INTRIPLE

**TEMPEST
MEASUREMENT
SYSTEMS**

**ELECTRONIC
WARFARE
EQUIPMENT**

2023

Who we are

INTRIPLE a.s. is a joint stock company founded in 2006, located in Prague, the Czech Republic.

In INTRIPLE we are customer oriented with focus on R&D and small volume production.

Our focus is on state-of-the-art electronics in the area of signal processing and microwaves.

From the very beginning we were involved in R&D projects for communications and defence market in the Czech Republic. A year later we started to work with a major US customer to develop high performance state of the art electronics to be used for chemical analysis. The experience with an overseas business led to intensive foreign cooperation in state-of-the-art electronics. We are now export oriented company but we still keep working on R&D projects in the Czech Republic for defence and security sectors.

Almost from the beginning we worked on projects for the Czech National Tempest Authority under the NBÚ, which has been since 2017 registered under NÚKIB (National Cyber and Information Security Agency). The projects led to development of complete test and measurements systems and solutions in all major areas of TEMPEST. Our background in wireless communications, radars, test and measurement is positively influencing our work in such a multi-disciplinary area as TEMPEST. What our engineers and scientists like is the extremely broad range of problems which are faced in TEMPEST and Electromagnetic Security. The difficulties with low frequencies as low as 100 Hz (ground loops, leakage currents, noise) to microwaves and very wideband signals. Measurements where frequencies, bandwidths and signal levels are changing in orders of magnitude are not required by any other standard. It is a very demanding area but with exciting possibilities. We are always learning and gaining experience but we also share our knowledge with EU and NATO laboratories. Our expertise in TEMPEST brought us new projects and cooperation in the defence and security industry.

TEMPEST is a niche market which we found a good fit for a technology oriented small company as INTRIPLE.

There are three major standardised procedures in TEMPEST which we are focused on

- Facility zoning – SDIP-28/2, IASG 7-02
- Installation – SDIP-29/2, IASG 7-01
- Equipment testing – SDIP-27/2, IASG 7-03

Facility zoning measurement system was our first system developed for the Czech NTA. The first system was further developed to a version designed for specific needs of NATO team to be air transportable around the world.

Installation of secure information systems from the Electromagnetic point of view require not only keeping rules of related best practice guides but also measurement of shielded rooms which are used to protect classified systems. Shielding effectiveness measurement system was developed for needs of the Czech NTA to be air transportable and to minimize transportation costs for measurements on embassies abroad.

After a success with export of the Facility zoning systems and Shielding Effectiveness measurement systems we came with a combined version which is now used by most government and defence organisations within EU and NATO.

Equipment testing is the most demanding area of TEMPEST. To test electronic equipment according to the related classified standards to minimize the risk of leakage of classified information is a difficult task. We are proud that we can work together with major national laboratories in the EU and overseas on improvement of our products and test methods. We are continuously working in this area on the development of better software and hardware to simplify the measurements and to achieve higher speed. We see the growing demand for secure information systems which requires to perform more tests in a shorter time. We have developed unique software and hardware especially for Tempest equipment testing. Our goal is to fully automate measurements for faster production while we also keep in mind needs of the National Tempest Authorities to verify it. Our software supports also products of other vendors – like the matured FSET receiver or the new FSWT from R&S. We appreciate the long-term cooperation with the Czech NTA. It started with development of IZ225 receiver which was used for video rastering and led to development of IZ27B receiver which is now used in laboratories of major EU Tempest producers as EUROTEMPEST, OSPL, SILTEC, SST and is also used by National Tempest Authorities.

We have been delivering our TEMPEST measurement systems to most of EU and NATO countries.

TEMPEST Equipment testing according to SDIP-27/2 and IASG 7-03

We have been developing, producing and supplying measurement equipment for TEMPEST in accordance with the NATO standard SDIP-27/1 since 2011. We have delivered and built new laboratories with custom design, assembly of shielded chamber, equipment installation and configuration. We provide customized solutions according to the national needs, trainings of the operators and long-term technical support.

We provide modernisations and updates of laboratories and laboratory equipment. We are not related to any particular producer; our software supports also test and measurement equipment from other manufacturers. The configurations are open and it is possible to integrate almost any equipment from various vendors. We are able to write drivers for the matured equipment to be used in the updated system if it is required. We are used to integrate matured equipment with GPIB interface to modern Gigabit secured networks. We understand that modern receiver has the functionality of oscilloscope so an extra oscilloscope is no more necessary. But it is good practice to have it connected to the system and be able to move from one technology to the next. We also know that in every laboratory is lot of specific devices to prove that the measurements are correct and the reports are valid.

The TEMPEST Laboratory is not only a high-quality Tempest receiver, oscilloscope and antennas. The integration and further automation of the procedures is important for performing complex tests of the increasingly integrated devices.

Our system for TEMPEST Equipment testing automates the whole process from measuring to documentation. An especially developed software controls switching and turning of antennas, commands the measuring receiver, communicates with external devices like oscilloscopes and generators, provides signal analysis and a lot more. The integrated database software controls the measurement tasks according to test plans and generates reports. Still there is a lot more to do for the Tempest engineer to do than put the Equipment to the chamber. With our solutions we make this job easier.

We understand that every laboratory is unique and has different needs even if they work according to the same standard. We work closely with every customer to deliver solution which is a good fit for the needs and budget. It is possible to do a step-by-step improvements and delivery only the parts which are necessary for the required measurements.

We have developed and offer these devices and components for Tempest Equipment testing.

Hardware:

IZ27B	Wideband TEMPEST Digital Receiver 100 Hz–18 GHz
IZ1027A	Low Noise Active Antenna Set covering 100 Hz–1 GHz
IZ1127C	Active Microwave Antenna 0.65 GHz–11 GHz
IZ1827A	Active Microwave Antenna 1 GHz–18 GHz
IZ727	Magnetic Loop Antenna 100 Hz–500 kHz
IZ229	Dipole Reference Antenna
IZ154B	Antenna System Control Unit and RF Switch
IZ427B	TEMPEST LISN 5 kHz to 10 GHz
IZ337	TEMPEST Turntable
IZ350	Isolation Transformer
IZ324B	TEMPEST IP Camera
IZ330	TEMPEST LAN Switch to control Equipment Under Test
IZ510T/R	Data Diode 10 Gbit/s
IZ1280	Set of TEMPEST Breakout Boxes

IZ287	Subnanosecond Pulse Generator
IZ338	TEMPEST GPIB-LAN Gateway
IZ325	Transient Limiter, DC-1 GHz for LISN
IZ311A	LISN high-pass Filter 5 kHz–1 GHz
IZ311B	LISN high-pass Filter 150 kHz–1 GHz
IZ326	Isolated RF Pick-off Clamp
IZ351	Keystroke Enabler

Software:

IP927	TEMPEST Studio Measurement Software
IP928	TOffice Software
IP930	PC EUT Remote Control Software

IZ27B – Digital TEMPEST Receiver

IZ27B Receiver is specifically designed for tempest measurement according to NATO SDIP-27/2 and EU IASG 07-03 with focus on test automation. The receiver is usually installed in a rack next to the shielded chamber. The receiver has no display and is operated from a computer connected over network. The receiver satisfies SDIP-27 Level A for connection to classified networks. Due to very good shielding of the receiver it is not required to install the receiver in a special shielded room.

- High repeatability due to digital signal processing
- Built-in RF generator
- Built-in trigger generator
- High sensitivity preamplifiers
- High selectivity preselection filters
- Gaussian and Flat filters
- Automatic self-calibration and diagnostic
- Powerful digital signal processing in the FPGA
- High capacity acquisition memory
- High speed LAN and fibre optic interfaces
- AM and FM demodulations required for TEMPEST
- USB and LSB demodulations for audio tests
- EMI measurement according to MIL-STD 461G
- Video and IF outputs
- Resistance to vibrations
- Tempest level EMC/EMI Shielding

Parameter		Value
Frequency range		100 Hz to 18 GHz
Frequency resolution		<0.1 Hz
RF Inputs		INPUT A and INPUT B, 50 Ω N connectors
Preselector		22 low pass filters
		14 high pass filters
		50 MHz wide YIG tracking filter 2 GHz–18 GHz
		500 MHz wide YIG tracking filter 6 GHz–18 GHz
Demodulation bandwidth		1 Hz to 550 MHz (1.8 GHz without preselection)
Filter bandwidth steps		At least 1-2-3-4-5-6-7-8-9
Noise figure		<4 dB up to 3 GHz, <7 dB up to 18 GHz
Minimum detectable signal		-170 dBm (1 Hz bandwidth, 1 GHz frequency)
Maximum input power range		30 dBm (1W)
Input attenuator range		80 dB in 1dB steps
ADC resolution		16 bits (up to 225 MS/s), 12 bits (up to 3.6 GS/s)
ADC sampling rate		Programmable up to 3.6 GS/s
Acquisition memory		4 GB
Phase and noise limited ADC range		>150 dB/Hz
Amplitude measurement range		>100 dB (100 kHz bandwidth)
Calibration generator	Frequency range:	100 Hz to 20 GHz
	Frequency resolution	<0.1 Hz
	RF level:	-100 dBm to 0 dBm
	RF level resolution	0.1 dB
	Phase noise	(<-120 dBc/Hz at 10 kHz offset on 10 GHz)
Reference frequency		10 MHz, <0.1 ppm frequency stability
Data Interfaces		Ethernet 10/100/1000 Mbits/s
		Fibre optic 1 Gbits/s
IF output		Analogue output of 1.25 GS/s DAC, Bandwidth up to 400 MHz (optional)
VIDEO output		Analogue output of 1.25 GS/s DAC, Bandwidth up to 400 MHz (optional)
Noise Source Power Supply		+28 V
Operating temperature		0 °C to +55 °C
Power Line supply		AC 110 V–230 V/50 Hz–60 Hz
Power consumption		< 200 W
Dimensions		0.474 m × 0.429 m × 0.179 m (4U height 19")
Weight		< 35 kg
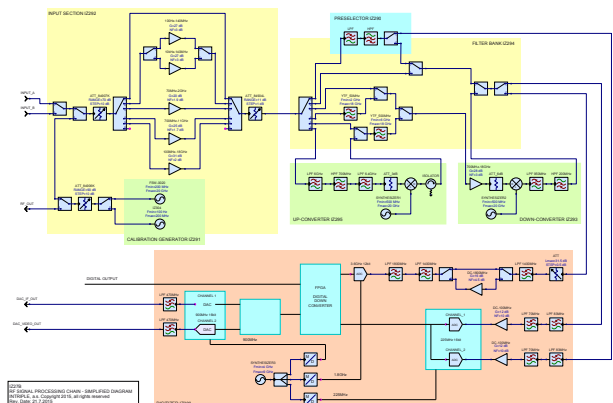
IZ1027A – Antenna Set 100 Hz to 1 GHz

The antenna set IZ1027A consists of a polarisation rotator with an electronic control and three active high sensitivity antennas to cover frequency range 100 Hz–1 GHz. The antenna set is designed for high sensitivity Level-A measurements of radiated emissions according to NATO and EU Tempest standards. Antennas are controlled remotely to change polarisation, preamplifiers or filters in an automated system.

The set consists of

- **IZ700** – Rotator with an electronic control
- **IZ701** – Vertical active rod antenna 100 Hz up to 50 MHz
- **IZ702** – Biconical active antenna 20 MHz up to 200 MHz
- **IZ703** – Dipole active antenna 200 MHz up to 1000 MHz
- **IZ308** – Power distribution to antennas IZ701, IZ702, IZ703 and rotator.

Control unit IZ154B is required for antenna operation.

IZ1127C – Active Microwave Antenna

IZ1127C is a dual polarisation active antenna with build in low noise preamplifiers. The quad ridge antenna design is optimized for TEMPEST Level A measurements. Preamplifiers are connected directly to the antenna outputs to minimize losses and keep maximum sensitivity. Outputs from preamplifiers are selected by coaxial relay. Gain of the preamplifiers is approx. 25 dB. Noise figure of preamplifiers is between 1.5 and 1.7 dB. Power consumption is less than 450 mA from 24 V power supply. Switching of the polarization is done by IZ154B Control Unit or IZ155B Antenna Controller, which also ensures power supply for the antenna.

- High suppression of cross polarized signals
- Operating temperature range from 0 °C to +55 °C
- Aperture size 180 mm × 180 mm

IZ1127C Features

- Ultra-high sensitivity dual polarized directional antenna
- Wide frequency range from 0.65 GHz up to 11 GHz
- High gain directional antenna

IZ1827A – Active Microwave Antenna

IZ1827A is a dual polarised active antenna up to 18 GHz with build in low noise preamplifier for each polarization. The preamplifiers are connected directly to antenna output to minimize losses. Gain of the preamplifiers is approx. 31 dB. Noise figure of preamplifiers is between 2 and 2.5 dB. Switching of the polarization is done by IZ154B Control Unit or IZ155B Antenna Controller, which also ensures power supply for the antenna.

IZ1827A Features

- Frequency range 1–18 GHz
- Dual polarized directional antenna with high sensitivity
- Operating temparture 0 °C to +55 °C
- Aperture size 170 × 170 mm

IZ727 – Magnetic Loop Antenna

The IZ727 is magnetic loop antenna especially optimized for TEMPEST measurements of magnetic fields in 100 Hz to 500 kHz frequency range. The IZ727 antenna fulfils criteria of the most demanding standards SDIP-27/2 and IASG 07-03 for radiated emissions and emanations. It can also be used for general tests in EMI and EMC measurements. The B version has a symmetrical output which is used with balanced preamplifiers or transformers placed out of the chamber for suppression of ground loop currents and interferences.

- IZ727A with N female connector
- IZ727B with Twinax female connector
- Dimensions 78 cm × 70 cm × 21 cm
- Weight 2.3 kg

IZ727 Features

- Frequency range 100 Hz up to 500 kHz
- 70 cm diameter shielded loop
- Passive design – can be used as transmitting
- Sensitivity -30 dBμA/m/Hz at 1 kHz with 0 dB NF
- Sensitivity -73 dBμA/m/Hz at 500 kHz with 0 dB NF

IZ229 – Dipole Reference Antenna

The IZ229 is a dipole antenna working in the frequency range from below 5 MHz up to 3 GHz. The antenna behaves as an electrically short dipole on low frequencies. It is used as a transmitting antenna inside an anechoic chamber for validation of receiving antennas or whole chain up to a receiver. IZ229 antennas are also used for measurement of small shielded enclosures as receiving and transmitting antennas.

- Wide frequency range
- Small size and lightweight
- Built-in attenuator 5 dB, 1W to keep impedance matching
- Built-in balun to keep electrical symmetry
- Impedance matching is better than -10 dB up to 2 GHz
- Good VSWR even at kHz frequencies

IZ229 Features

- Optimised for mobile measurement system of shielding effectiveness
- Optimised to be placed in a reverberation, anechoic or shielded chamber
- No degradation of signal from power amplifier or generator due to reflections
- Linear polarization (vertical or horizontal placement)

IZ154B – Antenna System Control Unit and RF Switch

The IZ154B is RF Switch especially designed for remote control of IZ1027A Antenna Set and of IZ1127C Active Microwave Antenna. The IZ154B consists of RF coaxial relays (DC – 18 GHz), power supply outputs for active antennas and other devices (e.g. IZ324, IZ330, IZ351) and LAN switch. IZ154B satisfies NATO SDIP-27 Level A for connection to classified networks.

- Two general purpose DC outputs 24 V/0.5 A (e.g. IZ324, IZ330)
- Two fibre optic outputs to control R&S antennas
- Output for Keystroke enabler IZ351
- Web browser control

IZ154B Features

- 11 RF input connectors
- 2 RF output connectors
- Tempest level EMC/EMI Shielding
- General-purpose relay configurations
- Mains supply 110 V–230 V AC / 50–60 Hz
- Two LAN interfaces and four fibre optic interfaces 1Gbit/s
- Resistance to vibrations
- Power supply outputs for active antennas

IZ427B – Active TEMPEST LISN

High sensitivity active PLISN for measurement of conducted emissions according to SDIP-27/2. The PLISN is designed for the most demanding measurements on power line networks to extend the frequency range to microwave band up to 10 GHz. The IZ427 satisfies NATO SDIP-27 Level A for connection to classified networks.

- DUT supply is circuit breaker protected
- Maximum continuous DUT current consumptions 10 A (AC/DC)
- Fibre optic interface for remote control over TCP/IP protocol
- Web browser control

IZ427 Features

- Ultra-wide frequency coverage from 5 kHz up to 10 GHz
- Built-in preselector, limiters, preamplifiers and electromechanical attenuators
- Two measurement channels, 50 Ω N-type coaxial connectors
- Single output for a test receiver, 50 Ω N-type coaxial connector
- Mains AC supply of the electronics 110 V–230 V/50 Hz–60 Hz
- Independent DUT supply DC or AC up to 250 V rms, DC up to 60 Hz

IZ420 – Plug adapter

IZ428 – Socket adapter

These adapters are suitable for application of power line filter measurement or together with LISN for connecting of EUT during Tempest measurement. Each adapter has two RF N-type connectors for each line connection.

IZ350 – Isolation Transformer

The IZ350 is important for audio and low frequency TEMPEST measurements to minimize influence of ground loops and currents from power line network. IZ350 contains three independent 230 V transformers, active cooling, overheating protection and SFP interface for remote control. Each transformer is protected against overcurrent and can be remotely turned ON/OFF through the web. The IZ350 is designed primarily for TEMPEST measurement laboratories and satisfies NATO SDIP-27 Level A for connection to classified networks.

IZ350 Features

- Output 2.3 kVA (shielded chamber)
- Output 400 VA (measurement receiver)
- Output 100 VA (RF switch)
- Separate input for the 2.3 kVA transformer
- Two-pole circuit breaker for each output
- Remote ON/OFF switching of each transformer
- Active cooling
- Over temperature protection
- Two fibre optic ports, SFP compatible, 1 Gbit/s
- WEB interface
- Indication LEDs on the front panel

IZ337 – Turntable

The turntable is designed for the TEMPEST measurements in the anechoic chamber according to SDIP-27/2 standard. Dimensions are 2×1×0.85 m. Diameter of the rotating plate is 0.9 m. Fibre optic control interface and DC power supply are used to minimize electromagnetic radiation.

Main features: Rotation range ±180°; SCPI commands for automated control; Two fiber optic ports SFP compatible, 1Gbit/s, Position sensor.

IZ324B – TEMPEST IP Camera

IZ324B is designed for installation inside anechoic chamber for TEMPEST measurement. The extremely low electromagnetic radiation is a must for sensitive TEMPEST measurements. The camera also satisfies NATO SDIP-27 Level A for connection to classified networks. Data connection is made through the SFP module. Video stream, snapshots and settings of the camera are accessible via a web page. The camera supports lenses with DC auto iris control. Fibre optic interface and DC power supply are used to minimize electromagnetic radiation. The power supply connection is well filtered and shielded so the switch mode power supply adaptor can be placed outside of the shielded chamber.

- Video fame rate 25 fps
- DC auto iris control

IZ324B Features

- Resolution 1920×1080 pixels

IZ351 – Keystroke enabler

During TEMPEST measurement it is usually required to put the measured PC into real operation mode – writing on the keyboard. Keystroke enabler is an artificial finger controlled by IZ154B (mandatory for operation) and by software IP927 to perform pressing of any button of the keyboard in requested period during measurement.

IZ326 – Pick-Off Clamp

IZ326 is a passive RF current transformer serving for measurements of high frequency currents flowing through cables and fortuitous conductors such as pipes or mechanical constructions. The IZ326 is specifically designed for TEMPEST to permit tests on busbar under high voltage. Frequency range is from 1MHz to 400MHz with a flat response from 80MHz to 380MHz.

- Complete electrical isolation (measurements on live power lines)
- Window diameter 39 mm

IZ326 Features

- Transfer impedance 20 dBΩ at 100 MHz
- Sensitivity decreases with 20 dB/decade below 20 MHz
- Isolation voltage 500 V
- DC current 400 A max.
- CW RF current 60 A max.
- Pulse RF current 800 A at 0.001 duty
- SMA male connector

IZ330 – TEMPEST LAN Switch for Sensitive Environment

IZ330 represents metallic Gigabit LAN to fibre optic cable interface for use inside anechoic chambers. It was developed primarily for connection of EUT with metallic Ethernet to control system placed outside of the chamber. The IZ330 is compliant to MIL-STD 461G and NATO SDIP-27/2 Level A standard for connection to classified networks. The IZ330 is configurable by SCPI commands and web page.

Main features: Power supply +15V to +25V; Two 10/100/1000 BASE-T, RJ-45 connectors; Two SFP 1000BASE-X or 100BASE-X Modules; 1M Packet Buffer; Support IPv4 and IPv6 operation, Web browser control

IZ338 – TEMPEST GPIB-LAN Gateway

IZ338 represents GPIB instrument bus to fibre optic LAN interface. It was developed primarily for connection of test and measurement equipment to a standard Ethernet network in the laboratory. The IZ338 is compliant NATO SDIP-27/2 Level A standard for connection to classified networks. The gateway also acts like a firewall for connection to classified network.

Main features: IEEE 488.2, IEC 60488 compatible; Power supply by USB interface; WEB interface for user friendly setup; Fibre optic 1000Base-X or 100Base-X Modules; Support IPv4, VXI-11

IZ311A – LISN high-pass Filter 5 kHz–1 GHz

The IZ311A is designed for Tempest measurements of conducted emissions on power lines. The filter is improving suppression of low frequencies below 5 kHz in connection with some PLISNs. Very low insertion loss <0.75 dB. Suppression of fundamental frequency 85 dB (50–60 Hz). Maximum operating voltage is 700 V rms.

IZ311B – LISN high-pass Filter 150 kHz–1 GHz

The IZ311B is designed for Tempest easurements of conducted emissions on power lines. The filter is improving suppression of low frequencies below 150 kHz in connection with some PLISNs. The insertion loss is <1 dB. Suppression of fundamental frequency is 105 dB (50–60 Hz). Maximum operating voltage is 700 V rms.

IZ325 – Transient Limiter

The wideband limiter was developed for protection of sensitive receivers in measurements with PLISNs. Transient voltage spikes produced during heater regulation in laser printers are one of the highest. The transient voltage in connection with PLISN can be several kV high. The transient limiter attenuates such kV spikes to hundreds of millivolts. It also protects receiver against general too strong CW and impulse signals. It is important to use a high-pass filter in front of the limiter for some PLISNs to suppress 50/60 Hz fundamental power line frequency.

- Low insertion loss – 0.7 dB maximum
- Excellent return loss (-19 dB)
- Limitation above 0 dBm
- Maximum CW power 150 W @ 50 Ω
- Maximum peak current 50 A @ 100 µs
- Versions A with N connector, B with BNC

IZ325 Features

- Wide frequency range DC–1 GHz
- Input and output impedance 50 Ω

IZ510T/R – Data Diode 10 Gbit/s

Data diode IZ510T/R enables safe unidirectional transfer of data from unclassified to classified network. Data connection in the local network segment can be realized by 10 Gbit/s fibre optic interface or metallic LAN 1 Gbit/s. Save connection between network segments is ensured by 10 Gbit/s transmitter module in unclassified part IZ510T and receiver module in classified part IZ510R. Received data can be recorded to internal M.2 NVMe SSD with 2.5 TB capacity before being sent to other segments of the classified network. Information about unsuccessful data transfer can be sent by optional return channel. Internal GNSS receiver in unclassified part of data diode IZ510T enables time synchronization. The receiver part IZ510R is time synchronized to the transmitter part IZ510T.

IZ510T/R Features

- 10 Gbit/s fibre interconnection (BLACK to RED)
- One 10 Gbit/s transmit only port (unclassified part IZ510T) and one 10 Gbit/s receive only port (classified part IZ510R) for save unidirectional data transfer
- Three fibre optic SFP modules 10 Gbit/s
- Metallic LAN 1Gbit/s
- USB 3.1 interface (optional)
- Internal GNSS receiver for time synchronization in unclassified part
- Internal M.2 NVMe SSD with 2.5 TB capacity
- Optional return channel with communication protocol according to customer request (RS-232, SPI, I2C, pin signalization)
- WEB interface for user friendly setup
- Power supply 110-230 V AC, 50/60 Hz
- Dimensions 330 mm x 215 mm x 43 mm

IZ1280 – Set of TEMPEST Breakout Boxes

TEMPEST breakout boxes are adapters which can be used for easier find and identify of signal in the measured spectrum by using a correlation method. Coupled signals from the data lines lead to SMA connectors and can be directly connected to the input of the measurement receiver. The boxes are well shielded to be able to be used in an anechoic chamber.

The set consists of

- IZ284 – USB 3.1 detector
- IZ285 – USB 2.0 detector
- IZ286 – LAN detector

IZ287 – Subnanosecond Pulse Generator

General purpose very narrow impulse generator used for evaluation and validation of measurement equipment for TEMPEST and EMC. Test of receiver chain bandwidth. Measurement of time delays. Measurement of impulse response characteristics (receivers, oscilloscopes).

IZ287 Features

- Pulse width < 300 ps
- Pulse period 10 ms
- Pulse amplitude 750 mV
- Power supply 5V DC, USB-C connector

IP927 – TEMPEST Studio

The Tempest Studio software has been designed for Equipment testing according to NATO SDIP-27/2 and EU IASG-07-03 standards. The software controls Tempest receiver, antennas, LISN, turntable, generators, oscilloscope, key stroke enabler and EUT to automate and simplify everyday tasks of equipment testing. The full package contains not only the core sweep functionality with automatic switching of antennas and control of their polarisation but supports also various types of analysing tools to identify and classify emanations. The integrated template editor enables to enter test parameters and measurement chain settings. The SDIP module is used to prepare test plans (including BOB) according to RED signal parameters. The SDIP module is available only for EU and NATO member countries in cooperation with NTA. IP927 is designed for 64-bit Windows 10/11.

- Software for automated equipment testing
- Control of the RF Switch IZ154B, Antenna Set IZ1027A and Microwave Antenna IZ1127C, LISN IZ427B
- Transducer factors and cable loss inserted into the software
- Measurement template editor
- Swept measurements including fast STFFT and Real Time Spectrum analysis with Waterfall
- Time domain measurements (colour scope) and Correlation analysis
- Rastering, Histogram, IQ data analysis and recording
- Connection to SQL database (IP928 Tempest Office), connection to EUT controller (IP930)
- Support of the external generators, oscilloscopes and power meters
- Supported Tempest receivers: IZ27B, IZ225, FSET, FSWT
- Supported Monitoring receiver IZ245
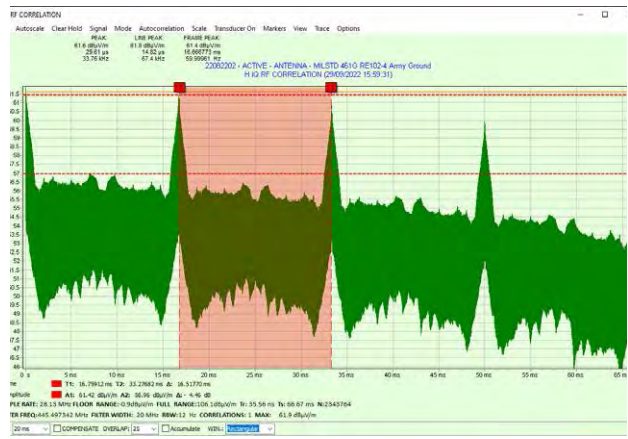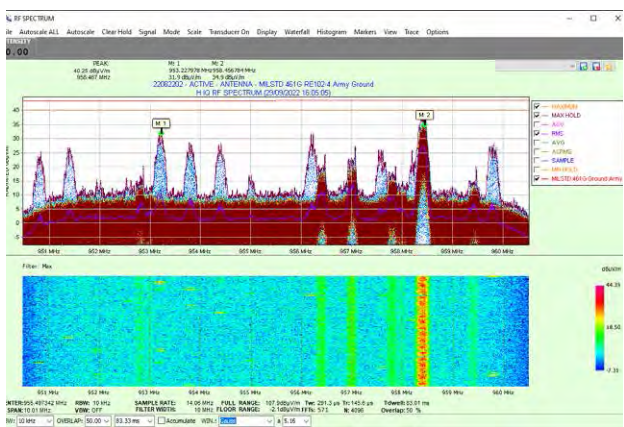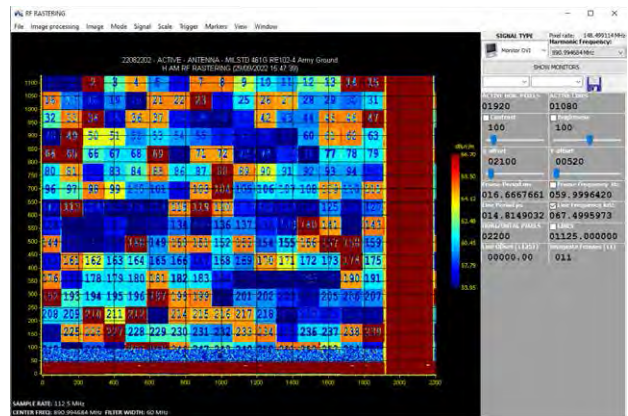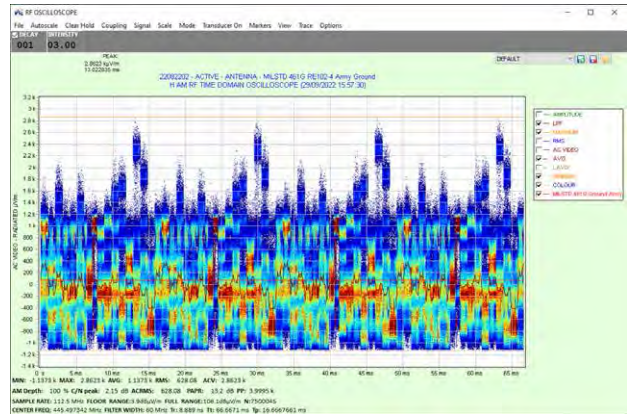
IP928 – TEMPEST Office

The Tempest Office software is used to organize measurements in the TEMPEST laboratory, to prepare test plans and command IP927 measurement application to conducts measurements according to test plans and finally generate reports. It is based on SQL database and can be operated in a LAN for multiple test cells. Each test cell can have an independent setup and use different hardware. IP928 is designed for Windows 10/11.
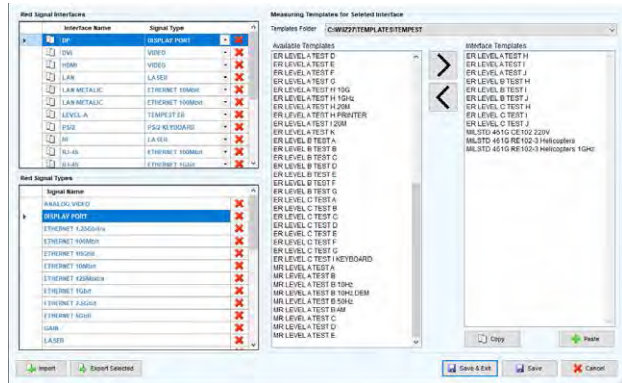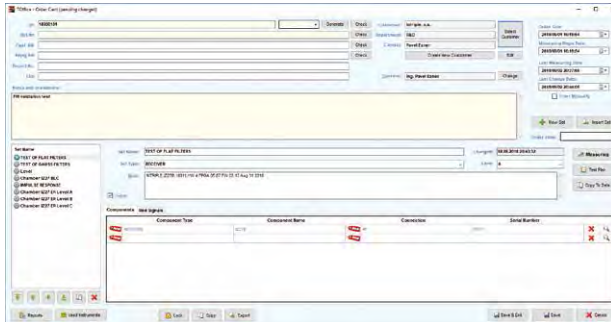
IP930 – Equipment Under Test Remote Controller

IP930 is test pattern generating software package to evaluate Windows based computers and peripherals. The software runs from a USB stick on the evaluated computer and communicates over LAN with the operator's computer. Tested interfaces are Monitors, Printers, USB, Serial Ports, LAN and Audio. The software can be also operated locally without network connection. However main application is in remote operation. It is used for fully automated tests in connection with IP927 Tempest Studio. IP930 is designed for Windows 7, 8 and 10/11.
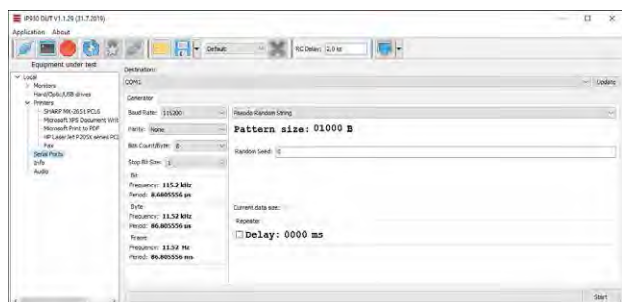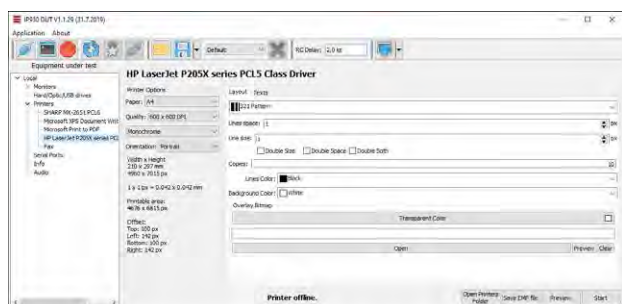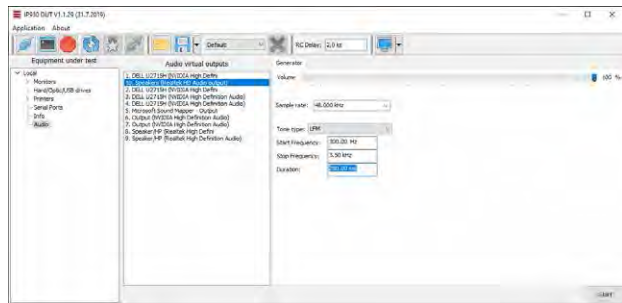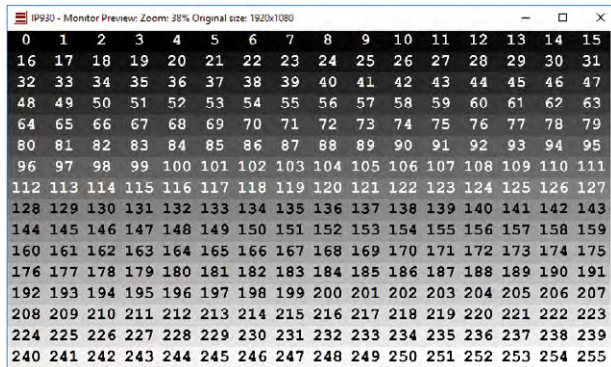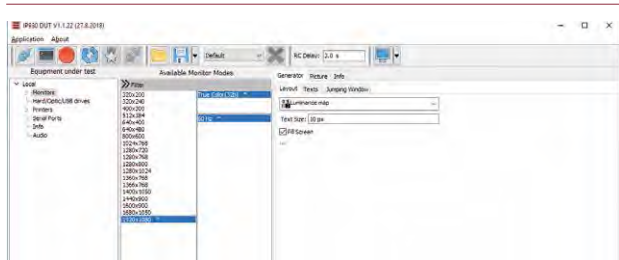
IZ906806 – Zoning and Shielding Measurement System

System for facility zoning measurement has been developed as ruggedized system to resist influence of environmental conditions wherever is needed to use it. Battery operation, very fast setup of the measuring chain and simple user interface are the key factors making facility zoning system very powerful. The system is compliant to relevant military standards and is easily upgradable to new requirements. The zoning system can be upgraded by available options to Shielding Effectiveness measurement up to 18 GHz.

IZ906806 Facility Zoning system

Standard frequency range of the system is from 10 MHz to 3 GHz and fulfils requirement of latest SDIP-28/2 and IASG 7-01 standards. The dynamic range is by 30 dB higher than is required by the standard. Special omni-directional antennas supplied with the system are easy demountable and are stored in a transit case. Sensitive receiver input is protected by limiter and 10 dB attenuator against ESD and accidental touch with the transmitter. Measurement application runs on the supplied laptop at receiver side. Transmitter is fully controlled by software application at receiver´s laptop via Telemetry radio signal. If no RF telemetry communication possible, then time synchronization mode is available. System is ready to further upgrades if new version of standards will be issued or according national needs.

Extension to Shielding Effectiveness Measurement

One of below mentioned Options extends IZ906806 by additional measuring software and antennas to perform Shielding Effectiveness measurement up to 18 GHz. The system was developed for security applications according to SDIP-29/2, IASG 07-02, IEEE Std 299, EN 50147-1, MIL-STD 188-125.

Synchronization of the transmitter and receiver during measurement can be done via optical fibre or if not possible to setup direct optical link then time synchronization mode can be selected.

Option F02 – Extension by Shielding Effectiveness measurement 1 kHz–18 GHz
Includes:
• Magnetic Field Loop antennas 1 kHz–50 MHz
• Microwave antenna 2–18 GHz with Generator 1–18 GHz
• Microwave antenna 2–18 GHz with Down Converter 1–18 GHz

Option F03 – Extension by Shielding Effectiveness measurement 1 kHz–18 GHz
Includes:
• Magnetic Field Loop antennas 1 kHz–50 MHz
• Microwave antenna 1–18 GHz with Generator 1–18 GHz
• Microwave antenna 1–18 GHz with Down Converter 1–18 GHz

Option F04 – Extension by Shielding Effectiveness measurement 1 kHz–3 GHz
Includes:
• Magnetic Field Loop antennas 1 kHz–50 MHz

Option H01 – Ancillary Transit Case
• Magnetic StormCase iM2720 including foam filling for Receiving or Transmitting part

Option H02 – IZ131 Receiving Directional Antenna 10 MHz–3 GHz

Option H03 – IZ129 Passive Biconical Antenna 20 MHz–1 GHz
• Set of two Biconical antennas for Shielding Effectiveness Measurement

Each Option is packed in plastic transit case for easy transport.
The IZ906806 system can be extended by additional software IP982 QScan for spectrum scanning and IP983 for Tempest rastering measurement.
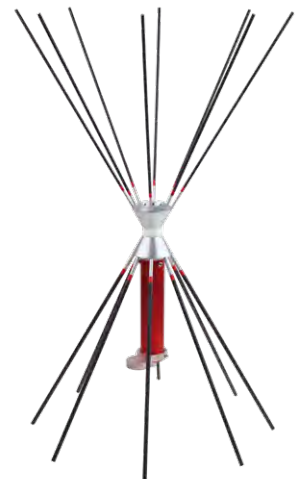
IZ960 – Shielding Effectiveness Measurement System

Portable conformance test system for measurement of Shielding Effectiveness of rooms and chambers in various locations e.g. at military facilities and embassies. Wide frequency range 10 MHz to 3 GHz (optionally up to 18 GHz) is covering requirements of Tempest standards SDIP-29, IEEE Std 299-1997, EN 50147-1, IASG 07-01. IZ960 is based on Windows application software IP960 and IP961 controlling transmitter and receiver side including evaluation of the measurement.

System description

Transmitting part is formed by High Power Generator IZ240 with an active omni-directional antenna IZ126-A03-38 on carbon tripod. Receiver part is formed by receiver IZ225 and active receiving antenna IZ126-A03-28 placed on carbon tripod as well. System offers two synchronization modes according user needs – via optical fibre or time synchronization mode can be selected. Time synchronization allows measurement without direct connection of transmitter and receiver.

Standard frequency range of IZ960 is from 10 MHz to 3 GHz, can be extended up to 18 GHz by these Options:

Option F02 – Shielding Measurement System 1 kHz–18 GHz
Includes:
• Magnetic Field Loop antennas 1kHz–50 MHz
• Microwave antenna 2–18 GHz with Generator 1–18 GHz
• Microwave antenna 2–18 GHz with Down Converter 1–18 GHz

Option F03 – Shielding Measurement System 1 kHz–18 GHz
Includes:
• Magnetic Field Loop antennas 1kHz–50 MHz
• Microwave antenna 1–18 GHz with Generator 1–18 GHz
• Microwave antenna 1–18 GHz with Down Converter 1–18 GHz

Option H03 – IZ129 Passive Biconical Antenna 20 MHz – 1 GHz
• Set of two Biconical antennas for Shielding Effectiveness Measurement

Each Option is packed in plastic transit case for easy transport.

IZ225 – Digital Receiver

The IZ225 receiver has software defined radio architecture which provides two modes – receiver and scanner. In the receiver mode it is used for signal analysis – swept spectrum measurements, demodulation, signal capturing and streaming. In the scanner mode it continuously scans frequency spectrum in spectrum monitoring applications. The scanning speed is extremely high – it can be more than 100 GHz/s with frequency resolution 12.5 kHz, which means that a scan in 1 GHz range is updated every 10 ms. The receiver IZ225 is supported by Windows application software and can be connected to the system by metallic LAN or fibre optic 1 Gbit/s.

Standard frequency range 1 kHz – 3 GHz can be extended by Microwave Down Converter IZ255B to the frequency range up to 18 GHz.

IZ225 Features

- Broadband 1 kHz to 3 GHz
- High sensitivity preamplifier
- High stability reference oscillator
- Wide band – 40 MHz instantaneous bandwidth
- Fibre optic and metallic LAN interfaces
- Low power consumption for long time operation
- AM, FM, SSB demodulations
- Space-saving system integration due to small dimensions
- Powerful digital signal processing in FPGA
- Supported in IP927, IP982, IP983, AKRS, SPECON

External option:

- IZ255B - Microwave Down Converter up to 18 GHz

Parameter	Value	
Frequency range	1 kHz to 3 GHz	
RF inputs	One INPUT, 50 Ω SMA female connector	
Noise Figure with LNA	4 dB (10 MHz to 1 GHz) 8 dB <3 GHz	
Noise Figure without LNA	12 dB < 1 GHz 16 dB < 3 GHz	
IF spectrum span	2 kHz to 40 MHz	
ADC range	16 bits	
Sensitivity (filter 3 kHz)	1 MHz to 1 GHz	1 GHz to 3 GHz
	0.2 uV	0.25 uV
IP3	with LNA	without LNA
	-8 dBm	+3dBm
Demodulation bandwidth	50 Hz to 40 MHz	
LAN throughput	950 Mbit/s	
IF spectrum FFT resolution	1 Hz up to 100 kHz	
Scan speed	>100 GHz/s with frequency resolution 12.5 kHz	
Frequency stability	0.2 ppm + 0.5 ppm/year	
IF frequencies (for input frequency above 30 MHz)	1st IF 4 GHz 2nd IF 140 MHz	
1st IF stop band selectivity	>100 dB	
2nd IF stop band selectivity	>100 dB	
Parasitic Image reception suppression	8.03 GHz–12 GHz >100 dB	
1st local oscillator range	4 GHz–7 GHz	
1st local oscillator leakage	<-100 dBm	
ADC sampling frequency	programmable up to 125 MHz	
Fixed input attenuator	0 dB/20 dB, 1W, relay control	
1st input attenuator	0.5 dB step, 0 dB to 31.5 dB	
LAN interfaces	Ethernet 10/100/1000 Mbit/s	
	Fibre optic 1 Gbit/s	
LAN throughput	950 Mbit/s	
Operating temperature	-20 °C to +55 °C	
Power supply	12–28 V DC	
Power consumption	Depending on signal processing, Maximum: 30 W, standby: 12 W	
Dimensions	0.238 m × 0.158 m × 0.053 m	
Weight	<2.4 kg	

IZ245 – Monitoring Receiver

The IZ245 receiver has software defined radio architecture based on FPGA. IZ245 can be used as a recording receiver, frequency scanner with scanning speed of 300 GHz/s and with extension modules as a Direction Finder and Responsive Jammer. Receiver offers analysis bandwidth of up to 80 MHz. IF preselection filters of various bandwidths are used to ensure high selectivity. Input of the receiver includes preselector to achieve excellent dynamic range with good sensitivity. Received IQ signals can be recorded to a removable internal fast NVMe disc drive with 2.5 TB capacity. Optical LAN interface together with hardware implemented TCP offers capability of 10 Gbit/s data transfer. VITA 49 protocol is supported for integration into large SIGINT systems. High stability reference oscillator can be disciplined by GPS through internal civilian GNSS receiver or external 1PPS signal. Built-in DAC with frequency range up to 6 GHz can be used as exciter for power amplifier to create responsive jammer. IQ signals stored on the SSD can be used as modulation signals for intelligent jamming. Direction finder antenna system can be controlled from the receiver to form a single channel direction finder. The receiver can be used as one of sensors for TDOA geolocation SIGINT system.

Reciever variants

- IZ245 Monitoring Receiver
- IZ245J Follower/Responsive Jammer
- IZ245F Direction Finder

IZ245 Features

- Frequency range up to 8 GHz
- High sensitivity preamplifier
- Tuneable preselector with bypass functionality
- High stability reference oscillator with ability to synchronize to GPS 1PPS
- IF preselection filters 500 kHz, 10 MHz, 50 MHz and 80 MHz
- RF input protected with power limiter up to 30 W
- Built-in exciter 10 MHz – 6 GHz, output power up to 0 dBm
- Built-in civilian multi-standard GNSS receiver
- Connector for external GNSS receiver
- AUX connector for extension modules
- Built-in removable M.2 NVMe SSD for IQ recording
- Mini SAS connectors for external HDD for IQ recording
- Mil Std connectors (power supply, external GNSS, LAN, AUX)
- Fibre optic 10 Gbit/s, 1 Gbit/s and metallic LAN interfaces
- OLED display 3.2"
- Custom digital signal processing blocks for special applications
- Supported in IP927, IP982, IP983 applications

| Parameter	Value
Frequency range	100 kHz to 8 GHz
RF Inputs	TNC connector, 50 Ω, max 25V DC
Gain control	AGC, MGC, AGC+M
Tuning step	1 Hz
Tuneable preselector	20 MHz to 8 GHz
Noise figure (LNA OFF)	< 12 dB, 20 MHz to 70 MHz
	< 16 dB, 70 MHz to 2 GHz
	< 19 dB, 2 GHz to 4 GHz
	< 23 dB, 4 GHz to 5.2 GHz
	< 25 dB, 7.4 GHz to 8 GHz
Noise figure (LNA ON)	< 7 dB, 20 MHz to 70 MHz
	< 5 dB, 70 MHz to 1 GHz
	< 7 dB, 1 GHz to 2 GHz
	< 9 dB, 2 GHz to 6 GHz
	< 11 dB, 6 GHz to 7 GHz
	< 15 dB, 7 GHz to 8 GHz
Sensitivity (3 kHz BW, 10 dB S/N, LNA ON)	0.17 µV, 20 MHz to 70 MHz
	0.14 µV, 70 MHz to 1 GHz
	0.17 µV dB, 1 GHz to 2 GHz
	0.22 µV, 2 GHz to 6 GHz
	0.27 µV, 6 GHz to 7 GHz
	0.44 µV, 7 GHz to 8 GHz
Number of channels	Up to 20 (option) narrowband, 1 wideband
Bandwidth of channels	narrowband 5 kHz to 400 kHz, wideband up to 80 MHz
Audio demodulation	CW, AM, FM, USB, LSB, ISB
Demodulation bandwidth	50 Hz to 80 MHz
A/D convertor resolution	16 bits
FFT resolution	1 Hz to 1 MHz
Scan speed	>100 GHz/s at resolution 12.5 kHz
	>300 GHz/s at resolution 50 kHz
Frequency stability	± 5 ppb ± 50 ppb/year
1st if frequency	4140 MHz / 2140 MHz, Bandwidth 80 MHz, selectivity >100 dB
2nd if frequency	140 MHz, Bandwidth 500 kHz, 10 MHz, 50 MHz and 80 MHz, selectivity >100 dB
Image frequency rejection	>100 dB
1st local oscilator range	2.21 GHz – 12.14 GHz
ADC Sampling frequency	Programmable up to 230 MHz
Fixed Input attenuator	0 dB, 10 dB, 20 dB, max 2 W
Variable input attenuator	0.25 dB step, 0 dB to 31.75 dB
Maximum input power	Uncompressed up to 13 dBm, Max incident power 30 W CW
Built in IQ exciter	10 MHz to 6 GHz, 0 dBm max, 6 channels
LAN interfaces	Ethernet 10/100/1000 Mbit/s
	Fibre optic 10 Gbit/s
Operating temperature	-20°C to +55°C
Power supply	10 – 30 VDC, overcurrent protection, overvoltage protection up to 250 V
Power consumption	70 W max.
Dimensions	360 mm x 205 mm x 80 mm
Weight	5.5 kg

IP983 – TEMPEST Rastering Software

The Tempest Rastering software is developed for visualisation of emanations from computer monitors, but can be used also for printers and document scanners. The software is used by Tempest laboratories for visual inspection of detected emanations extending capabilities of previous generations of tempest receivers. The small size of the IZ225 receiver makes it very popular for Tempest attack demonstrations. Together with a small laptop and a simple antenna it makes a lightweight but powerful kit. The Tempest raster software application runs under Microsoft Windows in connection with the receivers IZ225 or IZ245.

It is often used with built-in receiver of the Zoning and Shielding measurement systems to extend functionality to Tempest vulnerability demonstrations.

The IP983 software is not intended for measurement purposes. There is no support for limit lines and antenna factors. IP983 does not contain any classified information and is not related to any classified standard. The amplitude levels are informative and not calibrated. Correlation display cannot be used for estimation of amplitude, the unit is percent of correlation with previous frame.

- Processing of signals from computer monitors, CRT, LCD, TV Screens, Projectors
- Processing of signals from Laser and LED printers
- Processing of signals from Document Scanners
- Advanced signal processing to improve quality of the captured signal
- Averaging – up to 140 frames on 60 Hz monitors
- Real time processing and also offline processing
- Correlation tool to find Frame frequency of the monitor
- AM video spectrum analyser display to find line frequency of the monitor
- RF spectrum analyser to find optimum RF frequency
- Image stabilisation – Automatic frame frequency tracking
- LAN connection to the IZ225 or IZ245 receivers
- Runs under Microsoft Windows 7, 8 and 10/11 in 32 bit mode
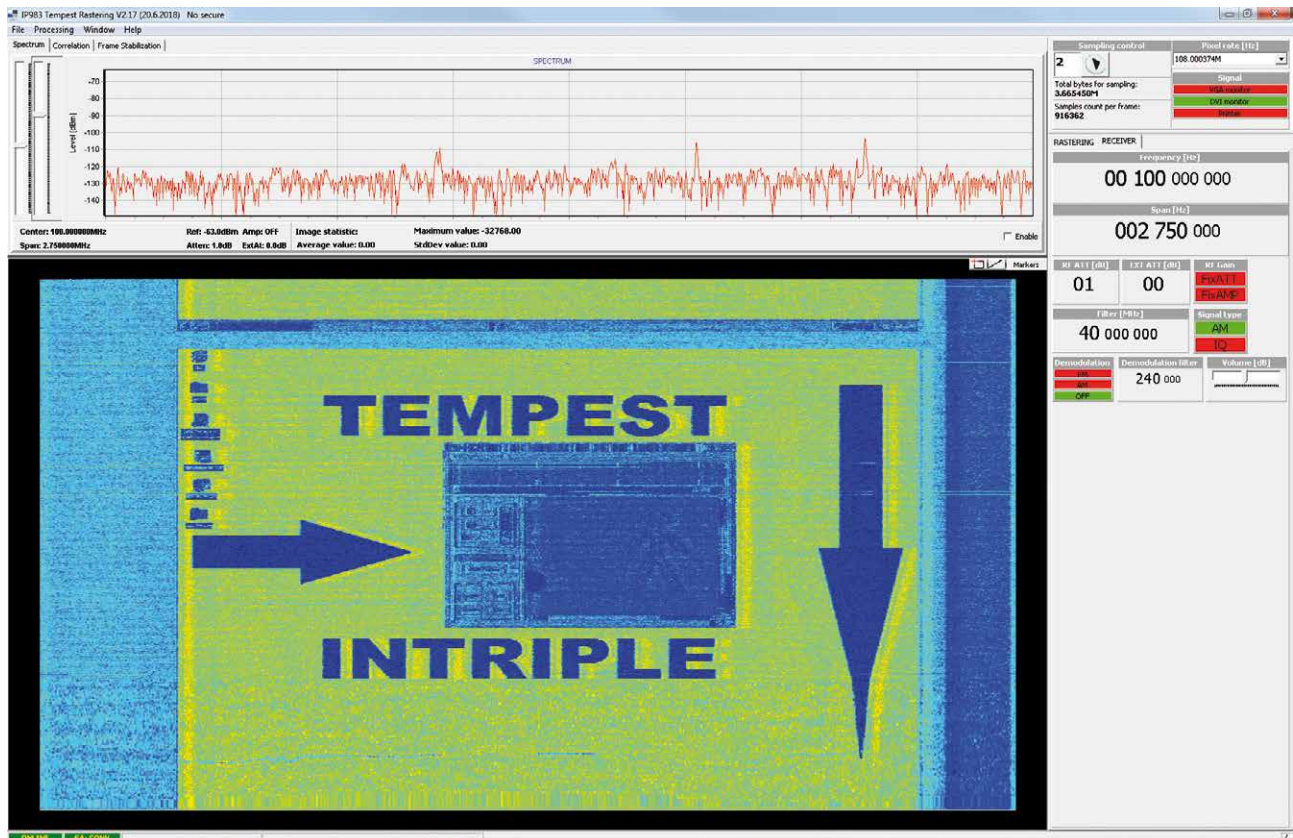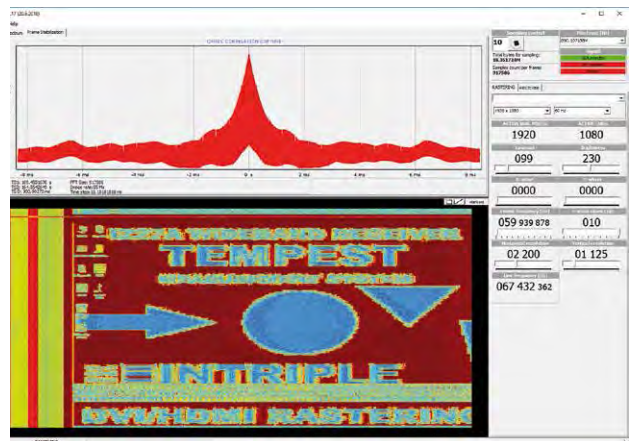
IP982 – QSCAN

The QScan software has been developed for detection of short duration signals in a radio spectrum. There are currently applications in TSCM, EW and TEMPEST. The QScan Lite version is simplified version of QScan bringing advantages of high-speed scanning to Tempest laboratories. It was demonstrated with QScan by EU national laboratories that with a fast scanning receiver it is possible to estimate parameters of Laser printers in a faster way. It can also be used for estimation of emanations from computer monitors and general frequency spectrum monitoring in open space environment and during on-site measurements.

The QScan Lite software application runs under Microsoft Windows in connection with digital receivers IZ225 or IZ245. It is often used with built-in receiver of the Zoning and Shielding measurement systems to extend functionality to frequency monitoring.

- Frequency range 0 to 3 GHz (with receiver IZ225) or up to 18 GHz with Down Converter IZ255B
- Frequency range up to 8 GHz (with receiver IZ245)
- High scanning speed – more than 100 GHz/s in 12.5 kHz channel spacing (with receiver IZ245)
- Very high scanning speed mode – more than 300 GHz/s in 50 kHz channel spacing (with receiver IZ245)
- Snapshot memory for past 1000 lines
- Channel spacings selectable from 3 kHz up to 400 kHz
- Software recalculated bandwidths up to 80 MHz
- Offline analysis of snapshot files
- Waterfall display – zoom in both frequency and time
- Time View display to show power vs time – zero span like mode
- Database of frequencies
- LAN connection to the receivers IZ225 and IZ245
- Runs under Microsoft Windows 7, 8 and 10/11 in 64 bit mode
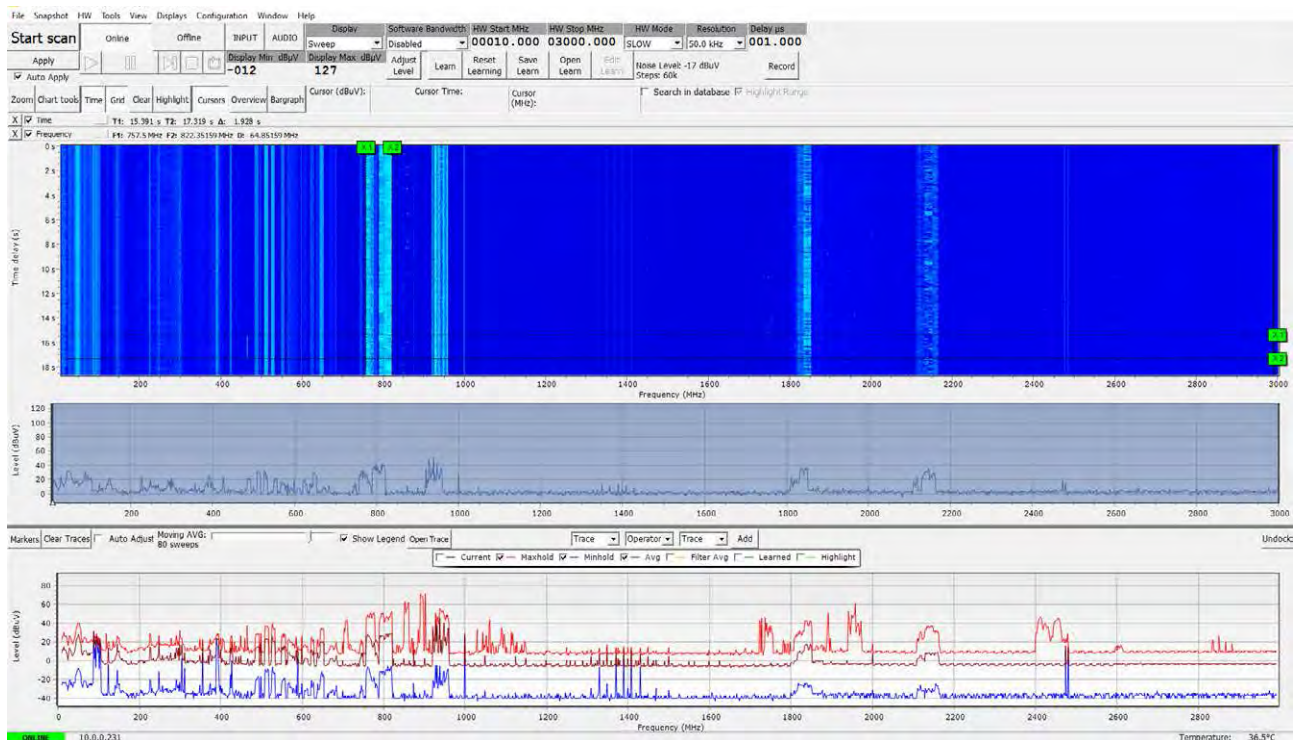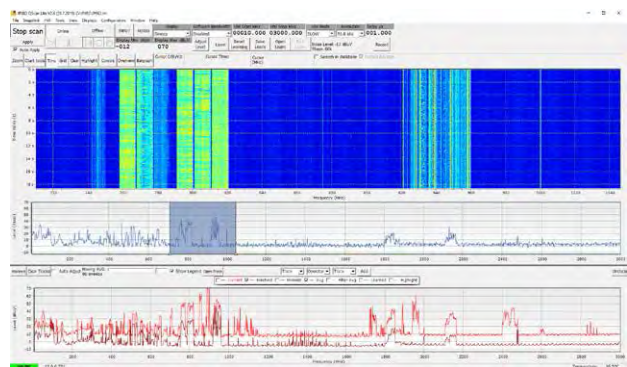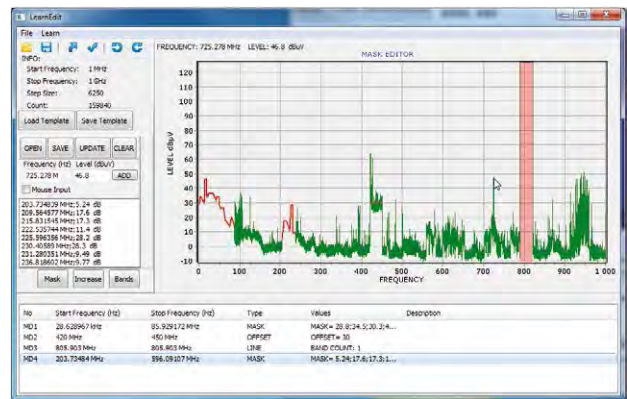
TEMPEST Training Courses

We provide courses in our facility in Prague

- Courses with demonstrations
- Hands-on training courses on operation of equipment
- Hands-on training for testing procedures according to various standards
- Classified certified training courses to prove knowledge of standards with exams

Available is

- Complete Tempest laboratory with Anechoic chamber
- Shielded chamber
- Training room

Training courses regarding the classified standards are organised in cooperation with the NTA of the Czech Republic (now under NÚKIB – National Cyber and Information Security Agency, formerly under NBÚ). These courses are held as classified according to the discussed NATO or EU standard. The course attendees are required to have a valid NATO or EU clearance of the particular level or higher.

National Cyber and Information Security Agency

**Available classified certified courses according to**

- NATO standards SDIP-27/2, SDIP-28/2, SDIP-29/2
- EU standards EU IASG 7-01, IASG 7-02 and IASG 7-03

The courses are subdivided into modules which are focused on different topics and level of knowledge (basic, advanced, expert).

Our TC10/1 course "TEMPEST Fundamentals" is NATO recognised course focused on NATO personnel involved in information assurance. Based on this course we provide introductory course "TEMPEST vulnerability" for government organizations and security forces of EU and NATO countries.

The "TEMPEST vulnerability" is organized as unclassified and it is intended for people who are not specialists in the TEMPEST or EMSEC area but who are working with classified matter. The course demonstrates risks and vulnerability due to compromising emanation. During the course we demonstrate attacks of monitors, serial ports, fibre optics and RF flooding. Demonstrated are also fortuitous conductors and unintentional couplings. The goal of the course is to demonstrate with real equipment that the Tempest attack is doable and rules make sense to follow.

Contact us for list of available training courses. We can also develop one to fit your needs. Some courses are going to very deep details so it is usually more discussion between participants and lectors.
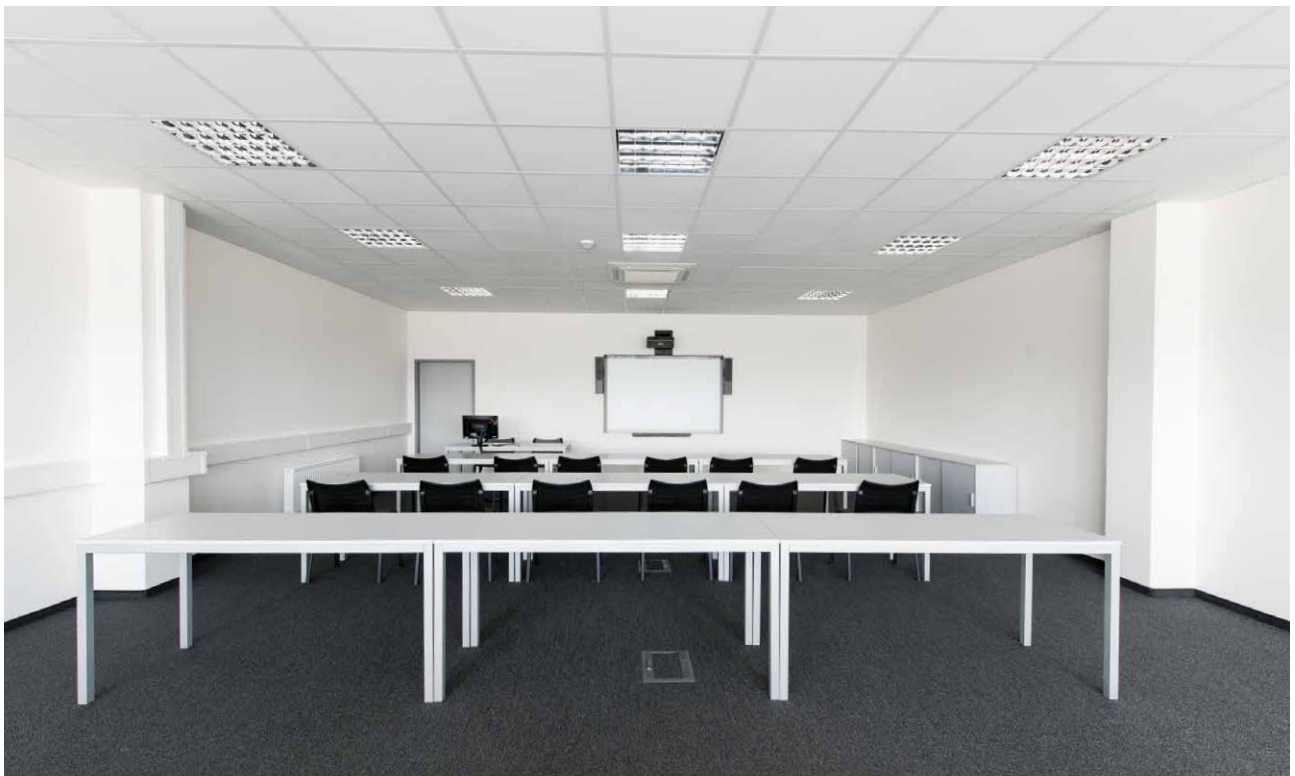
Research and Development services

We provide contract-based research and development services with focus on state-of-the-art electronics mainly in the area of signal processing, FPGA, high frequencies and high data rates.

Our research activities are focused on:

TEMPEST – electric field, magnetic field, electromagnetic waves, signal reconstruction, detection, improvement of SNR, digital filtering, correlation analysis, low noise amplifiers, high sensitivity antennas, test instruments

Radar – ultra-low phase noise oscillators, high dynamic range receivers, impulse transmitters, high stability clocks and time standards

TSCM and EW – fast frequency scanning, detection of spread spectrum signal, signal analysis and classification, signal generation and simulation, EMP detection and protection

GNSS – time synchronisation, spatial filtering, beam forming and nulling, smart antenna, spread spectrum signal processing, interference mitigation

Most of our R&D projects are focused on development of specific complete products some others are focused just on a particular problem.

We deliver feasibility studies, software, firmware, FPGA design, electronic design, mechanical design, prototypes and test and measurements. We can help with certifications and we provide consulting services in the above fields.

We cooperate with Czech technical university in Prague, University of defence in Brno and Brno University of Technology.
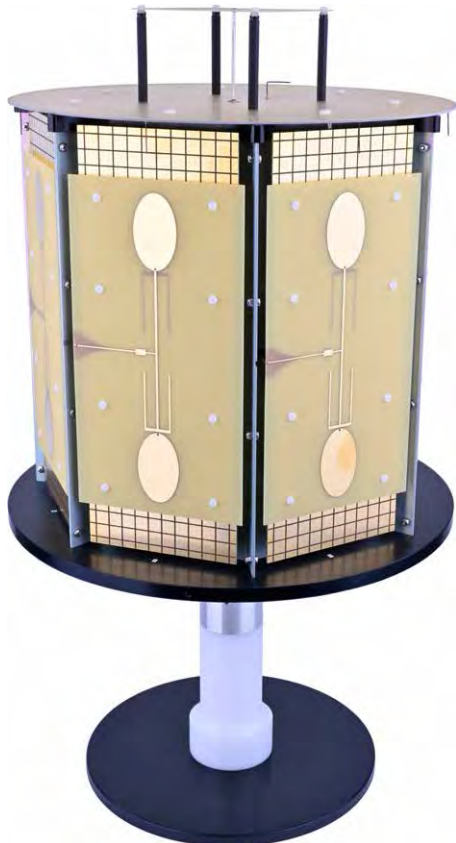
Examples of recent R&D projects

8 channel beam forming receiver with high speed A/D converters 4 GS/s

8 channel transmitter with high speed D/A converters 4 GS/s

Custom wideband receiver with 900 MHz bandwidth and real-time streaming over 40 Gbit/s LAN

Custom wideband receiver with 100 MHz bandwidth and real-time streaming to SSD

Custom wideband generator with 100 MHz real-time signal player from SSD