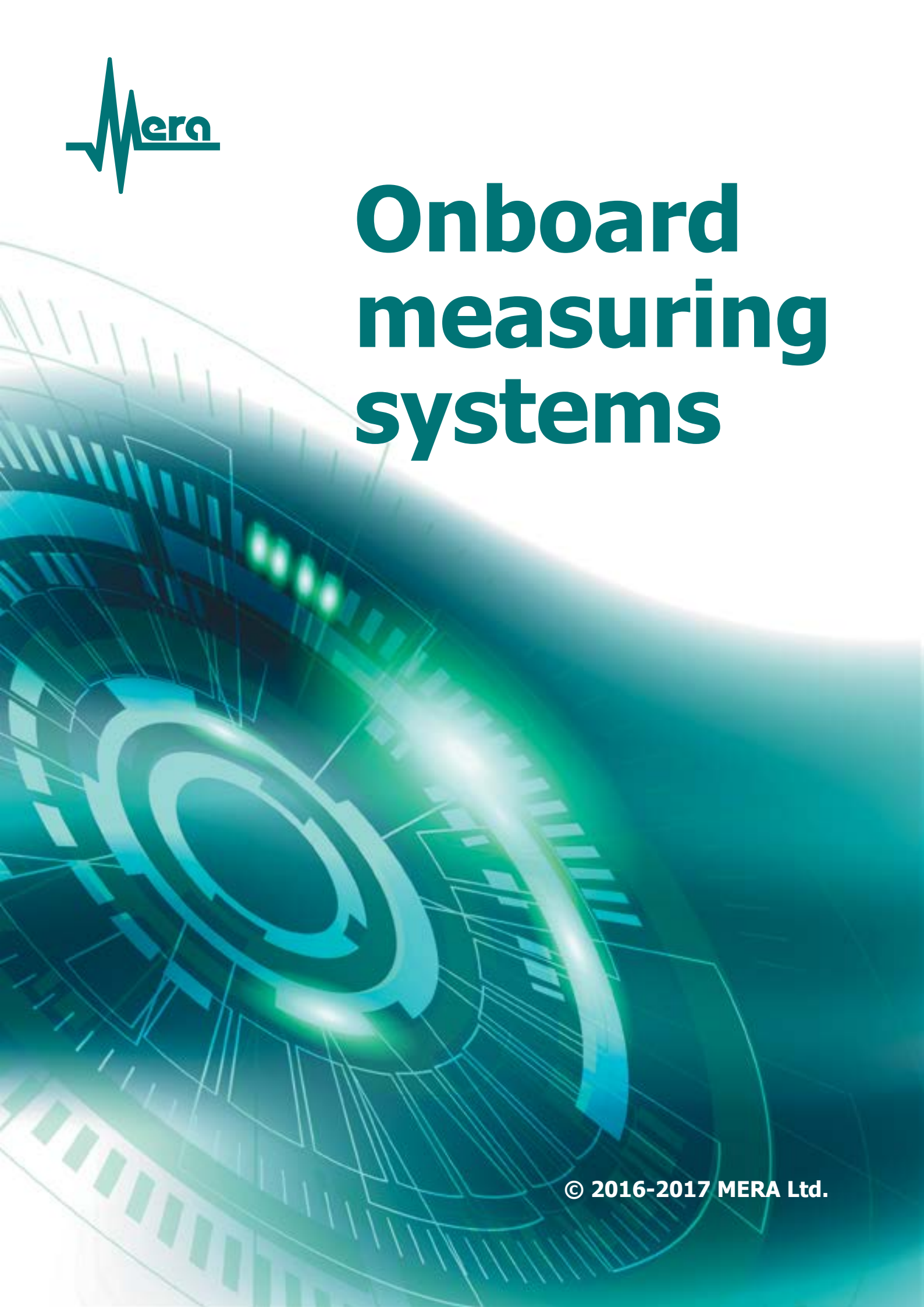
Onboard measuring systems



Contents

Onboard measuring systems from Russian developers

Requirements to modern onboard measuring system

- Comprehensive range of measured parameters:
  temperatures, pressures, discrete signals, position (attitude), vibration, strain, frequency, video...
- High system reliability and high data consistency (accuracy)
- Advanced requirements for measurements accuracy
- Hard operation conditions
- Strict requirements for energy consumption and output
- Versatility and flexibility
- Scalability and upgradability
- Parts diversification

MIC-1500
Telemetry measurement system

MIC-1150
Dynamic measurements (stresses/strains/vibrations)

MIC-700
Digital interfaces ARINC, MKO, RS-485, CAN

MDU-812
Switching unit (power supply, synchronization and interfaces)

MIC-700
Digital interfaces ARINC, MKO, RS-485, CAN

MIC-1170
Distributed modules

MIC-170H
Pressure scanner

Control console

MIC-140H
Temperature scanner

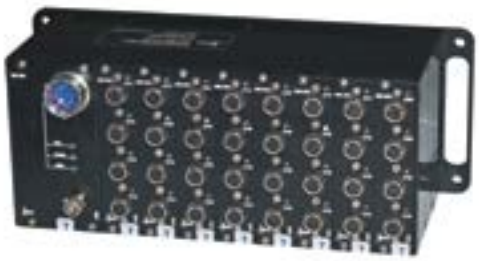
MIC-1200
Tip timing (discrete-phase method)

Modern architecture of onboard measurement systems

- Modern design principles
- Common software
- Unified hardware solutions

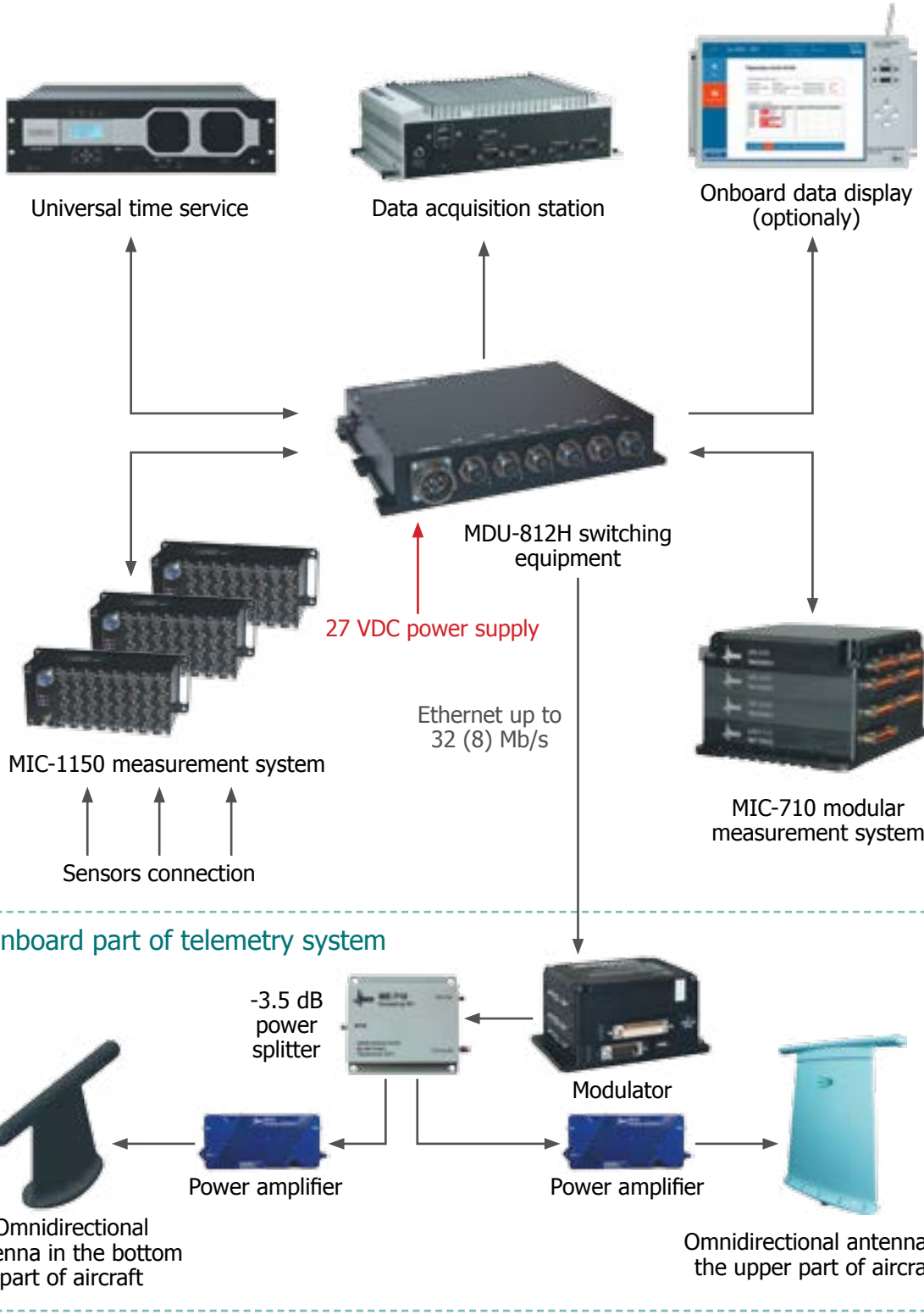
MIC-700

MIC-1150H



MIC-1150P

MERA Ltd. performs designing, manufacturing and implementation of onboard measurement systems. The onboard measurement system (OMS) comprises software and hardware solutions designed to provide flight testing of aviation and rocket-space equipment.



OMS performs collecting, recording and processing of measurement data received from sensors and onboard systems during ground and flight tests as well as during the operation process.

OMS is a distributed measurement system based on a compact modular units. (MIC-1150 measurement system was developed for aviation application, and MIC-710 – for rocket and space application.) Each system can comprise up to eight measuring modules. The amount and type of measuring channels is determined by the specific task of testing and research. The range of measuring modules provides the measurement of a wide range of parameters: temperature, absolute and differential pressure, acoustic pressure, dynamic pressure, vibration, speed, displacement, dynamic strains, cracks propagation, etc.

In addition to the MIC-1150 systems the OMS can be equipped with other onboard measuring equipment such as MIC 140 & MIC-170 temperature and pressure scanners.

Preparation, testing and measured data processing are performed by software Recorder (MIC systems control environment) and by WinPOS (signal processing application program). Specialized Recorder software allows to process the measurement results and modify the test program on board during the flight.

All the OMS parts are tested for environment impacts according to GOST RV 20.39.304 group 3.2.1 for onboard application systems.

OMS can operate in standalone mode, acting as a convential flight recorder with extended functionality. Additionally OMS can be supplied in the special version for research tasks.

The onboard measurement system of 1A2 flyight laboratory («Beriev Aircraft» Company)

The OMS for «Beriev Aircraft» flyight laboratory has successfully passed all preliminary tests. Based on preliminary tests results system is driven through State tests. State tests certificate allows implementing OMS on serial production aircrafts.

OMS for engine parameters acquisition and recording implemented in IL-76LL flyight laboratory («Gromov» Flight Research Institute)

OMS for flyight laboratory («Gromov» Flight Research Institute) is recommended for usage within PD-14 engine complex testing. PD-14 was developed for MS-21 aircraft constructed by JSC Irkut Corporation. M. M. Gromov Flight Research Institute is caring out the works regarding system approval for usage in airborne applications.

Onboard measurement systems

MIC-1150 – compact modular signal recorder dedicated to onboard data acquisition systems construction, technological equipment monitoring as well as transportation testing.

MIC-1150H

MIC-1150P

Features

- Modular design: 8 MS-series measuring modules allows flexible system configuration
- 8 to 128 measuring channels dependent on number and types of measuring modules
- Communication with data acquisition station via Ethernet. Group connector: power supply, UTS, Ethernet
- Device casing modification in accordance to customer request (up to IP65)
- Operating temperature range: -55 ... +75 °C
- Power consumption: 45 W
- Supply voltage: 18 ... 36 V DC
- Size: 206 × 120 × 133 mm

MIC-710 – PC/104 standard measuring system for operation with various types of sensors.

MIC-710

Features

- Variable structure: up to 7 MB-series measuring modules
- Up to 128 analog channels and up to 192 digital channels
- High-level protection from environmental impacts, shock and vibrations
- Data exchange via Ethernet, SpaceWire, MKO GOST R 52070-03 interfaces
- Measuring channels redundancy for advanced reliability
- Operating temperature range: -40 ... +85 °C
- Supply voltage: 18 ... 36 V DC
- Size: 120 × 134 × 161 mm

Onboard physical parameters scanners

MIC-140 – multichannel high-precision temperature scanner for thermocouples.

MIC-140

Features

- Automatic cold junction compensation. Embedded cold junction temperature sensors
- 48 measuring channels
- Thermocouples: R, S, B, J, T, E, K, N, A, L
- Cold junction temperature measuring accuracy: ± 0.2 °C
- Communication with data acquisition station via Ethernet. Group connector: power supply, UTS, Ethernet
- Temperature-resistant housing for hard operation condition
- Operating temperature range: -55 ... +70 °C
- Supply voltage: 18 ... 36 V DC
- ize: 228 × 228 × 94 mm

MIC-170 – multichannel scanner for absolute and differential pressure measurement of dry nonaggressive gases.

MIC-170

Features

- Automatic temperature compensation
- 16 measuring channels
- Pneumatic connectors: clamping fittings or quick-release couplings
- Pressure measurement ranges:
- differential: 35 (5) ... 690 (100) kPa (psi)
- Communication with data acquisition station via Ethernet
- Dust- and waterproof housing (IP65)
- Operating temperature range: -55 ... +70 °C
- Supply voltage: 18 ... 36 V DC
- Size: 210 × 110 × 90 mm

Switching devices

MDU-812H – switching module designed for communication and distribution in measuring and control systems. The module provides power supply, synchronization and Ethernet LAN.

MDU-812H

Features

- Installation in uninhabited aircraft area
- 12 connecting outputs
- Cascading capability
- Supply voltage: 18 ... 36 V DC
- Synchronization: 10 MHz
- Current consumption: 0,8 A
- Size: 310 x 310 x 65 mm
- Weight 2 kg

MS & MB series onboard modules

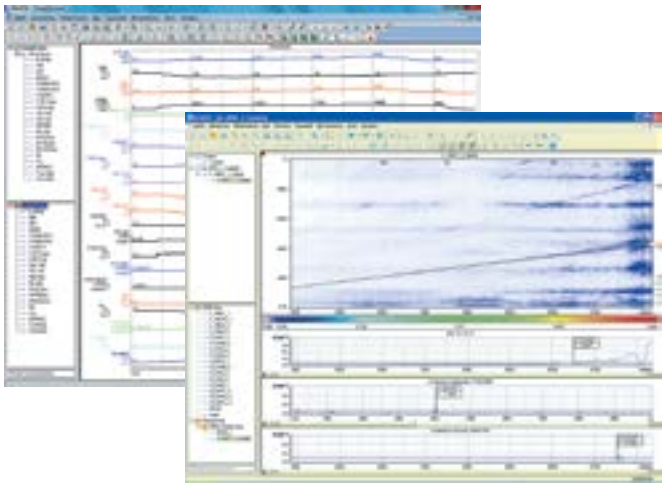
Model	Purpose	Application	Parameters
MS-142 **MB-142**	Precision DC voltage measurement	Temperatures, pressures, voltages measurements	16 channels ± 0.025 % up to 2 kHz per channel
MS-152 **MB-152**	DC resistance and DC voltage measurement	Voltages, resistances, temperatures measurements	16 channels ± 0.05 % up to 2 kHz per channel
MS-202	Dynamic AC voltage measurement	Vibrations, shocks, pressure oscillations, dynamic strains, acoustic pressure measurements	4 channels ± 0.1 % up to 105 kHz per channel
MS-304	Strain gauge sensors measurement	Strains, pressures, displacements, forces measurements	4 channels ± 0.05 % up to 4.8 kHz per channel
MS-340	Dynamic AC voltage measurement	Dynamic pressures, dynamic strains, acoustic pressure measurements	4 channels ± 0.05 % up to 105 kHz per channel
MS-451	Periodic signal frequency measurement	Flow measurements	8 channels ± 0.01 % up to 200 Hz per channel
MS-405 **MB-405**	Digital signal input	Actuators operation registration	16 channels 100 µs 0 ... 20 V
MS-632 **MB-632**	Coupling with RS-485, RS-422, RS-485 interfaces	Data exchange with external devices: • MS – 4 channels RS-232, 4 channels RS-485 • MB – 4 channels	115 200 bps
MB-2355	Data input and output	4 ports (2 channels per each) for data exchange	SpaceWire
MB-2087	Data exchange	2 channels for data exchange	MKO, GOST R 52070-03
MB-628	ARINC-429 receiving		12.5; 50; 100 kbps
MB-629	ARINC-429 transfer	ARINC simulator	12.5; 50; 100 kbps

Software products

Recorder – multipurpose software for measurement systems control. Allows to apply special plug-ins for system capabilities enhancements.

Features

- Control, setup and diagnostic of measuring channels
- Calibrating of measuring channels using the calibration characteristics database
- Measured parameters are displayed in real time mode during testing trough tables, graphs and mnemonic diagrams
- Control of data acquisition and store processes
- Statistical processing of measurement results, report generation
- Mnemonic diagrams creating
- High-level smart driver for SCADA-systems (OPC-server)



WinPOS – software package for post-processing of measured dynamic and slow-varying parameters, graphic data presentation and report generation. The software provides interfaces for creating user programmed scripts in almost every programming environment.

Features

- More than 50 signals processing algorithms
- Powerful graph tools for report generation
- Quick report generation
- Batch data processing
- WAV and UFF data format processing
- Signal editing
- Scenario support (built-in VBScript editor)
- Data import and export plug-ins
- Signals values representation in tables
- Unlimited signals length
- Integration with MATLABTM
- Client-server distributed system for post-experimental data processing
- Windows XP/Vista/7/8/10
- Comprehensive Help

Application experience

Onboard loads monitoring system for Be-200 aircraft

The challenge

System was designed to monitor aircraft conditions such as loads, major components destruction processes and etc.

Key features

- System located onboard of Be-200 aircraft with sensors installed on structural elements provides:
  - data collection of aircraft structural elements damage via load repeatability estimation
  - monitoring of single loads due to wind gusts, maneuvers, contact with the water surface and runway
  - monitoring of crack propagation in main power elements of the aircraft structure.

- System has a unified modular structure and contains:
  - 96 channels for permanent mounted strain gauges;
  - 96 channels for crack propagation monitoring;
  - 16 channels for overload monitoring;
  - 8 channels for ARINC-429 receiving.

Solution

Hardware equipment

Strain gages, MIC-1150 & MIC-1170 compact measuring systems, ME-005F switching module, onboard computer, control and display console, cables.

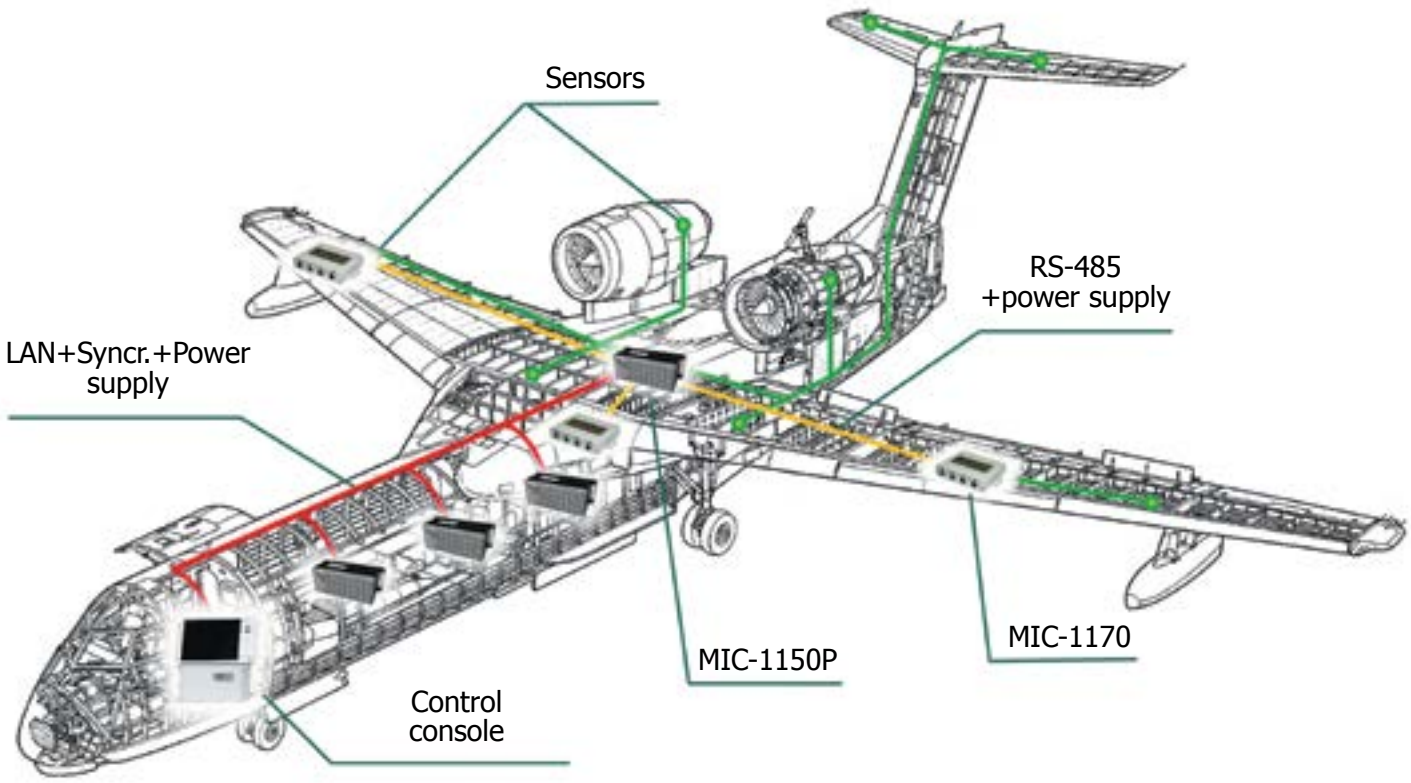
Software

System operates under control of software packages based on Recorder software in combination with "Simon" special plug in.

If necessary, WinPOS package is applied for additional data processing.

The core of system is a MIC-1150 in version with individual inputs and modular structure. The hardware is equipped with MS series measuring modules. MIC-1150 can contain up to 8 MS-series modules with the total number of channels up to 128.

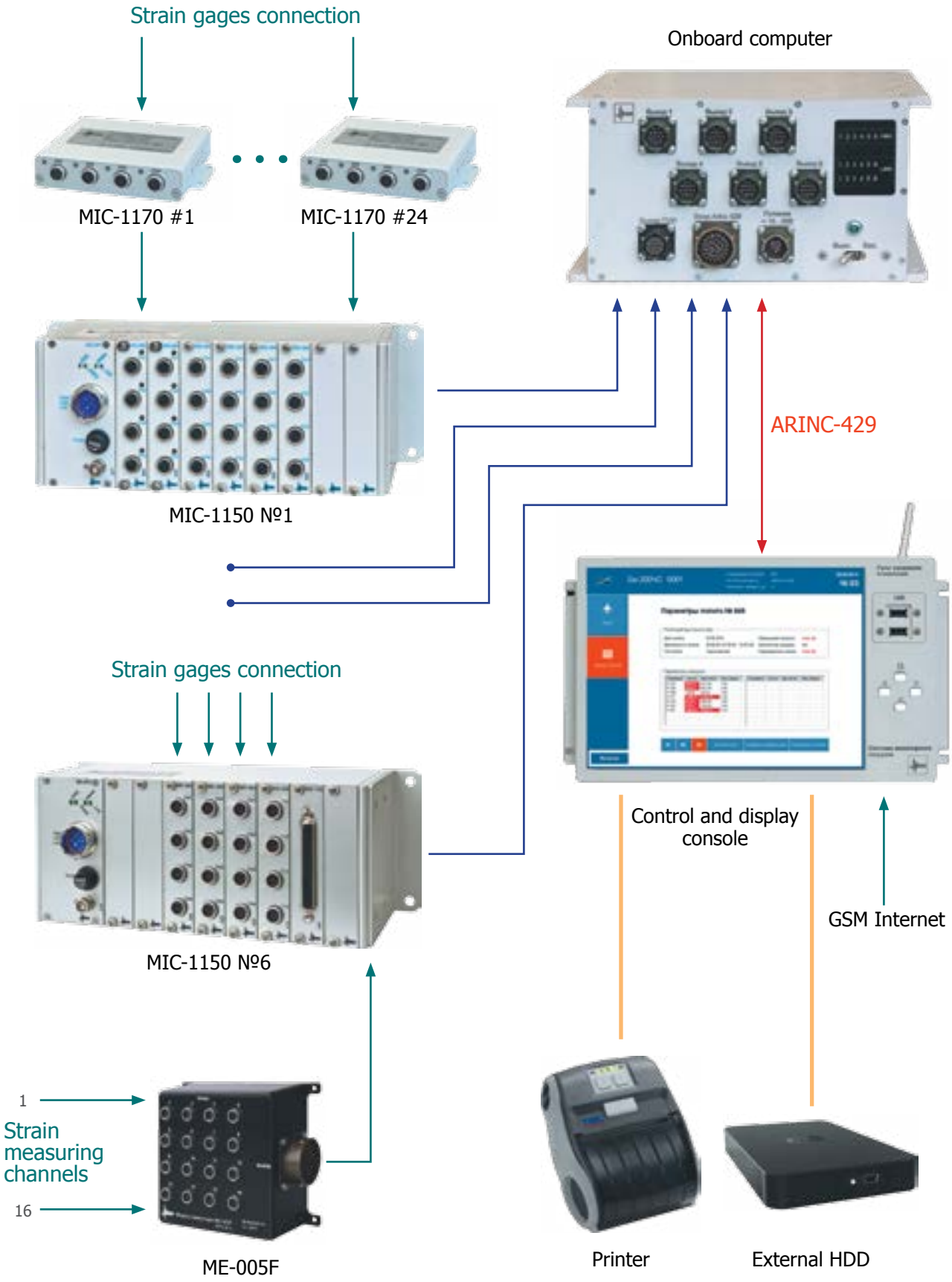
The MIC-1150 systems are accompanied with specialized remote MIC-1170 measurement modules. When placed in the close proximity to detected cracks, MIC-1170 miniature remote modules can be used effectively for distributed systems construction. Such system design can significantly reduce the cables length, thus reducing installation time and cost.



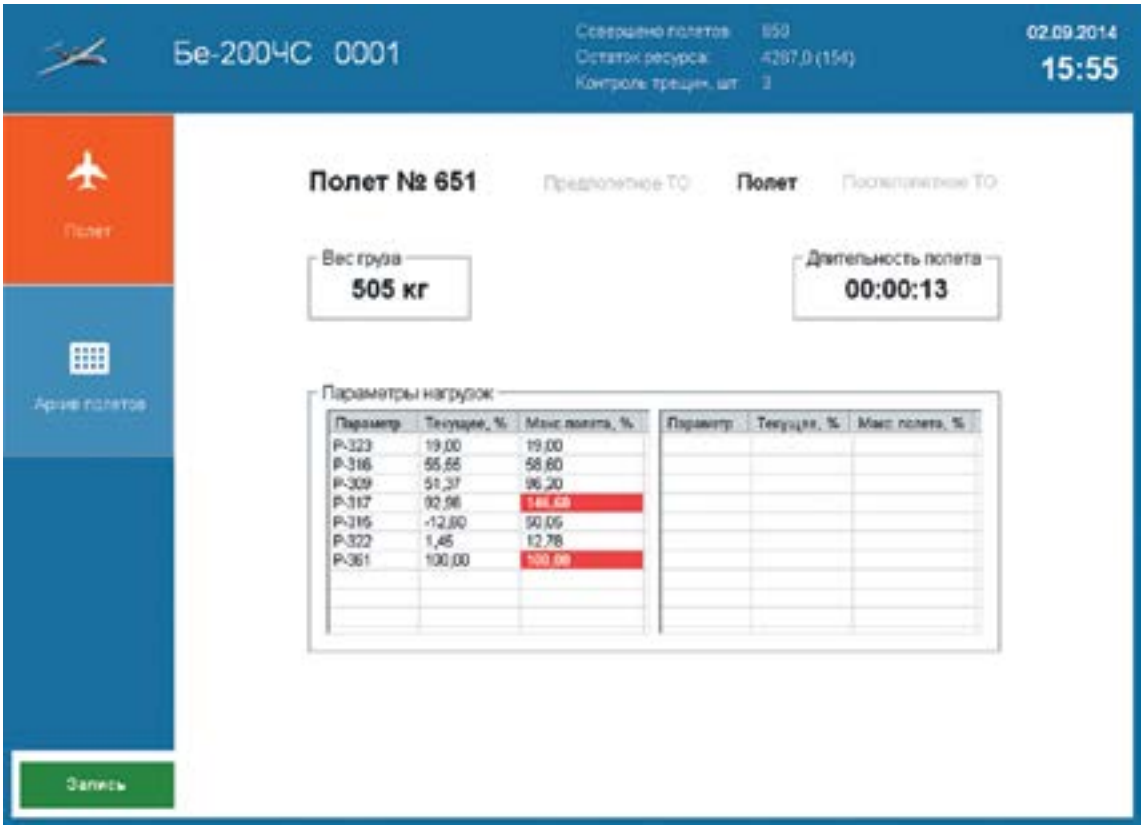
Structure of Be-200 aircraft distributed monitoring system

Connection of measurement systems to the host computer, synchronization, powering supply and information receiving via ARINC-429 is performed by onboard computer.

Control and display console is used for acquisition and storage of data, automatic processing of registered parameters, measurement systems control, displaying of processed results in real-time mode and report transferring via mobile networks.


Strain gages connection
Onboard computer
MIC-1170 #1
MIC-1170 #24
MIC-1150 №1
ARINC-429
Strain gages connection
Control and display console
GSM Internet
MIC-1150 №6
1
Strain measuring channels
16
ME-005F
Printer
External HDD

Simon software provides pre-flight preparation of the monitoring system (strain gages calibration, accounting of parameters values while parking). It also serves to assess the quality of the recorded information, analysis of the maximum values, in-flight calculation of the accumulated damage. Then the software is used to calculate the remaining service life and to monitoring of discovered cracks growth.



Simon software screen

Results

The system has been put into operation.

System allows to automate measurements and recording of aircraft structure loads parameters in different operation modes. Automation allows to reduce labour intensity and both measurement and processing time, as well as to provide users with accurate and timely information about aircraft structural elements condition.

Flying laboratory onboard data acquisition and recording system

The challenge

To develop, produce, install on board and to put into operation data acquisition and recording system (DAQRS).

Range of measuring channels

Channel type	Q – ty
Potentiometric sensors	128
Thermocouples	32
Frequency	8
Voltage, ±10 V	16
Discrete	96
ARINC 429	6

Key features

- DAQRS is designed to operate on board of the IL-76 flying laboratory during the testing of PD-14 aircraft engine. DAQRS equipment is located in the area with adjustable temperature and pressure, in the habitable compartment.
- System functionality:
  - data acquisition from transducers installed on the structural elements of the engine under test;
  - engine parameters data processing

Solution

Hardware equipment

Sensors, MIC-710 & MIC-224 measuring systems, MIC-140, signals conditioner, digital streams acquisition unit (DSAU), ME-020 synchronization unit, Ethernet switches, PC, cables.

Software

Recorder software for MIC systems control is used to configure the hardware operating modes, data stream collection, recording and processing.

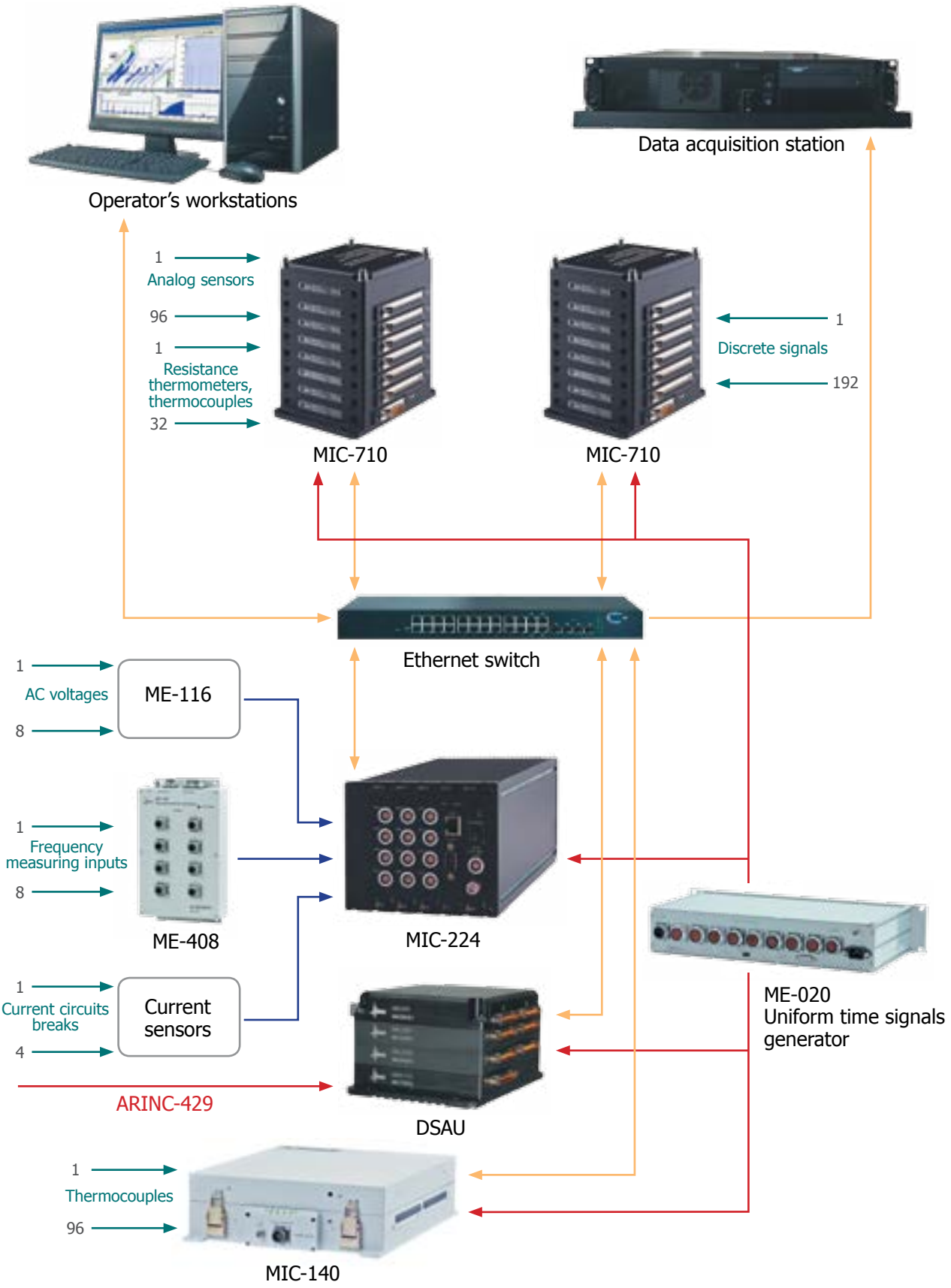
WinPOS software is used for post-processing and extensive analysis of recorded data.

The signals from transducers placed on the engine under test, come to MS-710, MS-140, MS-224 modules input channels.

Exchange of serial data streams is implemented by modules in DSAU via ARINC-429, RS-232, RS-485, RS-422 interfaces.

The MS-710, MS-224, MS-140 devices and DSAU are joined in the local network with data acquisition station and PC-based workstations using Ethernet switches.

The measurements results are recorded in data acquisition station and displayed on workstations in a uniform time scale, which is formed in the ME-020 synchronization module.



Results

The system has been put into operation. From November 2015 DAQRS has been operating in the IL-76LL flight laboratory of M. M. Gromov Flight Research Institute during the PD-14 engine flight testing.

Onboard measuring and information system for aircraft engines testing

The challenge

In order to perfrom flight testing of PD-14 engine it was required to develop, produce and put into operation the «Parus-LL» information and measuring system, intended for information acquisition and recording on flight laboratory.

Range of measuring channels

Channel type	Q – ty
Thermocouples	288
Pressure	352
Strain gages (dynamic measurements)	32
Strain gages (static measurements)	16
Vibration	32
Resistance thermometers	64
Frequency	8
Voltage, ±10 V	64

Key features

- In accordance with the specifications large part of the measuring equipment and switching devices must be placed directly on the test object.
- During the testing system hardware is exposed to high vibration loads, sound pressure and a number of other adverse factors.

Solution

Hardware equipment

Sensors, MIC-1150H compact measuring system, MIC-170H multichannel pressure scanner, MIC-170H temperature scanner, signals conditioners, ME-020 synchronization unit, Ethernet switches, PC, appropriate cables.

Software

Recorder, WinPos

Placement of «Parus-LL» hardware on the aircraft engine

For implementation of this project, MERA Ltd. has developed a modification of the MIC-1150, MIC-170 and MIC-140 system, specialized for testing conditions.

In order to confirm operating capabilities in these conditions, the measuring modules had been tested in the 46 Central Research Institute of the Ministry of Defense of the Russian Federation for resistance to the external factors: sinusoidal vibration, single and multiple mechanical shocks, low atmospheric pressure, salt fog.

In the crew compartment of the aircraft, general-system cabinet is installed with the equipment, intended for:

- data acquisition from information and measuring system, radio telemetry system, and radial gaps measurement system;
- control of measuring systems;
- power, synchronization and LAN supply;
- power circuits protection, etc.

The cabin of the flight laboratory during the equipment installation

Engineers of MERA Ltd. and JSC Aviadvigatel next to the instrument rack aboard of flight laboratory

Results

The system has been put into operation. From November 2015 DAQRS has been operating as a part of IL-76LL flight laboratory of M. M. Gromov Flight Research Institute during the PD-14 engine flight testing. The system is recommended for use during integrated testing of PD-14 engine as part of basic MS-21 aircraft, aircraft developed by JSC Irkut Corporation. M. M. Gromov Flight Research Institute is caring out the works regarding system approval for usage in airborne applications.

MERA is a Competence centre in aerospace testing 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:

- Onboard measuring systems
- 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)

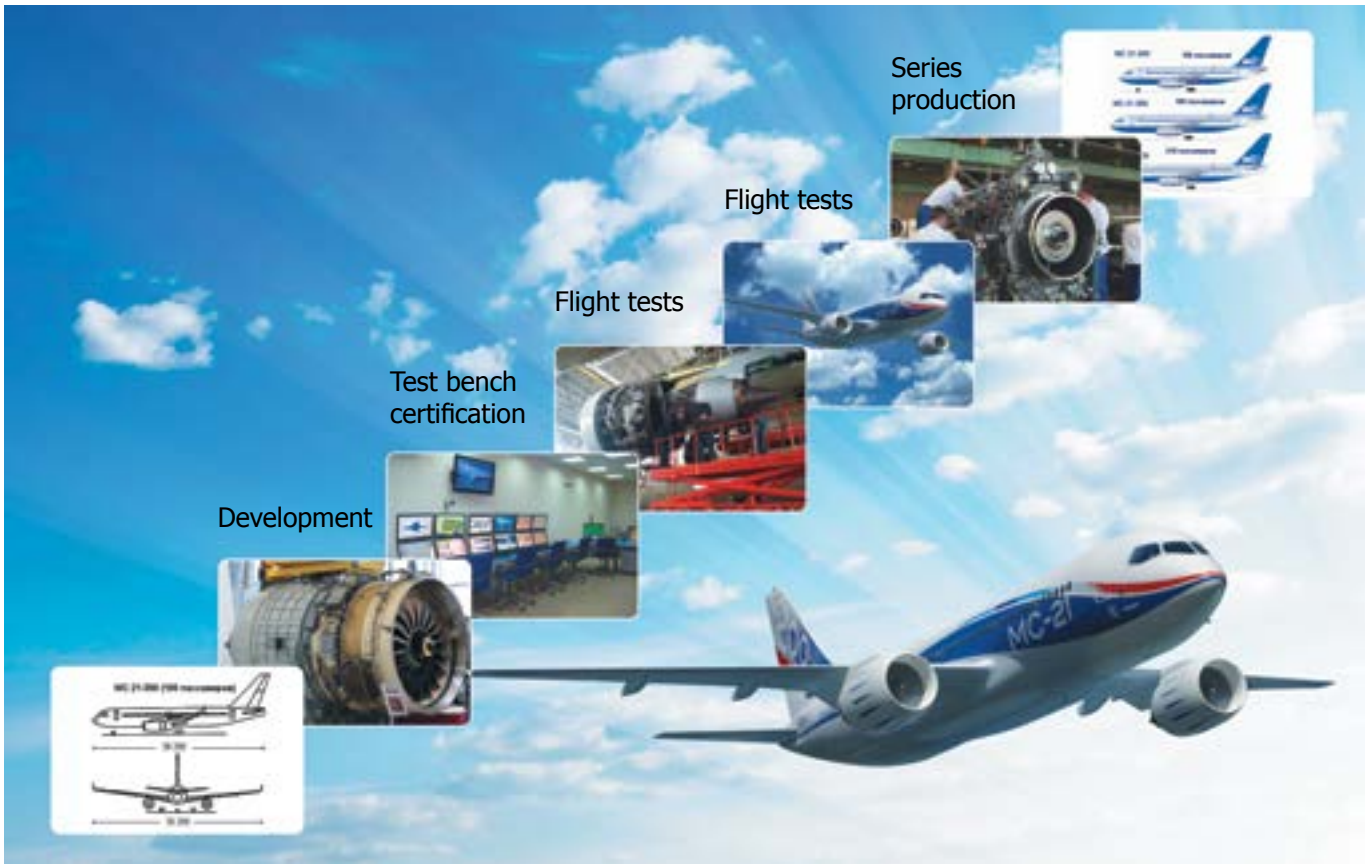
Onboard distributed data acquisition systems (MIC-700, MIC-1150)

Low frequency process parameters (MIC-236)

Specialized subsystems (TCL, video, ACS)

Non-contact measuring systems (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).

At present MERA rapidly develops the areas of onboard measurement systems for flight testing of aircrafts and is able to provide hardware and software solutions for onboard measurements for air, on land or water vehicles testing.

About the company

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
2000	Development and implementation of MIC-TM telemetery systems at Baikonur and Plesetsk space launch facilities
2001	Launch of commercial MIC-300 equipment production
2004	Development of a quality management system and certification for compliance with GOST R ISO 9001-2001
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 OJSC
2015	Upgrade of data acquisition and test control systems of altitude test facilities Ts-4N and Ts-IA of CIAM
2016	Creation of a system for measuring the impact of launch on the site facilities of the Vostochny cosmodrome. Creating MIC-1500 radio telemetry system.
2017	The first experience of the international partnership for the creation of a system.

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 incorporates 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.

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 is 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.

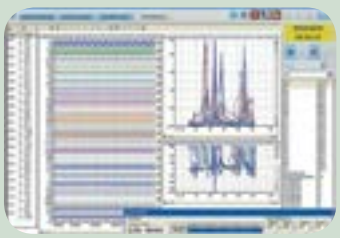
Integrated approach

1 Investigation of an automation object.

2 Elaboration of technical specification meeting the customer's recuirements. Creation of technical design and full set of technical documentation

3 Development and manu-facture of equipment, testing of system components on steadiness to external effects. Primary metrological check. Development of operational documentation.

4 Development of specialized software.



5 Design and manufacture os cross-boxes, signal conditioners. System integration using subcontractor's products.

6 Deployment and complex adjustment.

7 Training the customer's staff.

8 Technical support and assistance.

Certificates

Our quality management system certified for compliance with GOST ISO 9001-2011 (ISO 9001:2008).

ОРГАН ПО СЕРТИФИКАЦИИ СИСТЕМ МЕНЕДЖМЕНТА

РОСТЕСТ-МОСКВА

СЕРТИФИКАТ СООТВЕТСТВИЯ

Выдан ООО «Научно-производственное предприятие «МЕРА»

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НАСТОЯЩИЙ СЕРТИФ

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обслуживанию информаци

измерительно-вы

СООТВЕТСТВУ

ГОСТ ISO 9001-

Выпуск 5. СМК орг

Регистрационный № РОСС RU.ИТ

Дата регистрации 28.02.2017

Руководитель органа по сертифи

систем менеджмента

Эксперт

[On the official letterhead]

FEDERAL SERVICE FOR ACCREDITATION
RUSACCREDITATION

AUTHORITY FOR CERTIFICATION OF MANAGEMENT SYSTEMS
ROSTEST-MOSCOW
CERTIFICATE OF ACCREDITATION NO. ROSS RU.0001.13IT19
FEDERAL SERVICE FOR ACCREDITATION OF THE RUSSIAN FERERATION

CERTIFICATE OF CONFORMITY

Issued to
LLC "Scientific and Production Enterprise "MERA"
2 Kolpakova Str., bldg. 13, Mytishchi, 141002, Moscow Region

THIS IS TO CERTIFY THAT
the quality management system as applied to the development, manufacture and maintenance of information-and-measurement systems and measuring-and-computing systems

COMPLIES WITH THE REQUIREMENTS OF
GOST ISO 9001-2011 (ISO 9001:2008)

Issue 5. QMS has been certified since May 2004

Explanations as to the scope of QMS certification can be obtained through consultations with LLC "SPE "MERA"

Registration No. ROSS RU.IT19.00173

Date of registration: **February 28, 2017** Valid till: **September 15, 2018**

Head of Authority for Certification of Management Systems <Signed> Yu.V. Egorov

Expert <Signed> O.V. Stanitskaya

[Seal: AUTHORITY FOR CERTIFICATION OF MANAGEMENT SYSTEMS ROSTEST-MOSCOW ROSS RU.0001.13IT19]

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