the specified systems are equipped with remote controlled shutoff and regulating and shutoff elements with alarm.

Control and monitoring facilities for process systems are located on the new test bench control panel.

The process flow chart for the test bed uses:

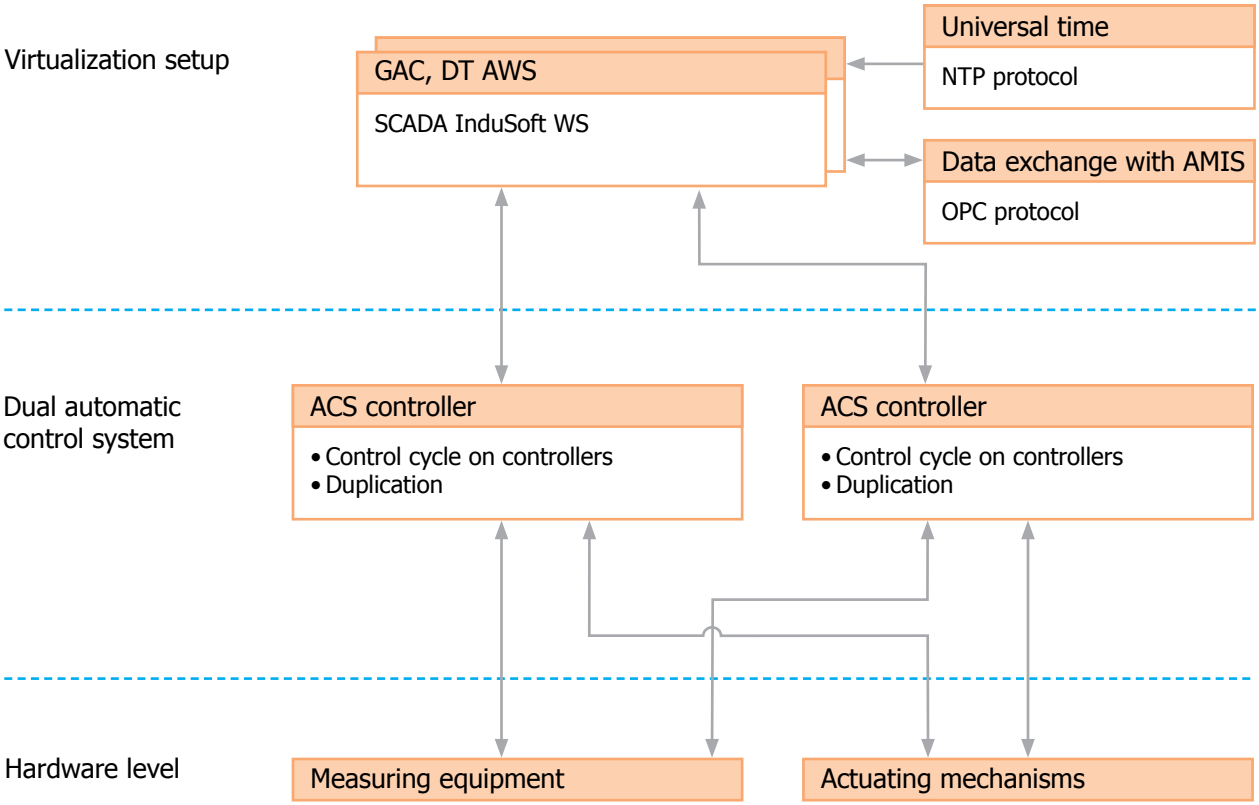
- Throttles (regulating and shutoff an -regulating elements)
- Shutters (shutter elements)
- Locks
- Valves
- Electric switches.

Actuators of drives of all throttles, shutters, locks, and valves receive signals from controllers (for automatic and remote control), as well as from manual (emergency) control buttons.

All actuating elements of the test bench are equipped with open and close position limit switches.

A hydraulic drive consisting of the following is used as a throttle actuator:

- Hydraulic cylinders (HC) equipped with a position sensor and non-contact limit switches
- Sector control HC with non-contact limit switches
- Hydraulic cabinet equipped with hydraulic-automation elements
- Power supply, control, and alarm circuits.
- Actuators are controlled from the process control operator's control panel using functional button groups relating to specific devices and located on the virtual control panel on an individual screen page.

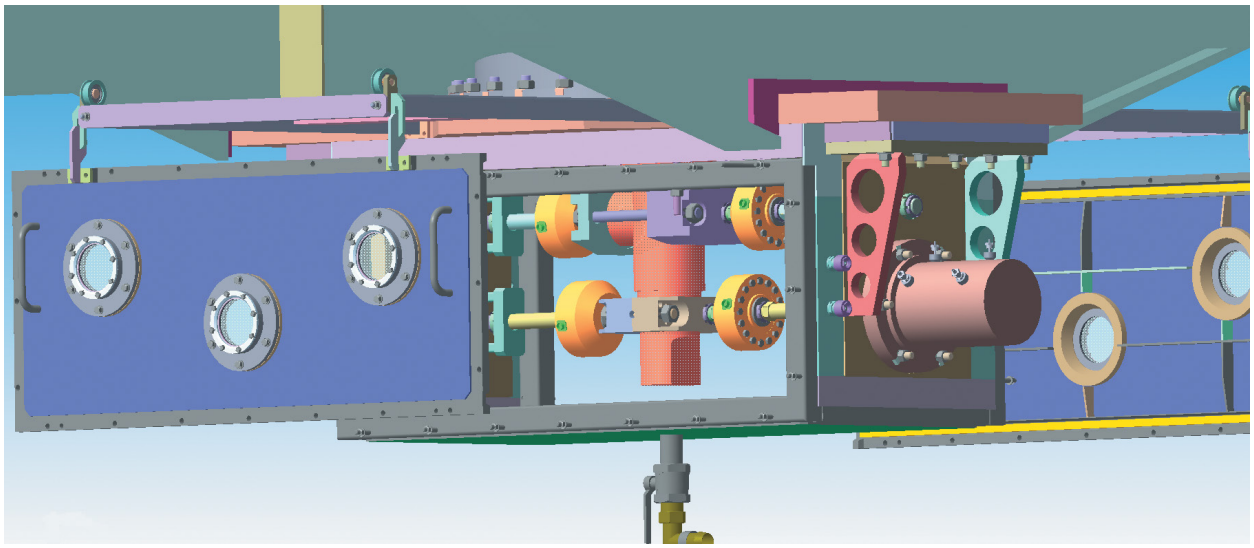


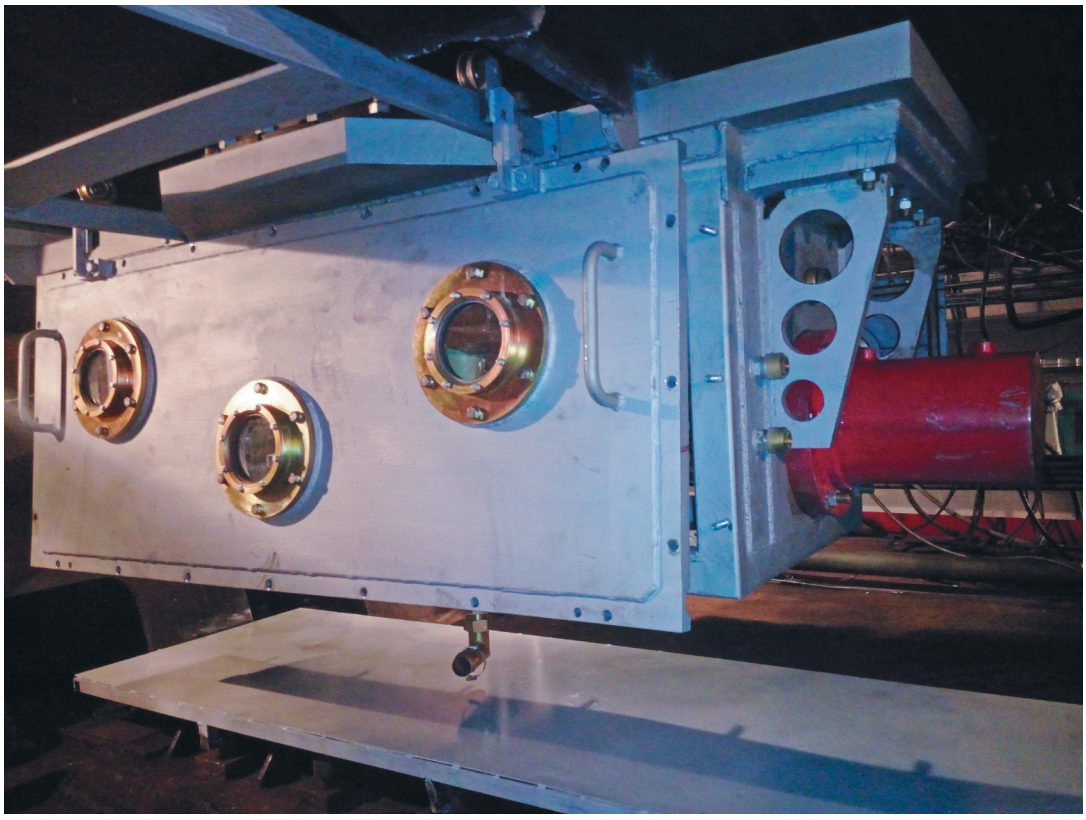
APCS software architecture

1.4. Force measuring system

During the upgrade of the test bench FMS we successfully solve the following problems:

- Replacement of a lever-operated calibration assembly with a hydraulic-strain calibration instrument enabling calibration in the positive and negative directions.
- Design of a device for measuring engine thrust in the positive and negative directions.
- Design of a axial calibration device (for installed engine with mounted piping). Device ensure to obtain calibration curves of measurement channels vs gas turbine engine thrust.
- The dynamometric platform design and analysis with account of weight of the installed engine, piping, and input pipeline.





The force measuring system made in accordance with the project of CIAM

Results

The test bench upgrade allowed to obtain following results:

- Increased reliability, availability and safety of complex tests in automatic, manual and emergency modes.
- The increase of the number of measuring channels is enabled to provide the required information content of tests.
- The required measurement accuracy and reliability of collected data are ensured through the use of new measuring tools. Storage security of the recorded test data is increased.
- Flexible and open architecture of ATPCS software, ability to set up the software for testing of different types and dimensions engines.
- Real time processing and analysis features.

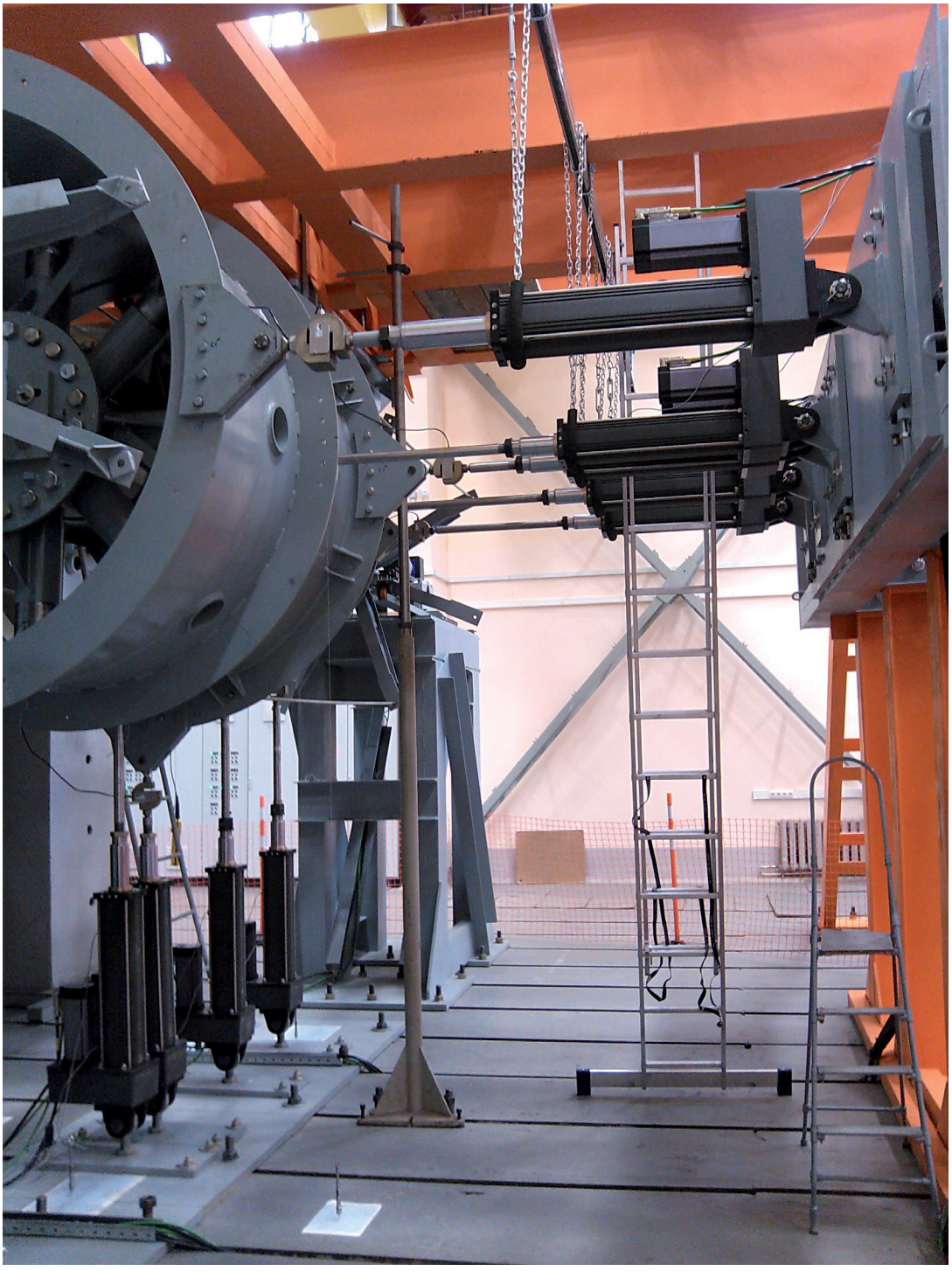
Summary

The upgraded ATPCS allows the customer to increase the quality and reduce the time for preparing and performing tests. Achieved significant savings of electrical energy consumed during the tests.

Update of the static test bench

Objective

Design and development of a bench for specific certification tests of housings and mounting of PD-14 engine. This tests are conducted to verify and confirm the durability, rigidity, stability, and bearing capacity of loading pattern of the engine housings under loads corresponding to different situations during the aircraft's flight and landing. Additionally, there is the possibility to conduct fatigue life tests of engine housings and mountings.



Static test bench

Key Features

- Simultaneous application of tension, compression, bending, and torsion loads to object under test at 25 points. The crosstalk of differently directed forces must be quickly compensated with high precision.
- Rigidity of the object under test requires high precision positioning of force actuators. The inaccuracy of force targeting should not exceed ± 1% of the nominal parameters of force actuators. The most powerful actuator can generate a force up to 40 tonnes.
- As force actuators the electric cylinders were chosen since they proved to be more efficient compare to hydraulic systems.

Solution

Loading system hardware

The loading system is divided into test object loading elements and the loading control subsystem.

The loading system contains 25 electric cylinders rated from 60 to 400 kN and enables application of the following loads in static mode:

- Axial forces distributed between the bypass and main engine ductings
- Torques supported by housings
- Inertial transverse forces (horizontal and vertical loading)

The loading control subsystem includes:

- Frequency converters
- Processor and DAQ modules based on the EtherCAT real time network
- Tension/compression S-shaped strain gauges
- Industrial computer and network equipment.

Power control cabinets

Data acquisition system hardware

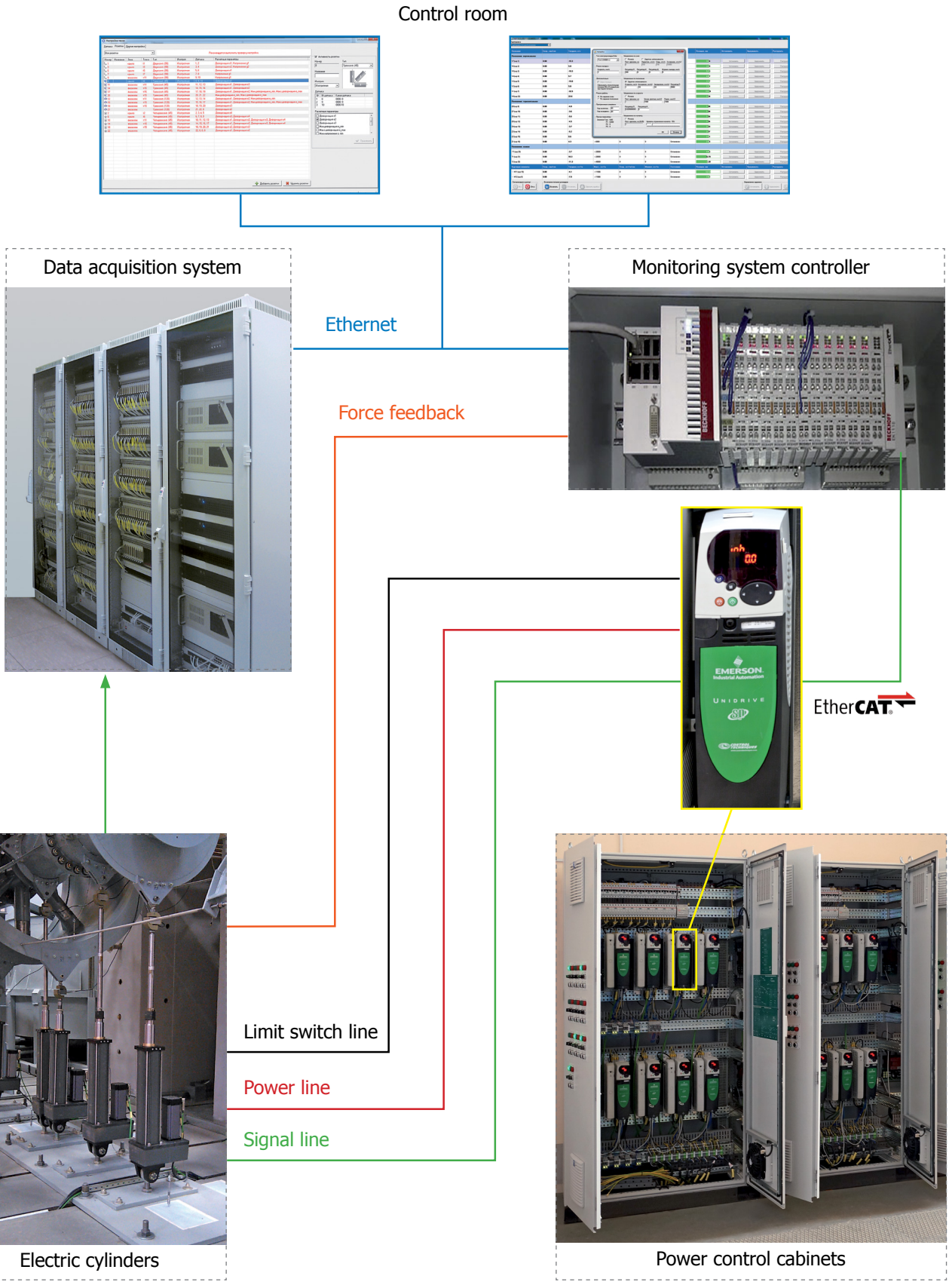
Data acquisition hardware include strain gauges, MIC-236 highway-module measuring system, ME-020 synchronization units, power units, Ethernet switches, PC, racks and cables.

The data acquisition system of the static test bench is intended to measure and record following parameters:

- Static loading parameters of the object under test, including applied forces
- Strains and displacements of the loaded assemblies and components
- Mechanical stresses of structural parts and components of the object under test.

The system contain 1024 channels for measuring static strains, and 43 channels for absolute and relative displacements measuring. Relative stress of resistance strain gauges measured using semi-bridge and bridge connections is measured with an intrinsic reduced error limit of ±0.05%. The maximum displacement measurement error is ±0.3% of the measured value. The maximum displacement measurement range: 25 mm.

Data acquisition system instrument racks



Loading system structural flowchart

Software

The multifunctional expandable software Recorder is designed for the management the test bench data acquisition system and video recording system.

Specially for this project plugins for Recorder software were developed:

- «Loading»: software module for configuring the loading control process
- «Strain»: software module for configuring algorthms of the strain parameters cflculation and strain gauge rosettes setup.

Data obtained during tests are processed by WinPOS Professional signal processing package. Based on readings of both single strain gauges and strain gauge rosettes it is possible to calculate normal and tangential stresses.

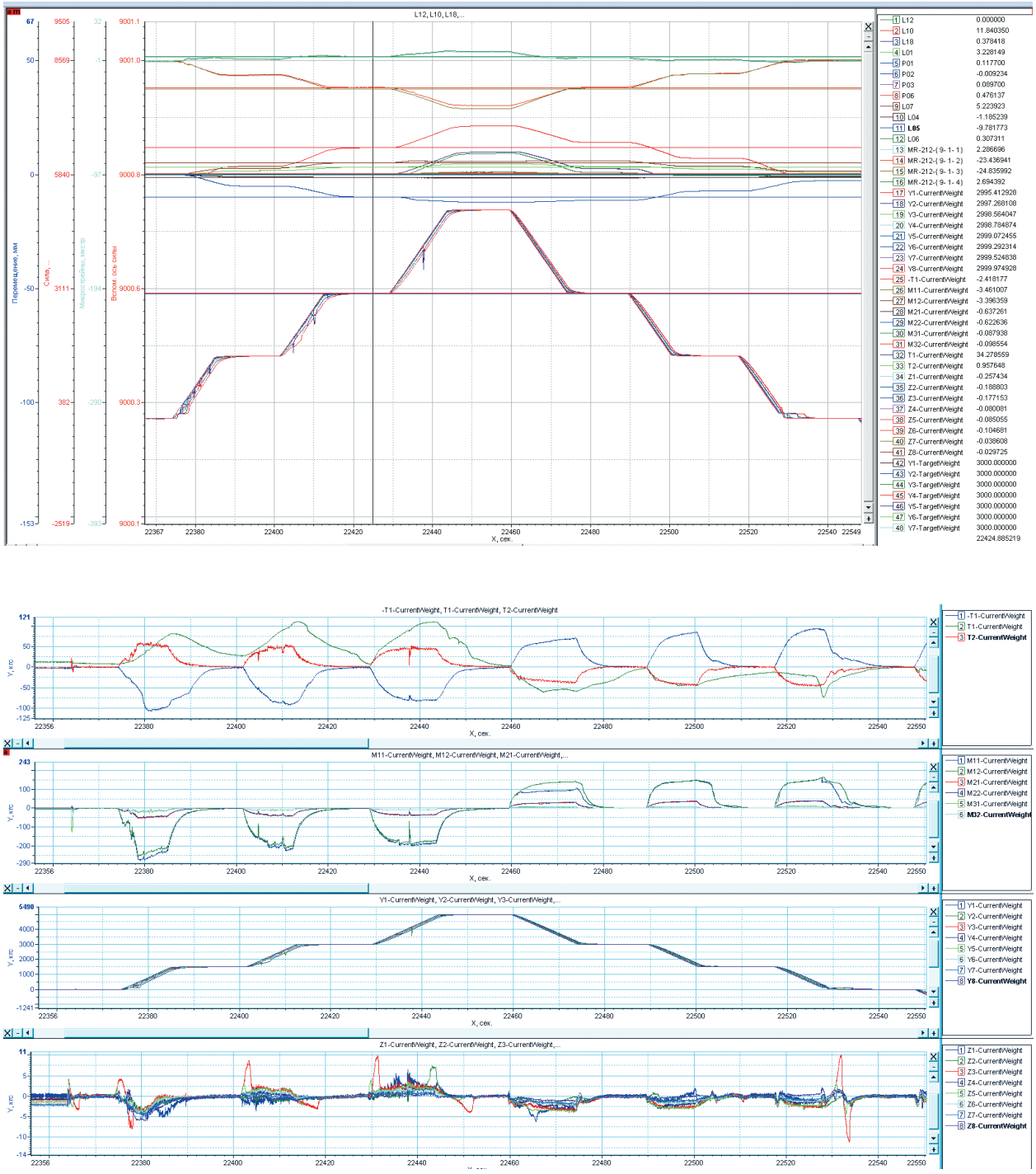
Software supports linear approximation of test data logged by all measurement channels.

Loading parameters relevant to test program are entered into the software installed on the control computer. Information about forces to be generated by each electric cylinder is transmitted to the processor module via Ethernet. The processor module transmits commands for control electric cylinders to frequency converters by the EtherCAT network. Each frequency converter generates voltage to power the electric cylinder connected to it.

S-shaped tension/compression strain gauges installed between the electric cylinder rod and the object under test are located at the start of the feedback loop of the loading system. Stress proportional to the applied force occurring on them is transmitted to input channels of the I/O module, where the signal is processed and transferred to the processor module, and then to frequency converters. By obtaining information about the real values of loads on rods of electric cylinders the high accuracy of loading is ensured.

On the housings of electric cylinders limit switches is mounted which defines the limits of rod displacements. These limit switches are incorporated into servo-motor control loops and provides shut off electric cylinders power when limit positions of the rods are reached.

Test bench software



Results of processing data from the loading system by WinPOS

In addition to the test bench data acquisition system an optical measuring system was purchased.

In 2014, MERA updated the software of the test bench data acquisition system by adding the functions of synchronization with the optical system and displaying data Recorder software.

Results

The data acquisition system of the test bench for PD-14 turbofan static testing from Aviadvigatel JSC has been entered into the State Registry of measuring equipment.

In 2014, the system was successfully used for testing of of the high-pressure compressor.

ФЕДЕРАЛЬНОЕ АГЕНТСТВО
ПО ТЕХНИЧЕСКОМУ РЕГУЛИРОВАНИЮ И МЕТРОЛОГИИ

СВИДЕТЕЛЬСТВО

об утверждении типа средств измерений

RU.E.28.004.A № 52157

Срок действия бессрочный

НАИМЕНОВАНИЕ ТИПА СРЕДСТВ ИЗМЕРЕНИЙ
Система измерительная стенда статических испытаний двигателя ПД-14 ОАО "Авиадвигатель" "СИ Стенд-ПД-14 ОАО Авиадвигатель"

ЗАВОДСКОЙ НОМЕР **001**

ИЗГОТОВИТЕЛЬ
Общество с ограниченной ответственностью Научно-производственное предприятие "МЕРА" (ООО НПП "МЕРА"), г. Мытищи Московской обл.

РЕГИСТРАЦИОННЫЙ № **54735-13**

ДОКУМЕНТ НА ПОВЕРКУ
БЛИЖ.401201.300.441 МП

ИНТЕРВАЛ МЕЖДУ ПОВЕРКАМИ **2 года**

Тип средств измерений утвержден приказом Федерального агентства по техническому регулированию и метрологии от **23 августа 2013 г. № 968**

Описание типа средств измерений является обязательным приложением к настоящему свидетельству.

Заместитель Руководителя
Федерального агентства — Ф.В.Булыгин

"..." ..... 2013 г.

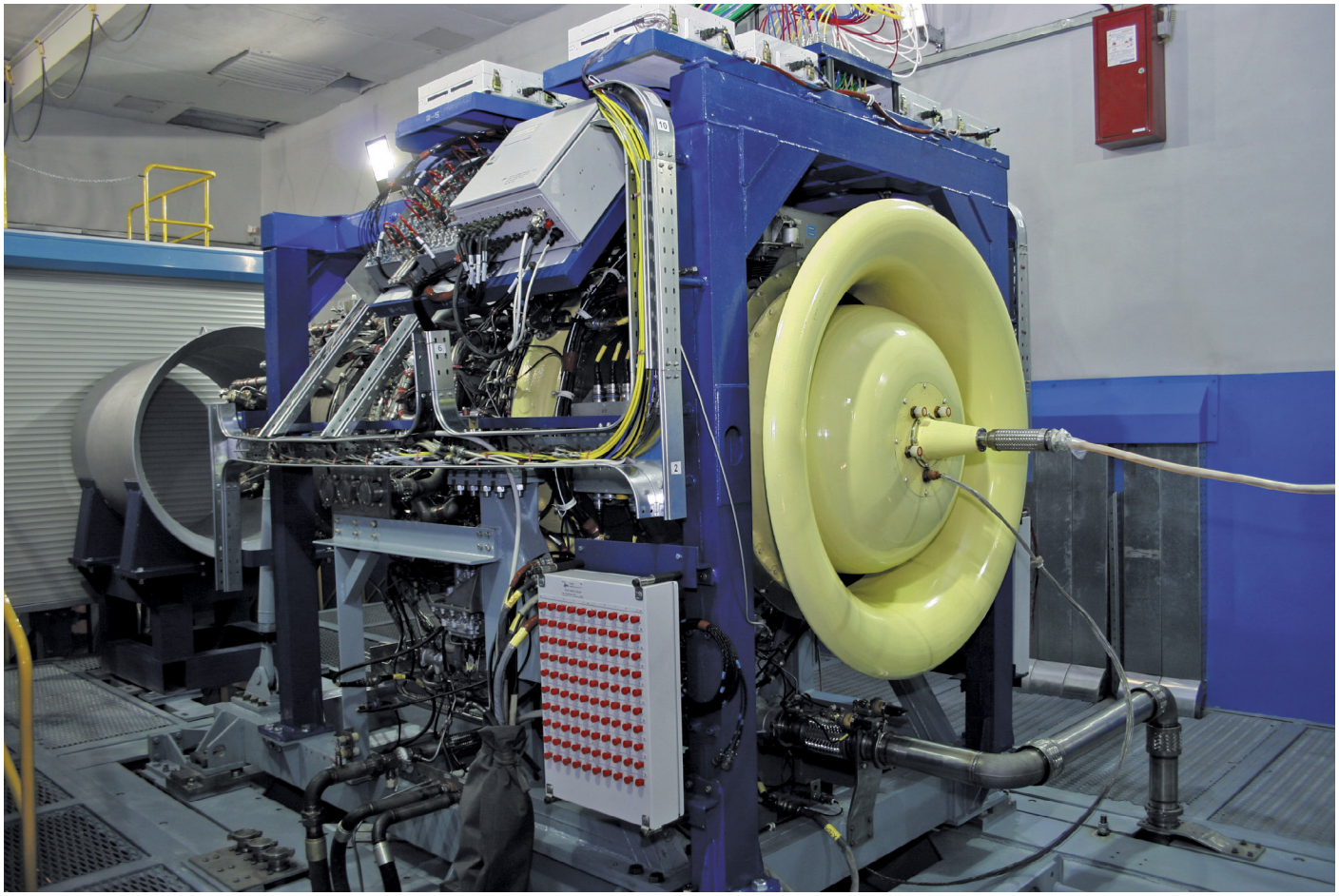
Серия СИ № 011485

Upgrade of the test bench for PD-14 experimental gas generator testing

Objective

Modernization of the automated system (AS) for control, measurement, monitoring, and recording of parameters along with other main and auxiliary systems of test bench #9 (force measurement, transport, fuel, starting, oil, heating and forced flow system, bleed simulation system, etc.).

The AS should enable control both the gas generator modes and test bench systems operation. Temperatures and strains of rotor parts should be measured using radio telemetry current collector.



Equipping the adapter of the PD-14 gas generator

Key Features

The PD-14 gas generator is designed to perform both investigative and certification tests. After the upgrade, test bench #9 should enable special operational development testind for gas generators under various conditions:

- Atmospheric
- With heating of air at the gas generator inlet
- With forced flow and heating of air at the gas generator inlet.

MERA-designed systems are ideal for control dynamic stresses and radial gaps of rotor blades. We have provided the following solutions:

- A non-contact data acquisition system
- A housing vibration data acquisition system
- Elimination of the interferences on the measurement channels: a special layout for high-frequency measurement channels is designed.

Dynamic strains and vibrations measurement results should be visualized in real-time mode. Preliminary estimation of measured values should be provided during the test.

The capabilities of low frequency parameters measuring and recording system:

- Total number of parameters to be recorded: 2000
- Recording frequency: up to 100 Hz
- Volume of recorded data: up to 46 GB per hour
- Real time visualization and analysis of parameters during the test is provided both at engineers workstations of the test bench and at remote workstations.

The capabilities of high frequency parameters measuring and recording system:

- Total number of parameters to be recorded: up to 300
- Recording frequency: up to 100 kHz
- Volume of recorded data: up to 150 GB per hour
- Real time visualization and analysis of parameters during the test is provided at engineers workstations of the test bench.

Special video surveillance system:

- Volume of recorded data: up to 4 GB per hour
- Transfer of video surveillance data to the network data storage after the test.

Solution

Hardware

The creation of unified model for test bench automation is a result of close cooperation between Aviadvigatel JSC and MERA. PARUS-M9 two-level measuring and information system is used to record engine operating parameters in steady-state and transient modes.

The 1st (lower) level consists of a set of subsystems based on MERA-developed hardware and software facilities intended to measure parameters and record data stream both from the engine, and test bench systems.

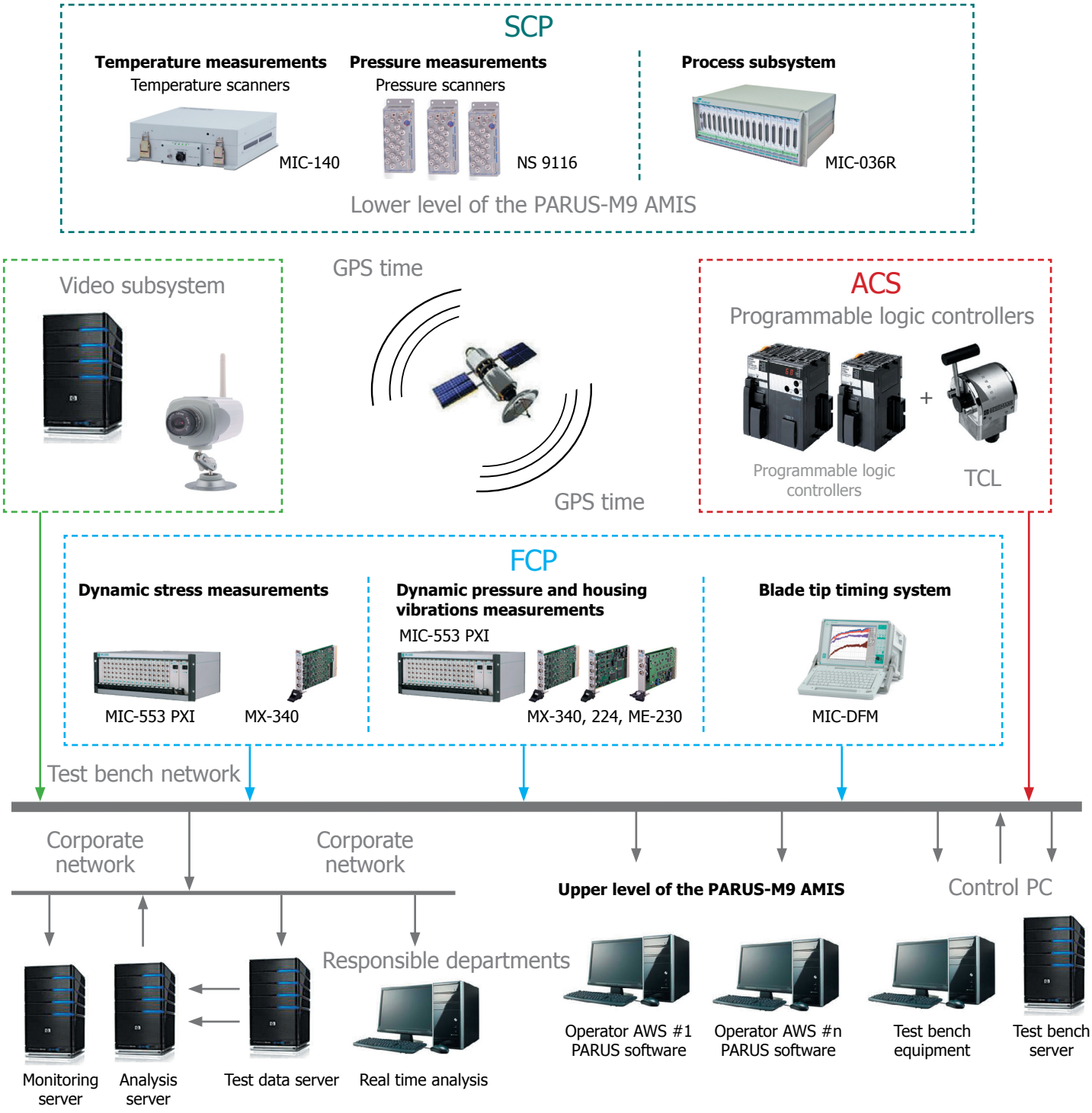
The 2nd (upper) level consists of test bench located operator and test engineer workstations. These workstation are designed for receive and consolidation of data coming from all lower level subsystems, and also for data processing and visualization. The other important features of these workstations is the management of test bench technological equipment, reports generation, storage data on disk, and transfer parameters to the corporative LAN during the tests.

The automatic control system has been developed in cooperation with Enrima JSC.

The automated measurement and control system for PD-14 engine gas generator testing has the following structure:

1. Low frequency parameters measuring system:

- Distributed data acquisition system based on MIC-140 temperature scanners and pressure scanners
- System for measuring of regular parameters and special gauging parameters based on MIC-036 modules
- System for acquisition parameters generated by electronic engine control module
- Control system for test bench technology equipment based on programmable logic controllers
- Control system for PD-14 engine gas generator (TCL)

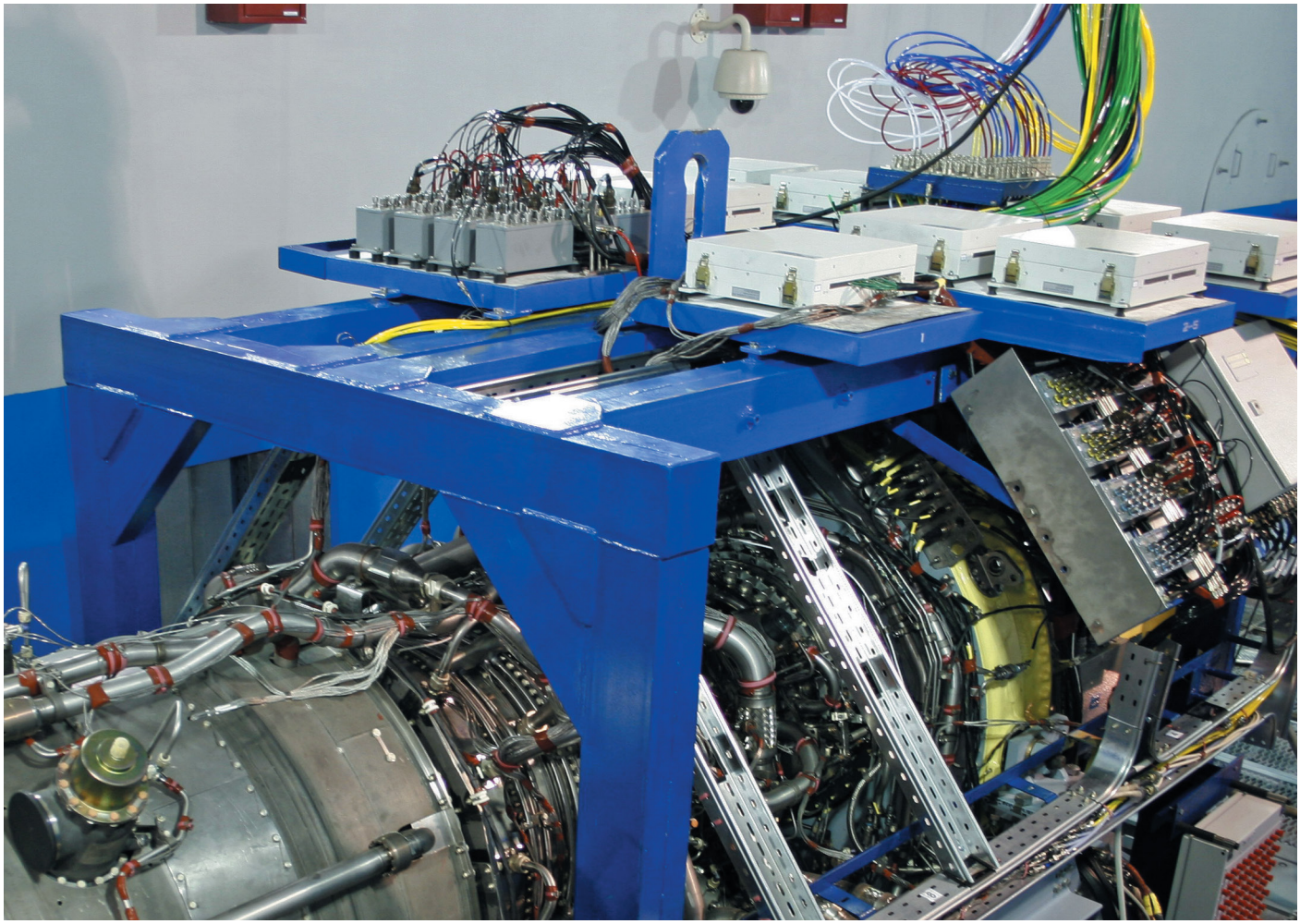


PARUS-M9 two-level automated system

2. High frequency parameters measuring system:

- Stator parts dynamic stresses and vibration measuring equipment based on MIC-553
- Digital telemetry system for measuring dynamic stresses and temperatures of rotating parts
- Blades tip timing sysytem

3. Video surveillance subsystem.



MIC-140 temperature scanners on gas generator adapter

All data acquisition subsystems of the test bench are integrated in LAN connected to the corporative network. The network environment contain resources intended for storing, processing, and analysis of the recorded data during the test and applications for post-processing. LAN data rate is 1000 Mbps.

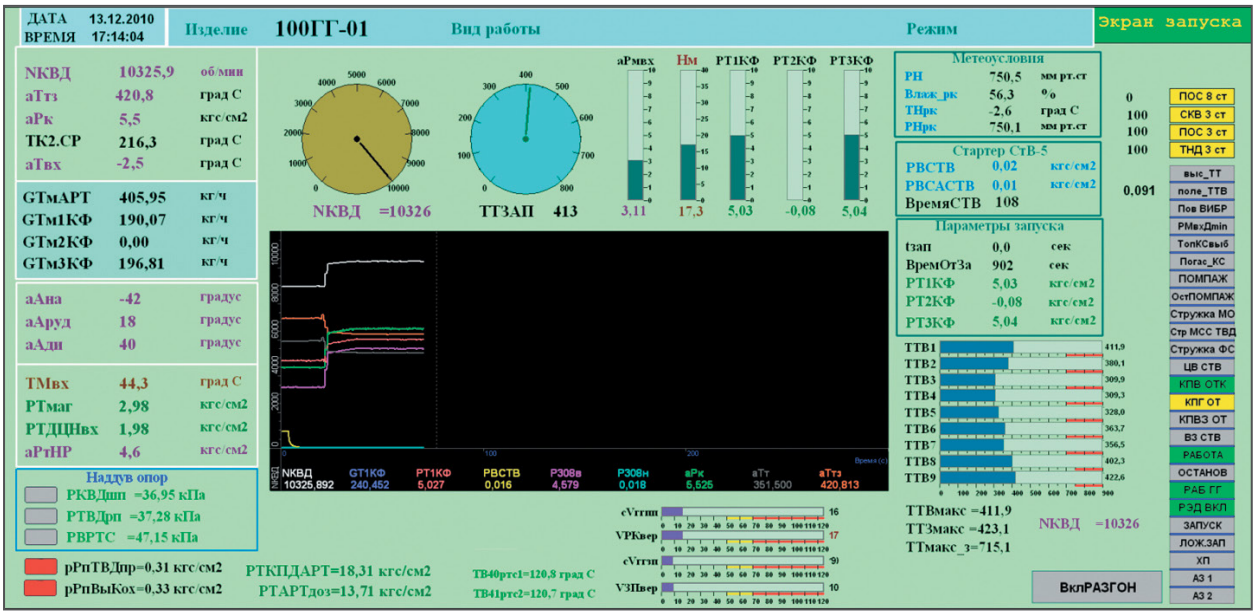
Depending on the testing tasks there is an option to deploy additional test bench workstations.The engine control systems keeps operability if the failure of some modules or terminal network equipment occurs . LAN traffic due test data transfer has minimum impact on the corporative network loading.

Software

The network transmission of data from the upper level PARUS AMIS to remote workstations allows to provide parameters monitoring and analysis in online mode.

The client application is installed at workstations in departments involved in the data analysis. This software has the following features:

- Real time data receiving from the test monitoring server with a data update rate up to 10 Hz
- Parameter visualization (display of information in the same form as on test crew screen) with the option to change screens and to generate new information display templates
- Data export into Excel format according to preset templates, real time recording on local disk with subsampling rate of 1 Hz, and acquiring independent measurements at workstations.

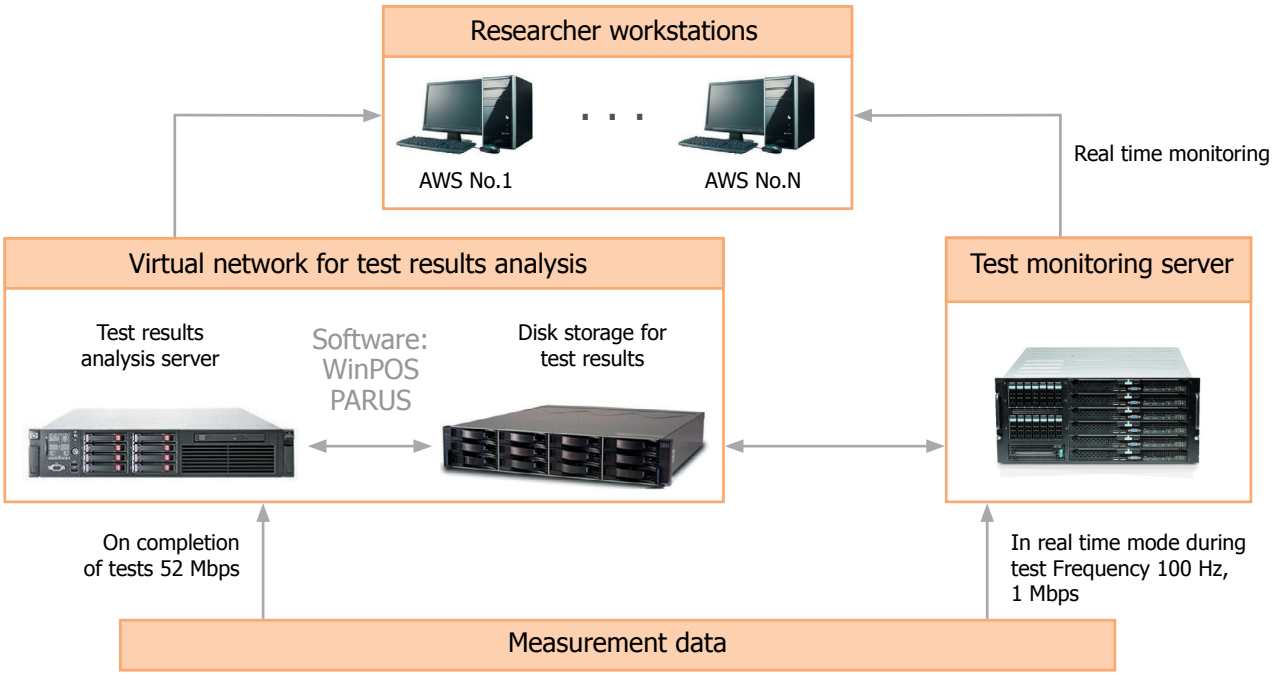


Main screen of the test team

Network arranged data processing server with special software enables to perform online analysis of test results placed in the data storage.

Test data are stored in unified formats and processed in the common information environment.

WinPOS software is used for data post-processing.



Test data processing and storage diagram

Results

- The company has implemented MERA-developed automated system with technical, functional, and metrological characteristics fully meet the requirements of OST1 01021-93 statnard.
- The number of measured operation parameters of object under test and test bench has increased, thus optimizing testing time (especially in critical conditions and during strain gauging).
- Improving the accuracy and reliability of measurement results eliminate the need of repeated testing and thus reduces costs of experimental works.

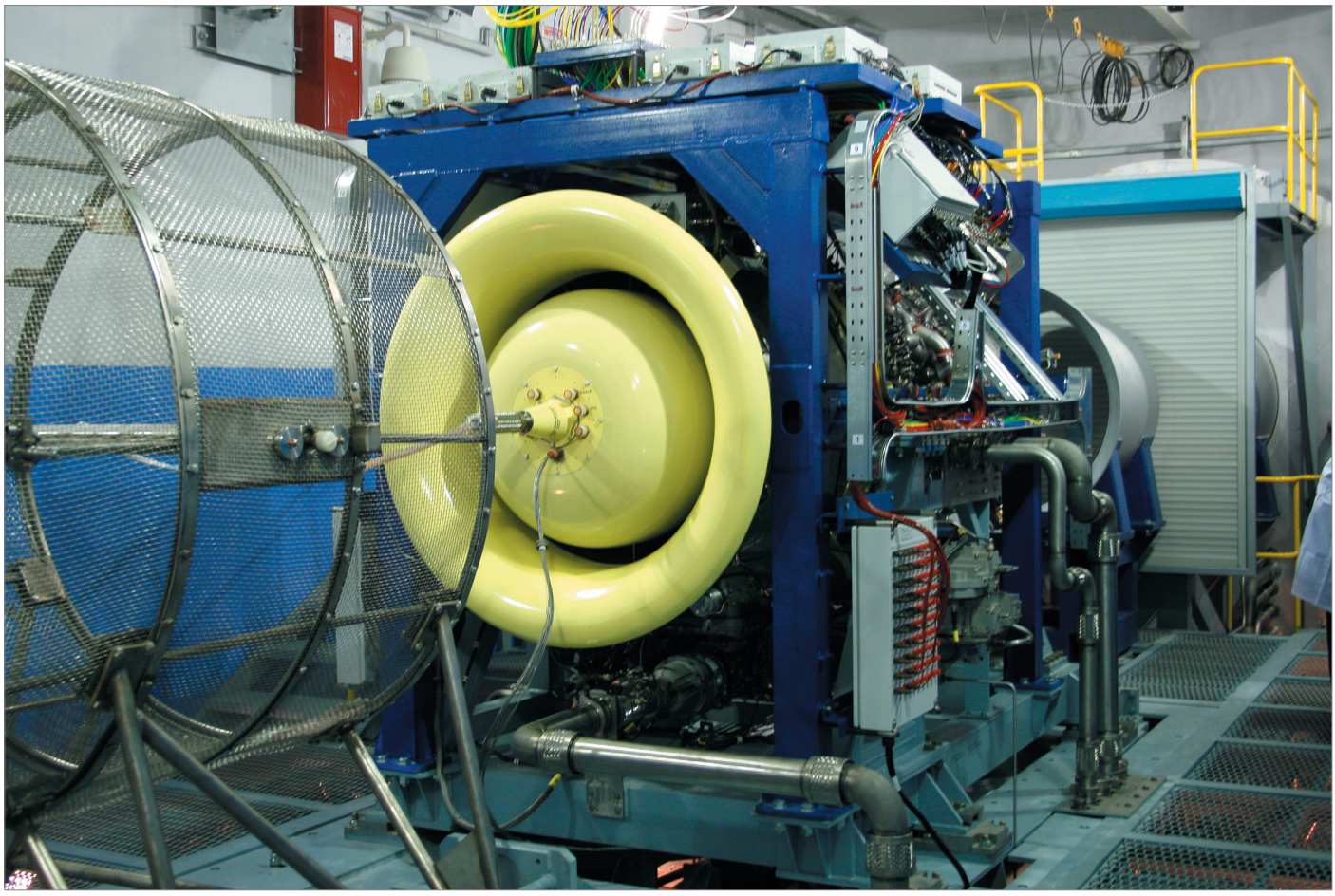
Technologies that enabled us to ensure the accuracy of measurements in accordance with the OST 1 01021-93 and OTU 2006 standards:

1. Using the pressure sensors with a maximum error lower than ±0.25%. We have also implemented a number of modern technical solutions, e.g. individual calibration of thermocouples, resistance temperature detectors and position sensors)
2. Using the MIC-140 smart temperature scanners with output physical values not requiring additional processing. Scanners placed at a minimum distance from the bleed location
3. Successful integration of MIC multichannel measurement computing systems with main modules maximum measurement error lower than 0.1% (FS)
4. Digital information receiving from a multichannel radio telemetry system simultaneously over all dynamic strain and temperature measurement channels without conversion into analog signals.

- Engineering solutions aimed to improving the accuracy of measurements results:
  1. Using the high frequency MIC measurement systems (up to 216 KHz/channel, depending on the type of measured parameter)
  2. Synchronizing test bench hardware and video surveillance system operation, using the common timescale and IRIG-B protocol (the time shift for the same sampling rate is lower than 1 ms; and 200 ns for high frequency parameters)
  3. Unique software in a multi-processor, multifunctional Windows environment. This software enables to perform any calculations and plotting any curves in real time mode
  4. Implementation of algorithms for eliminating human error through permanent monitoring of test bench systems and object under test parameters. Functions for automatic tracking of the calibration schedule is available.
- Emergency and pre-emergency control functions: reducing the probability of dangerous consequences in the events of defects during testing occurs, reducing the psychological stress on test engineers.
- Eliminating of the human factor (when manually recording measurement results from devices).
- Test data obtained from the system can used for on-the-fly analysis and quick decision making.

Summary

First start of the technology demonstrator engine core in the new indoor test bench No. 9 took place on November, 2010. The implemented system has fully met all expectations.



Test bech operating cabin

The Competence centre in the field of testing in the aerospace industry

For many years MERA is proudly recognized as the trustworthy supplier of turnkey test facilities and test automation systems for the aviation industry. We are perfectly able to apply modern automation methods and a mastery of advanced testing technologies. That is why we are a competence center in the field of aviation equipment testing and we are leaders in the supply of various measuring and control systems.

MERA is committed to supplying cutting-edge hardware and software for the widest possible range of measurement tasks.

We offer:

- Systems for recording and analyzing dynamic and slowly changing parameters
- Rotor telemetry systems
- Static testing systems
- Strength testing systems
- Onboard data acquisition systems
- Hardware for the discrete phase measurement method
- Automated control systems
- Auxiliary equipment (TCL, control panels, antennas, switchboard cabinets).

Strength testing (MIC-185)

Scanners (MIC-170, MIC-140)

Blade tip timing system (MIC-1200)

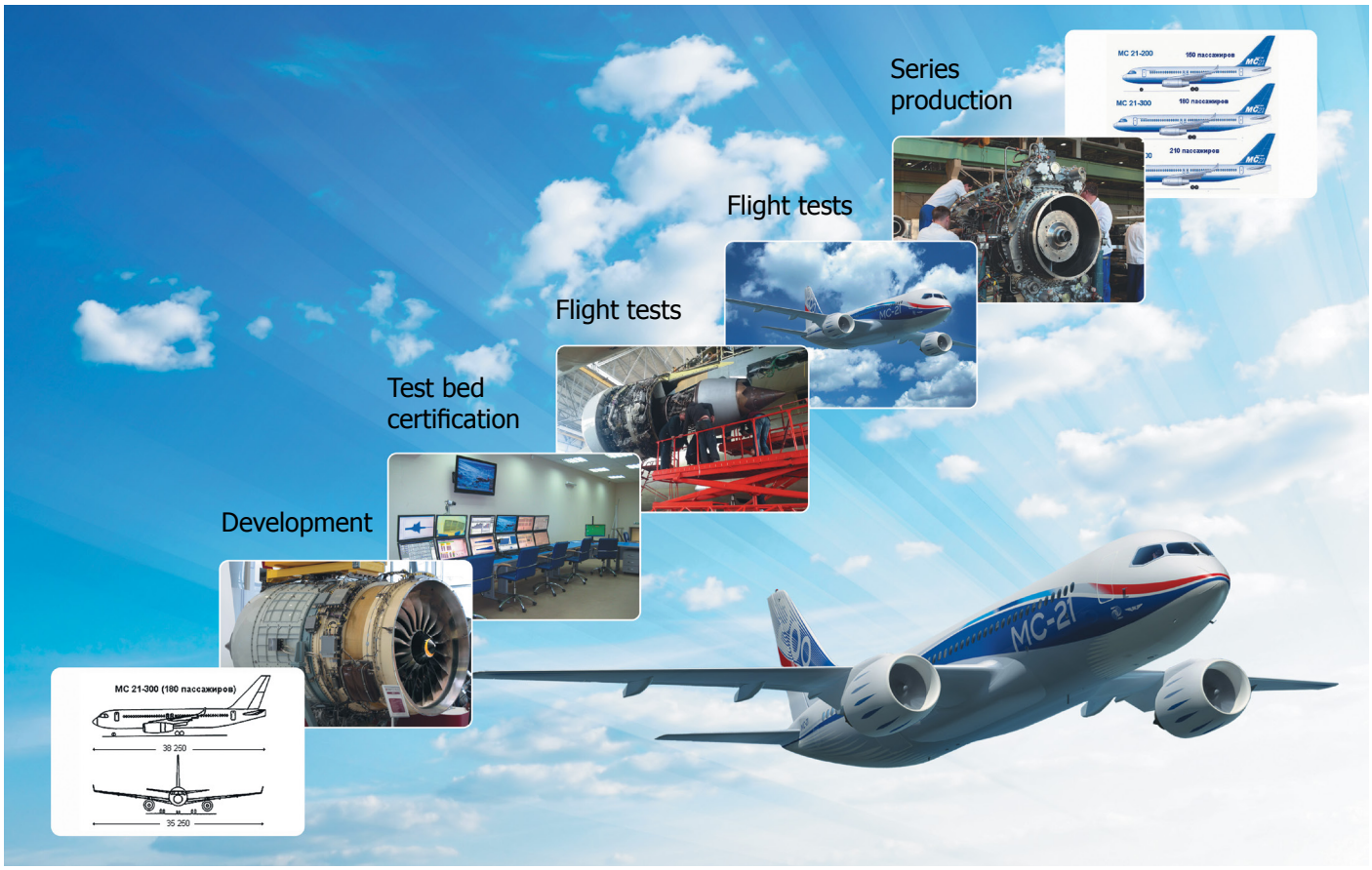
Distributed data acquisition systems (MIC-700, MIC-1150)

Low frequency process parameters

Specialized subsystems (TCL, video, ACS)

Rotating dynamic stress measurement system (MIC-1500)

High frequency parameters (MIC-553, MIC-355)



Our company is actively involved in developing test systems at all design stages of the PD-14 engine. MERA has the widest possibilities to support for various types of aircraft equipment tests including:

- Development of test bench data acquisition systems and control equipment
- Onboard data acquisition systems
- MECHATRONICS, test automation equipment based on computer-controlled pneumatic, hydraulic, and electro-mechanical systems.

MERA believes that superior customer support is a key factor in establishing and maintaining a trust relationship with our clients. That's why we offer an exceptionally wide range of services beyond the scope of conventional "Customer-Supplier" relations:

- Development and delivery of any scale "turnkey" solutions
- Manufacturing and delivery of components or subsystems
- Technical and feasibility assessment of other vendors projects;
- Selection of contractors and working group management
- Development and implementation of complex data acquisition systems (radio telemetry system for recording parameters of rotating parts, specialized test benches and many other solutions).

History

1992	Founding of the company and development of the our first software package for signals processing
1995	Development of the first prototypes of software and hardware suites using L-Card DAQ modules
1996	First foreign implementations of software and hardware suites
1996	Design and development of launch data acguisition systems for the Sea Launch project
1999	Establishment of in-house hardware production and development of the MIC-200, MIC-036, MIC-400 unit family
1999	Development and implementation of an automated test bench systems for aircraft engines
2000	Implementation of units of MIC series at Baikonur and Plesetsk space launch facilities
2001	Launch of commercial MIC-300 equipment production
2004	Development of hardware for studying dynamic processes of vibrations and monitoring the operating state of compressor and turbine blades using tip timing method
2010	Equipping the production and technical center with automated micro-mounting equipment
2010	Development of the MIC-1100 system to acquire measurement information from rotating shafts
2012	Installation of the MERA-produced MIC-700 certified telemetery data transmission unit on a spacecraft
2012	Purchase of industrial platform in Mytishchi, development production and office space
2012	Development of scanners to record parameters of spatially distributed processes (temperature, stress and pressure)
2013	Development of MIC-1150 and MIC-1110 miniature autonomous signal recorders
2013	Development of an automated system for flight testing of aircraft engines
2013	Development of a hardware and software suite for non-contact data acquisition from rotating parts of gas turbine engines
2014	Development of the MIC-1500 system for data acquisition from from high speed rotating shafts
2014 – 2015	Design and development of onboard data acquisition systems for PJSC Beriev Aircraft Company and Gromov Aircraft Aircraft Institute JSC
2015 – 2016	Upgrade of data acquisition and test control systems of altitude test facilities Ts-4N and Ts-IA of CIAM
2017	The stand for ground tests of aircraft engines in «UZGA» JSC

MERA today

MERA is the leading Russian company in the field of developing data acquisition systems and test benches automation for the aviation, aerospace, power, transportation and engineering industries.

The company encorporates R&D center, production division, a standardization and metrology department and a technical support department.

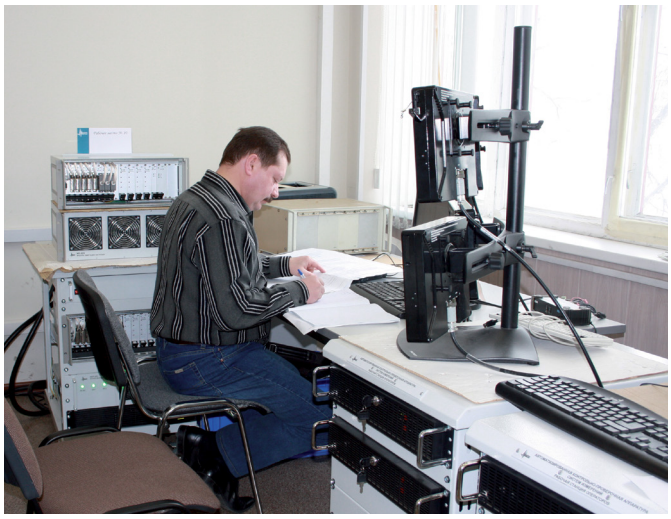
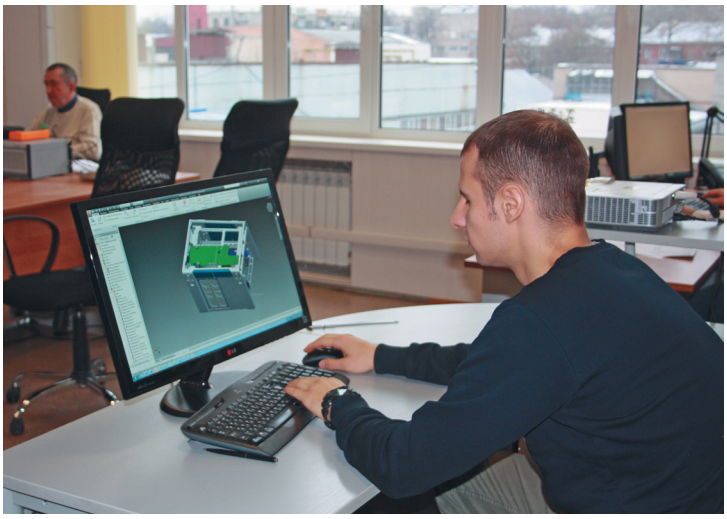
Our success is based on excellent teamwork. Skilled and dedicated team of professionals includes more than 200 specialists with extensive experience in development and production, as well as successful implementation of integrated measurement and control systems.

As a leaders, we are remembers necessity of not only stay current with the cutting-edge testing technologies, but on top of those that are constantly emerging. Our investment strategy is a key systems improvements and successful development of new innovative products.

Measurement equipment manufactured by MERA undergoes state registration for measuring facilities. The guaranteed service life for the products is 3 years; and 5 years for military products.

Mission

We help to create technologies of the future.

Concept

From development of specifications to delivery of the «turnkey» solution - at each stage of test benches automation systems creation we practices an integrated approach.

During the developing of the measuring equipment and systems NPP «MERA» utilizes the most advanced hardware and software solutions. The high reliability of our products is ensured by the high quality components, modern technologies of manufacturing and assembly.

Developing a modular system, we provide to our customers the wide opportunities to build the optimal structure of measuring complexes and the possibility of scaling and further modernization

All hardware developed by MERA, from individual measuring devices to complex automated systems are operating under the control of a unified MERA-software. The system interfaces adapted to the customers tasks, providing flexible, quick data processing, analysis and presentation of measurement results in the most convenient form.

Integrated approach

1

Our turnkey projects begin with a deep analysis, complete with recommendations for optimization of operation.

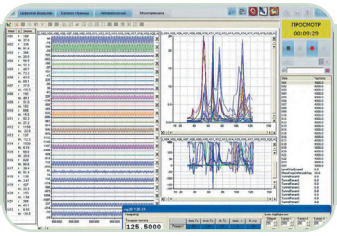
We work closely with our customers during the technical specifications development and design stage, striving to generate efficient and cost-effective solution.

2

3

On time and on budget: development and manufacturing of equipment, testing of system components, primary metrological verification, preparation of user friendly operational documentation.

Careful development of specialized software



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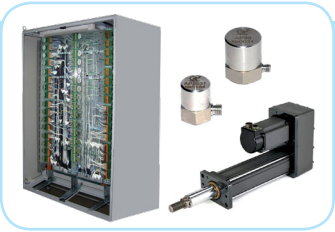

Design and manufacturing of cross-boxes and signal conditioners. System integration with subcontractor's products.

On site installation, commissioning and tuning works, put into operation.

6

7

Reliable technical support, customer staff training, metrological support according with standards

Proposals for the modernization

8

Certificates and licenses

Our quality management system certified for compliance with GOST ISG 9001-2011 (No. ROSS RU.IT19.00035 of 28.02.2014).

Products developed and manufactured by MERA are included in the State Register of Measuring Equipment. Some developments are protected by patents and copyright certificates.

License for space activities (development and manufacturing of new generation specialized modules for acquisition, processing, and display of telemetry information during testing of aerospace equipment).

Measuring equipment type approval certificate for MIC measurement computing systems.

Utility model certificate No.24553 «Recorder of measurement signals and their characteristics».

Invention patent No.2173857 «Method for pulse frequency measurement».

Certificate No.242789 for the «MIC» trademark registration for data acquisition units and instruments.

Certificate No.2004611912 of official registration of «WinPOS Signal Processing Package» software.

Certificate of conformity of ME series conditioning modules with explosion-proof mark [Exia]IIC, requirements of GOST R 51330.10-99 (IEC 60079-1199).

Istochnik-M TMS as a component of the telemetering information acquisition and recording system (TMI ARS) is approved for use at the International Space Station (Roskosmos FSS KT Certificate) No. FSS KT 134.09.1.3.766400.01.08 of 20.01.2009.

The quality management system for development and manufacturing of aerospace products for scientific, social and economic and military use corresponding to UCIA codes 1420, 1441, 1460, 1471, 7030, 7031, complies with the requirements of Regulations RK-98-KT, RK-98, GOST R ISO 9001-2011, state standards SRPP VT, including GOST RV 0015-002-2012 and OCT 134-1028-2012.

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The publication contains basic overview of the company products
For more information, contact the sales department