NEUTRON FLUX INSTRUMENTATION SYSTEMS

I&C Support not only for Nuclear Research Reactors

dataPartner® s.r.o has been providing services in the field of I&C systems for research reactors for more than 20 years. Based on long-term experience and the latest technical knowledge, our specialists have developed the third generation of neutron flux measurement instruments. NIS measurement channels provide neutron flux density measurements and rate of reactor power change (reactor period) for control, protection and safety systems of nuclear reactors.

System / Operator room

EVALUATION UNIT N801/2X

Reactor hall

INPUT MEASUREMENT UNIT

N711X **N712X**

Reactor

NEUTRON FLUX SENSOR

Fission / Ionization (gamma) chambers

I&C System - RPS & HMI

System / Operator room

SCRAM LOGIC CIRCUIT

Operator room / HMI

NIS CHANNEL'S STANDALONE DISPLAY

Encapsulated standalone display

dataPartner®

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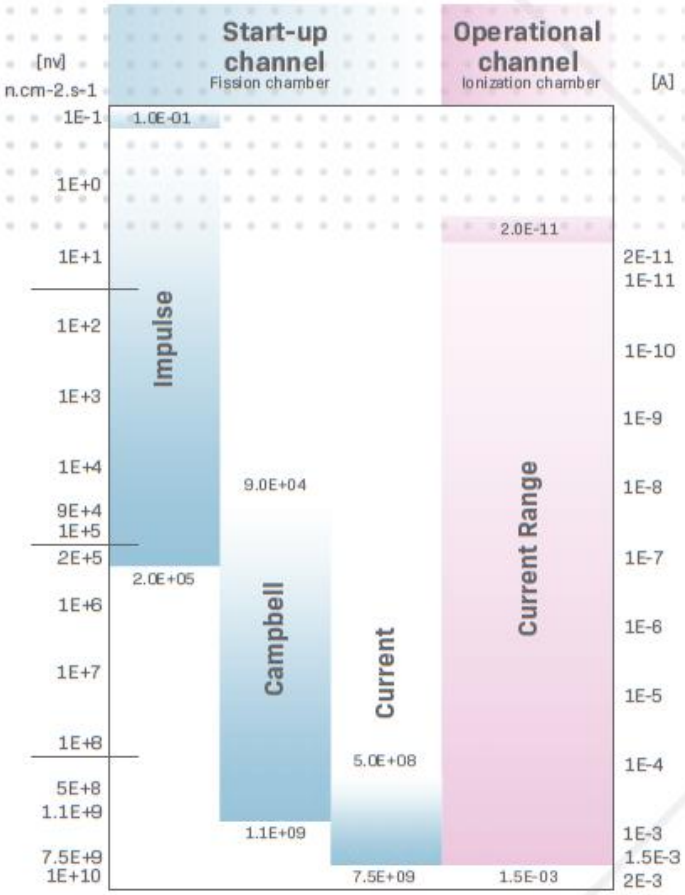
NEUTRON INSTRUMENTATION SYSTEMS Neutron Flux Measurement Channel

Each measurement channel of the NIS system consists of a neutron flux detector and a pair of electronic devices (measuring and evaluation unit), which communicate digitally with each other via fiber optic cable. This solution is immune to errors caused by EMC interference from the environment.

Input measurement units

Various neutron flux detectors can be connected to the input measurement units: Fission chamber CFUL08, compensated and uncompensated ionization chambers KNK50, KNK-56, RC6, RC7 or ionization gamma chambers CRGJ16 and many others.



Measurement unit N711B
It is used in the start-up channel, where it operates in a wide range of neutron fluxes, from pulsed to current mode. The input signal from the fission chambers is processed in three ways: pulse counter, Campbell method and current method.

By a pulse counter, from which the signal leads to 2 discriminators with an adjustable level of discrimination, which converts it into digital pulses. Their frequency per 10 ms is counted by the integrated microprocessor and sent via optical path for further processing.

By Campbell neutron flux measurement as the rms value of the signal obtained by filtering part of the input signal spectrum with a bandpass filter. The obtained signal is converted to DC and its effective value is converted to digital form. It is sent optically, along with other data, to the superior system for evaluation.

The N711B unit can be used for both single-cable and dual-cable chambers.

Measurement unit N712B/C
It is used in the operating channel for direct signal measurement from compensated current ionization chambers with positive supply and negative compensation voltage.

The measured current from the chamber is fed to the logarithmic element in the unit and then converted into digital form by an AD converter.

The converter uses sigma-delta technology, the conversion period is exactly 10 ms.

A test current source is built into the unit and it can be used to test the correct function of the entire measuring chain at any time.

The unit communicates with the superior evaluation and control unit via an optical link.

The N712C has advanced diagnostics for troubleshooting self-test results.

Measurement unit N717A
It is used in the wideband pulse channel Pulse Power Measurement (PPM) for direct signal measurement from uncompensated current chambers in experimental reactors that are operated in pulsed power mode.

The measured current from the ionization chamber is fed to a logarithmic element in the unit. Behind it, it is sampled by two fast AD converters, with the output of each connected to a separate evaluation.

The first unit performs basic measurement functions, status control, functionality testing and pulse detection. The sampling period is 1 ms. Pulse detection is a safety function here.

The second unit performs the power pulse record in detail and transfer the record to an optional superior system. There is measurement period for the recording 100 µs and the recording duration is 0,5 s.

Measurement unit N719N
It is used in the operating channel to measure the level of gamma radiation in order to determine the reactor power according to the decay of the N16 isotope.

NEUTRON INSTRUMENTATION SYSTEMS Neutron Flux Measurement Channel

Evaluation units

The evaluation units process data from the measurement units, the outputs are provided to the SCRAM chain of the reactor protection system and to other subsystems including the HMI panels in the reactor control room. The evaluation unit therefore performs the safety functions of the reactor protection. The safety functions of the unit are fully separated from the communication functions.

N801x series

N801S
The unit evaluates data from the N711B measurement unit. It contains 2 output relays for the emergency chain.

N801P/N
The unit evaluates data from the N712C unit for monitoring the reactor pulse power. It allows it to be included under a superior control system from which selected parameters of its behavior can be set.

N801W
The unit evaluates data from the N717A unit. Provides a safety function to prevent pulse repetition in a shorter time interval than the specified limit.

N802x series

These units retain the evaluation functions of the N801 series, in addition it provides authorized parameterization, is equipped with a display and provides analog outputs for exporting evaluated data.

N802S
The unit evaluates data from the N711B measuring unit in the start-up channel.

N802L
The unit evaluates data from the N712B or N712C measuring unit in the operating channel.

N802N
The unit evaluates data from the N719N measurement unit, which measures the level of gamma radiation detected by the ionization chamber at the inlet and outlet of the cooling circuit. The result is a determination of the reactor power based of N16 decay's gamma radiation.

REACTOR PROTECTION SYSTEM - SCRAM Logic Circuits

The SCRAM unit evaluates logical combinations of binary safety signals and controls the disconnection of the electromagnet circuits of the reactor's absorption control rods. The advantages of our SCRAM unit are as follows:

- Modularity
- Robust construction - Rack components are able to resist up to 20 G
- Mechanical design suitable for 19“ rack, size 3U
- Logical function of individual units can be customized during the manufacturing process
- Advanced I/O state diagnostics
- 100% circuits testability
- Outputs are prepared for online checking using independent PLC circuits

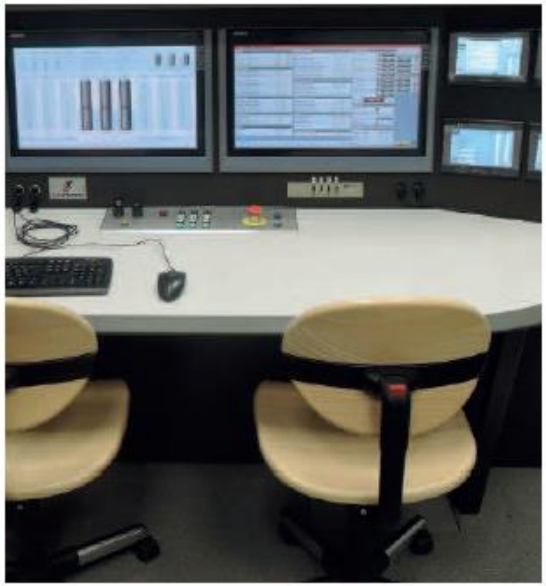
NEUTRON FLUX INSTRUMENTATION SYSTEMS

Possible Assemblies	Start-up Channel Source Range / Wide Range	Intermediate Range Monitor Power Range	Measurement and power pulse recording on the TRIGA	N16 Measurement
Typical Chamber	Fission chamber e.g. CFUL08 Single or dual cable connection	Ionization chamber e.g. KNK50, KNK-56, RC6 Compensated or uncompensated	Uncompensated ionization chamber e.g. RC7	1 or 2 ionization gama chambers e.g. CRGJ16
Measurement Unit	N711B	N712C	N717A	N719N
Evaluation Unit	N801S, N802S	N802L	N801W	N802N
Typical Measurement Range Depend on the kind and chamber position	0,1 ÷ 7,5e9nv 0,1 ÷ 2e5cps pulse 9e4 ÷ 1,1e9 Campbell, noise 5e8 ÷ 7,5e9 current	2e-11 ÷ 1,5e-3A 1e3 ÷ 7,5e10nv (For chamber sensitivity 2e-14A/nv)	2e-11 ÷ 1,5e-3A	Two manually switched ranges 10nA or 100nA Accur. 0.2% of measured value +0,1pA in 10nA range +1pA in 100nA range
Benefits from Using	Measurement is carried out even if the chamber is in distant position		recording values up to 10kHz – 10000 samples	

Configuration examples

Measurement units

Evaluation units



Operator's desk

The refurbishment of the neutron flux instrumentation system or the entire I&C system by dataPartner includes a complete design, support for the regulator's permitting, delivery of the equipment, its installation and adjustment, warranty service and long-term after-sales service.

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