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The ZS Electrostatic Septa Ion Traps control

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Keywords:

Summary

The SPS is equipped with a North extraction channel to a fixed target beam line. This channel is equipped with an extraction chain that comprises electrostatic and electromagnetic septa that contribute to the extraction process of the proton beam. The electrostatic septa (ZS) are the extraction elements that can cause the most problems during operation, this is mainly due to the combination of high fields and high voltages within the equipment. There are several systems that protect the equipment against the effects of which the 'ion trap system'. The ion trap is a cleaning electrode device and these are placed in the field-free region containing the circulating beam. They remove ions produced by beam interactions within the residual gas molecules. They are powered by power supplies that can output up to -10 kV with a range of -500 µA max. This internal note concerns the electronics and control of the ZS electrostatic septa ion traps.

1. Introduction to the Electrostatic Septa

Electrostatic septa provide an electric field in the direction of extraction, by applying a voltage between the septum foil and an electrode. The septum foil is very thin to have the least interaction with the beam when it is slowly extracted. Slowly means over millions of turns of the particles in the synchrotron. The orbiting beam generally passes through the hollow support of the septum foil, which ensures a field free region, as not to affect the circulating beam. The extracted beam passes just on the other side of the septum, where the electric field changes the direction of the beam to be extracted. Electrostatic septa are always sitting in a vacuum tank to allow high electric fields, since the vacuum works as an insulator between septum and electrode. To allow precise matching of the septum position with the circulating beam trajectory, the magnet is also fitted with a displacement system, which allows parallel and angular movement with respect to the circulating beam. An important feature a of septa magnet is to have a homogeneous field in the gap and no field in the region of the circulating beam. This is achieved by using the hollow support of the septum and the septum foil itself as a faraday cage. The septum separates the gap field between the electrode and the foil from the field free region for the circulating beam. Great difficulty lies in the choice of materials and the manufacturing techniques of the different components. In fig.1 a cross section of an electrostatic septum is shown. The septum foil and its support are marked in blue, while:

$$E = \frac{V}{d}$$

Where V is the voltage applied to the electrode and d is the distance between the septum foil and the electrode.

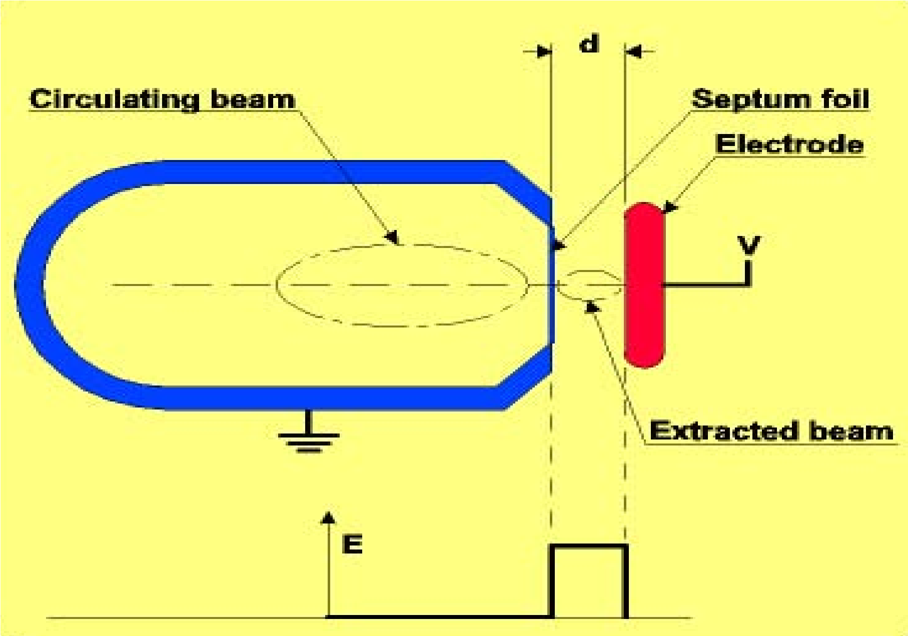


Figure 1 Cross sectional view of electrostatic septa

2. The Electrostatic Septa Ion Traps

The SPS is equipped with a north extraction channel to a fixed target beam line. This channel is equipped with an extraction chain that comprises electrostatic and electromagnetic septa that contribute to the extraction process of the proton beam. The electrostatic septa (ZS) are the extraction elements that can cause the most problems during operation; this is mainly due to the combination of high fields and high voltages within the equipment. There are several systems that protect the equipment against the effects of which the 'ion trap system'. The ion trap is a cleaning electrode device and they are placed in the field-free region containing the circulating beam. They remove ions produced by beam interactions within the residual gas molecules. They are powered by power supplies that can output up to -10 kV with a range of -500 µA max.

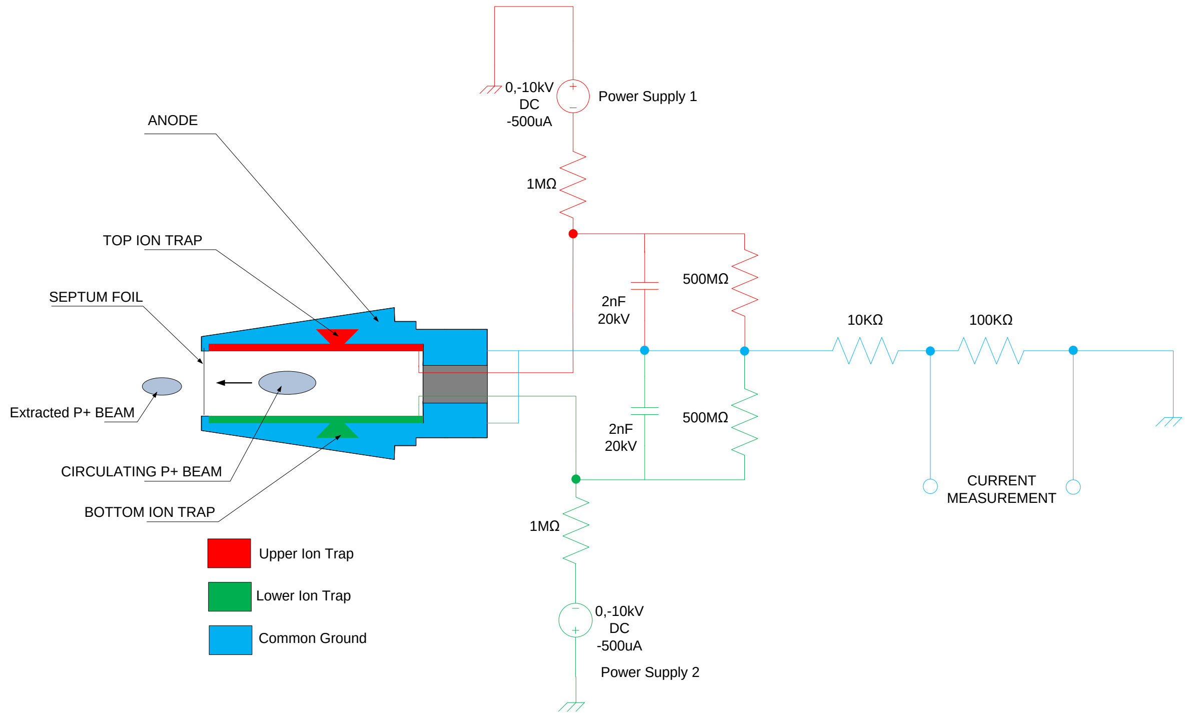


Figure 2 Simplified schematic view of the ion traps electronics

The ion traps are an important sub-system to the electrostatic septa magnets in the SPS north extraction area. The ion traps are elements inside the septa tanks and are themselves electrostatic devices with a field region solely aimed at trapping spurious ions that could aggravate internal sparking inside the electrostatic septum elements. These elements are electrically insulated from the septa tank by alumina inserts. The system uses negative polarised power supplies which 'sees' into a high Z (typ. 500 MΩ). Also a readout path is provided for the septa anode current which is the sum of both ion trap currents and the small anode current from the main power generator. The system is also equipped with 90 V spark gaps that protect the electronics upstream. The ZS tanks also are protected by additional circuitry (not shown here) for spark count detection coming from the ion traps electrodes.

3. The ion trap bulkhead system for cable feed trough

The ion trap local passive circuitry (resistors and capacitors) are fitted behind a bulkhead system that is put into place onto each ZS tank. The passive components are immersed into dielectric oil of type Valvata 460 Shell. The bulkhead flange plate has all the necessary connectors mounted onto its faceplate to allow for the control and readout signals to be routed, these are:

- Ion trap UP voltage
- Ion trap DOWN voltage
- Anode current voltage
- Spark count

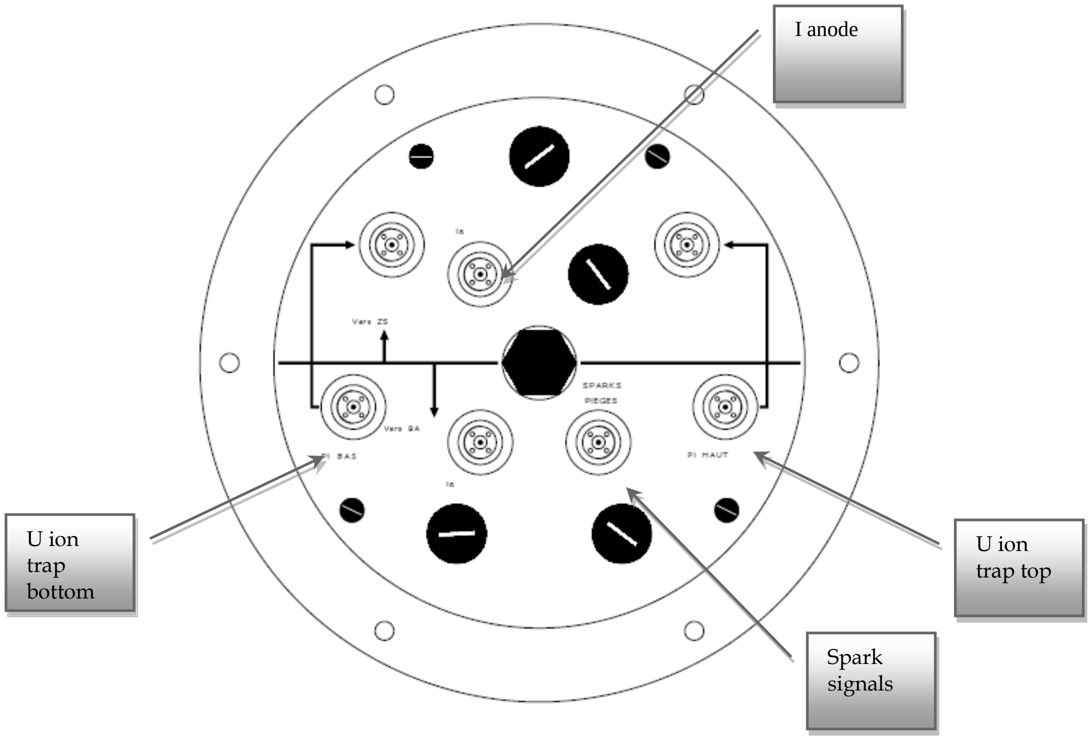


Figure 3 Top flange view of ion trap bulkhead system

4. Ion trap power supply specifications

The ion traps baseline power supply specifications are in the table below:

Ideal maximum Output Voltage (kV)	Ideal maximum Output Current (µA)	Maximum Output Power (W)	Maximum Regulation Time (ms)
-10	**-500**	**5**	**10**

The power supply feeds the high voltage to the ion traps with adjustable current and adjustable voltage within the following required specification set by the existing system pre-requisites:

UHT max (ideal)	-10kV
I max (ideal)	-500µA
Voltage operational range	(-2 to -10 kV)
Current operational range	50-500µA

Further details of ion trap power supplies specifications:

Ripple specification:

UHT	-7.5 kV
I	-230 µA
Voltage Ripple	+/- 0.2 %

Voltage ramp delay:

Voltage	-1.5 Kv
Time	1 ms

Response time given at 10 % of voltage scale with a step response for Vref

Voltage	-1 kV
Current	-40 µA
T	5 ms

Stability under full load conditions

Voltage	-10 kV / -500 uA
Test duration	8 hours (minimum)
Stability tolerance	$1x10^{-3}$
Temperature coefficient Voltage	$< \pm 2 x 10^{-4}$/°C

Within the ambient temperature range 15°C to 40°C.

Electromagnetic compatibility

Power supplies complies with European Standards EN 50081-2 / EN 50082-1 for Electro Magnetic Compatibility (EMC). In addition, the power supplies shall bear the CE mark and comply with the international standard EN 61010.

Power supply format:

Various power supply formats where considered, Nim, Europe, Camac, modular they all presented various design challenges for system integration.

5. The Heinzinger LNCE power supply

Finally the choice of the heizinger LNCE series supply fulfilled well the design criterions. Here are its' specifications:

General

Supply connection	24 VDC ±10 %, residual ripple ≤ 1 %
Maximum current consumption	2, 5 A
Environment temperature	0°C +40°C
Discharge time with no load at the output to 5% of the adjusted output voltage	< 10 s

Voltage stabilisation

adjustment range	approx. 1% up to 100% URated
Reproducibility	$5\cdot10^{-3}$
Regulation of the supply voltage (±10 % ΔUSupply)	$<\pm1\cdot10^{-4}$
Load regulation	$\leq5\cdot10^{-4}$
Regulation time	≤100 ms
Stability	$\leq5\cdot10^{-4}$ over 8 h
Temperature coefficient	$\leq5\cdot10^{-4}$ /K
Residual ripple	
Module < 3 kV-output voltage	$\leq1\cdot10^{-3}$
Module ≥ 3 kV-output voltage	$\leq5\cdot10^{-4}$

Current stabilisation

Adjustment range IRated	approx. 1 % up to 100 %
Reproducibility	$5\cdot10^{-3}$
Regulation the supply voltage (±10 % ΔUSupply)	$<\pm1\cdot10^{-4}$
Load regulation	$\leq5\cdot10^{-4}$
regulation time	≤100 ms
Stability	$\leq5\cdot10^{-4}$ via 8 h
Temperature coefficient	$\leq5\cdot10^{-4}$ /K
Residual ripple	
Module < 3 kV-output voltage	$\leq1\cdot10^{-3}$
Module ≥ 3 kV-output voltage	$\leq5\cdot10^{-4}$

Mechanical design

Euro cassette according to DIN 41494, 3 HE, 14 TE

Weight	approx. 850 g

Fig.4 below represents the Heinzinger LNCE power supply backplane connector showing the electronics control interface signals:

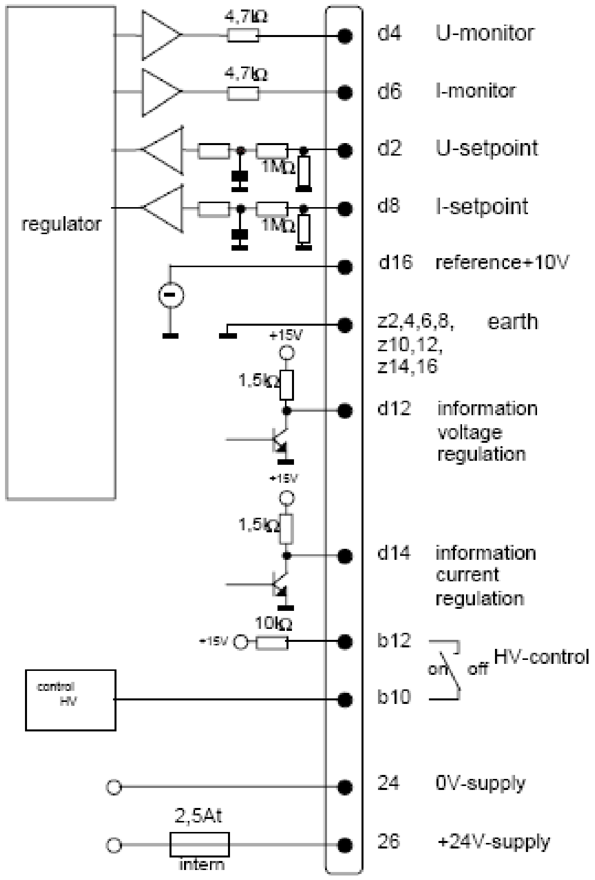


Figure 4 Heinzinger LNCE power supply backplane I/O connector

6. The ion traps controls equipment

The ion trap system can be broken into various control blocks, these are the following:

1.1 MASTER CPU controller

This unit contains the main CPU controller of the system coupled with a TCP/IP communication module for remote control of the system and also has a coupling bridge (PN/PN coupler) for communication with the deported I/O's together with a scalance network bridge for data sharing with the other electrostatic septa PLC sub-systems (generator and servo control system).

1.2 PSC (Power Supply Controller) 2 of:

This system controls solely the LNCE Heinzinger high voltage supplies for the system ion traps. We opted for a high reliability +24 V power supply (Delta Elektronica) to power up the Heinzinger modules, which is a better power supply for long term reliability than using a standard PLC based +24 V supply. The DELTA ELEKTRONIKA SX-Series are euro cassette switched mode power supplies with auto ranging inputs. The model used by the PSC is the 150 SX 15-15 Euro cassette type switched mode power supplies, 2 x 6-15 V, 5 A, 150 W. The LNCE power supply's use a Harting DIN41612 connector socket and its equivalent plug connector has crimp mounted pins, hence making a more easy and efficient backplane wiring.

The PSC controller is the principal Heinzinger power supply controller chassis. Each PSC houses 5 Heinzinger LNCE power supplies.

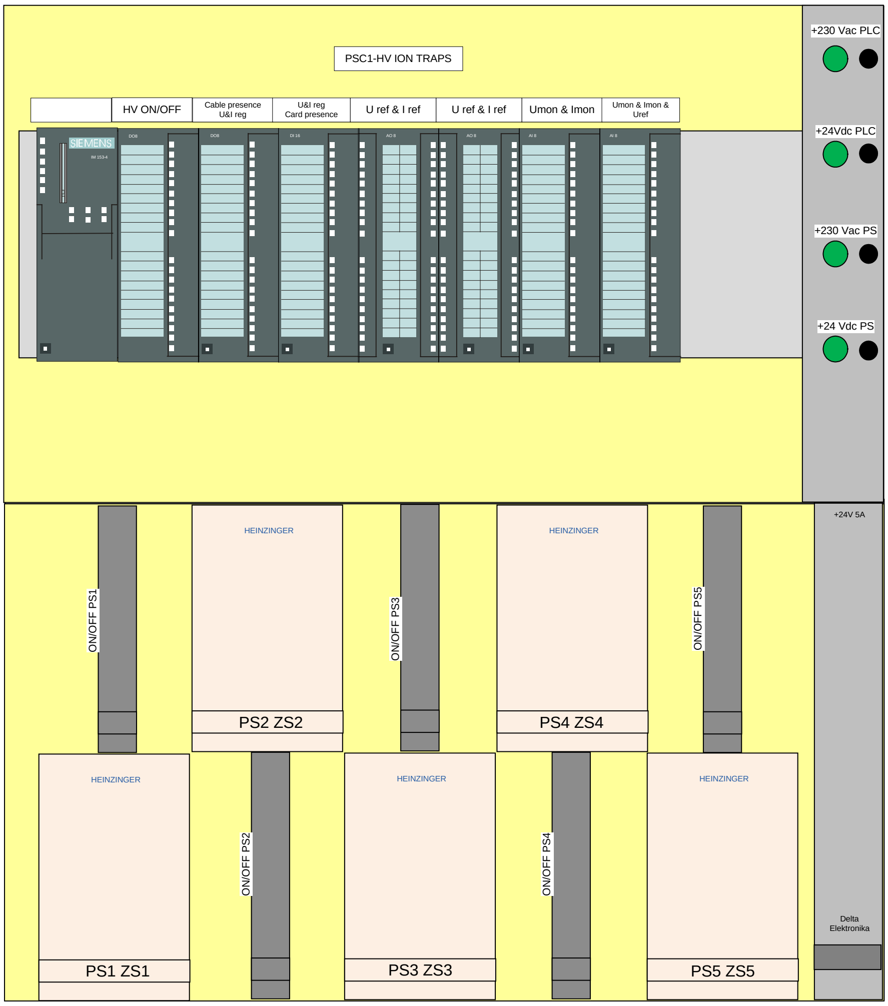


Figure 5 View of the PSC controller chassis for ion traps power supplies

The PSC crate contains 8 SIEMENS plc modules, 5 LNCE HV power supplies, 5 custom made controller cards (ON/OFF PS), 1 DELTA ELEKTRONIKA power supply that feeds the +24 V to the Heinzinger LNCE.

The custom made controller cards (ON/OFF PS) have been designed to fulfil 3 major functions:

1) Level shifting of the Ireg (current regulation) and Ureg (voltage regulation) for the Heinzinger LNCE current & voltage regulation status bits. The controller card shifts to +24 V these bits since these are only given for +15 V so that the Siemens DI module can acquire these at the correct voltage level.

2) The card also provides a interlock signal that cuts the power supplies when removed. This is a safety feature akin to the system, the LNCE having a reverse logic for it's 'ON' commutation, this was a necessary step to integrate this safety feature into the system. Removing any one of the 5 power supplies cuts automatically the others, this is achieved through a daisy chained loop that intersect with all the 5 power supplies backplane connectors.

3) A card presence flag for the actual ON/OFF PS card is also present which allows the PLC control to interlock and cut the powers supplies if one of these cards where to be removed.

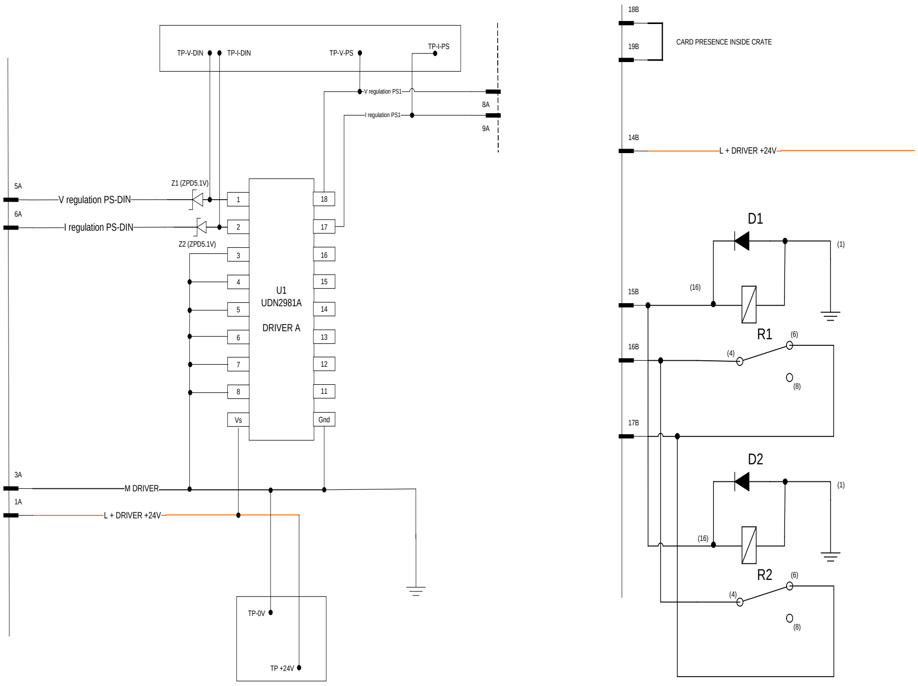


Figure 6 Circuit diagram of Heinzinger LNCE controller card (ON/OFF PS)

Another feature of the PSC controller system is the possibility to fit a link at the rear of the crate with 2 burndy 28 connectors onto a NE26 type cable (umbilical link) that allows the system to use isolation amplifiers if required. This feature is bypassed at the present but can become an extra option if the case arises for input protection via isolation amplifiers of the analogue acquisitions. The system bridges the two following signals, Umon and Imon. To bypass the isolating amplifiers option a cable made up of two BSF28 is connected at the rear of the chassis, also a short cable presence equips both ends to ensure a good connection and also interlocking of the system if removed.

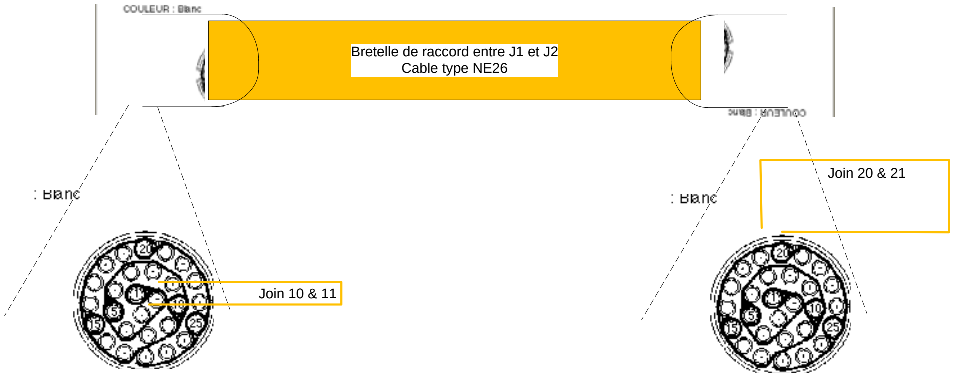


Figure 7 Isolation amplifiers PSC ombilical link

If in the future isolation amplifiers are required, these can be implemented from existing SPS design type (Isolation amplifier module SPS 5277) which uses an Analogue device 284J isolating amplifier or a more recent LEM voltage transducer module CV 4-75/SP1 is a potential choice.

PSC signals are:

Name	Description	Type
Uref1 Uref2 Uref2 Uref4 Uref5	Voltage set point for power supply (0-10V)	Analogue output
Iref1 Iref2 Iref3 Iref4 Iref5	Current set point for power supply, (0 – 10V)	Analogue output
HV ON PS1 HV ON PS2 HV ON PS3 HV ON PS4 HV ON PS5	HV 'ON'	Digital command
UregPS1 UregPS2 UregPS3 UregPS4 UregPS5	Voltage regulation status	Digital acquisition
IregPS1 IregPS2 IregPS3 IregPS4 IregPS5	Current regulation status	Digital acquisition
Presence J1 Presence J2	Umbilical isolating amplifier bypass system	Digital acquisition
Ext Interlock	HV/ON controller card presence	Digital acquisition
UmonPS1 UmonPS2 UmonPS3	Umonitoring of external voltage reference	Analogue acquisitions

UmonPS4 UmonPS5		
ImonPS1 ImonPS2 ImonPS3 ImonPS4 ImonPS5	Imonitoring of external current reference	Analogue acquisitions
UrefPS1 UrefPS2 UrefPS3 UrefPS4 UrefPS5	Power supply internal reference monitoring	Analogue acquisition

<u>SCADA description of ion traps control:</u>

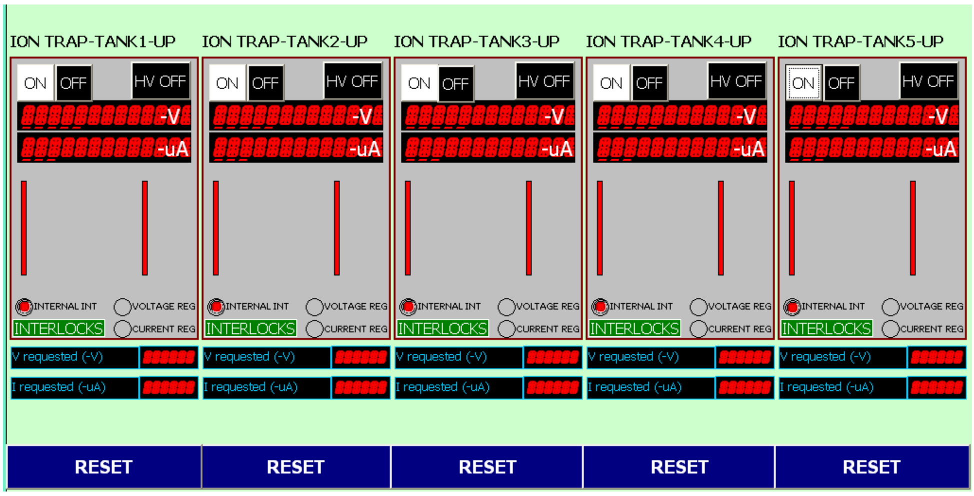


Figure 8 SCADA view of ion trap control

Each power supply has the following controls associated with it:

- ON/OFF
- HV ON STATUS
- Umon & Imon readings
- U & I regulation status
- External interlocks (Vacuum spark interlock)
- Internal interlock, PS ON/OFF card presence
- Uval and Ival request command (demanded voltage and current)
- Power supply interlock RESET

<u>Note:</u> Each supply can be controlled individually however the finite state machine in the PLC that uses GRAPH7 controls and turns ON simultaneously all 10 ion trap power supplies with adjustable ‘turn-on delays’ for each one if necessary.

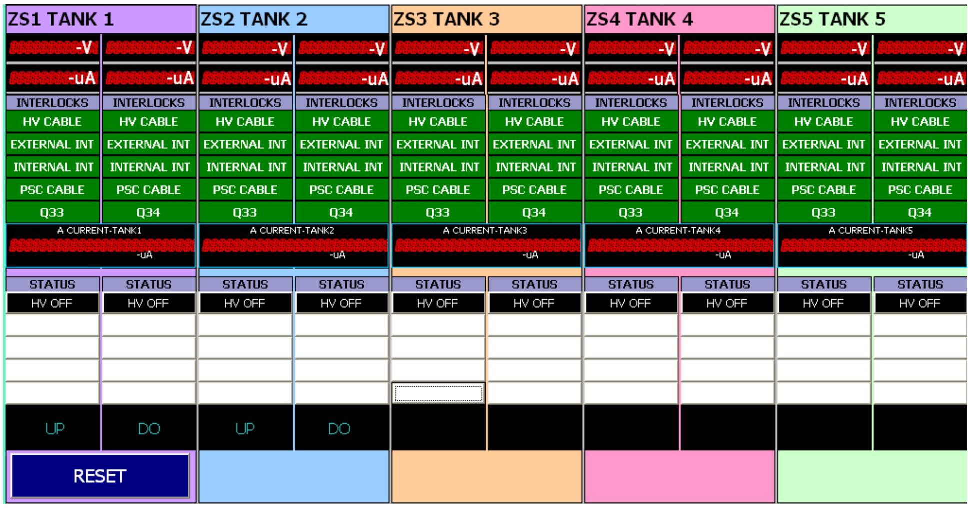


Figure 9 SCADA view of ion traps global status control screen

<u>Main ion traps power supplies status menu comprises the following information :</u>

- Umon & Imon readings
- HV cable interlock (CPC controller)
- External interlock (Vacuum sparking activity)
- Internal interlock (PS ON/OFF card presence)
- PSC cable presence interlock (isolating opamp umbilical link)
- Q33/Q34 circuit breaker interlock
- Anode current measurement for each ZS tank
- HV ON/OFF status
- PS ON & PS OFF faulty status (indicative if supply is really ‘ON’ based around pre-defined thresholds)
- Ureg & Ireg status bits

1.3 The CPC (Cable Presence Controller)

This chassis is dedicated to acquiring all of the HV cables presence status within the ion trap system. These contacts are configured in two different ways. These are fitted inside HV Fisher 105A036 connectors housing and the HV cable patch panels are secured with a panel presence security switch. This system allows a safe HV cable disconnection since it will immediately shutdown any HV that may be present on the cable.

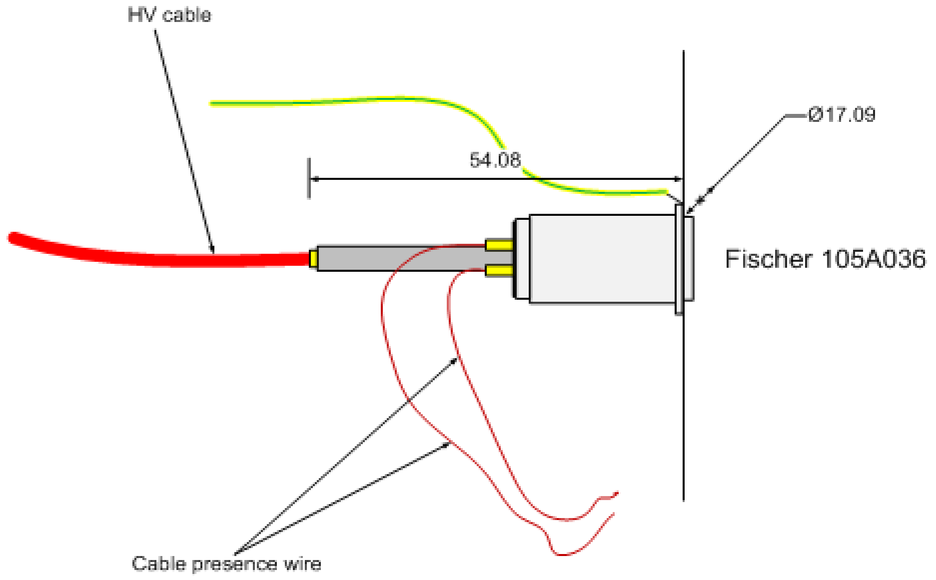


Figure 10 View of a Fischer connector type 105A036 with cable presence wire

Each status acquired is modified into a latchable alarm, if any one of these connections are severed or not properly mounted back to a patch panel this action will cut the HV on the ion traps and also cut the HV generator (-300 kV Cockcroft-Walton) of the ZS system.

The CPC system is an important contribution to the ZS septa human safety interlock chain, it monitors and surveys all the HV cables connectivity and will flag an interlock if any of these HV cable systems where to be disconnected.

The status of each HV connection is monitored with an array of digital input modules which has the following I/O mapping:

Table 1

Table of digital inputs, each one corresponds to a HV cable of the ZS system

60086	60012	60086	60012	60015 ZS1	60014 ZS1	NK32 01805	NK32 01806
60087	60013	60087	60013	60039 ZS2	60032 ZS2	oK32 01805	oK32 01806
60088	60014	60088	60014	60051 ZS3	60050 ZS3	NK32 01807	NK32 01808
60089	60015	60089	60015	60071 ZS4	60070 ZS4	oK32 01807	oK32 01808
60090	60016	60090	60016	60048 ZS5	60055 ZS5	NK32 01809	NK32 01810
60091	60017	60091	60017	HEPH ZS1	HEPB ZS1	oK32 01809	oK32 01810
60092	60018	60092	60018	HEPH ZS2	HEPB ZS2	NK32 01747	
60093	60019	60093	60019	HEPH ZS3	HEPB ZS3	oK32 01747	
60094	60020	60094	60020	HEPH ZS4	HEPB ZS4		
60095	60021	60095	60021	HEPH ZS5	HEPB ZS5		
60096		60096		60018 ZS1			
60097		60097		60036 ZS2			
60098		60098		60054 ZS3			
60099		60099		60074 ZS4			
60084		60084		60020 ZS5			
60085		60085					

Each DI number references a specific HV cable within the HV cable distribution network of the system.

CPC cable presence controller SCADA VIEW:

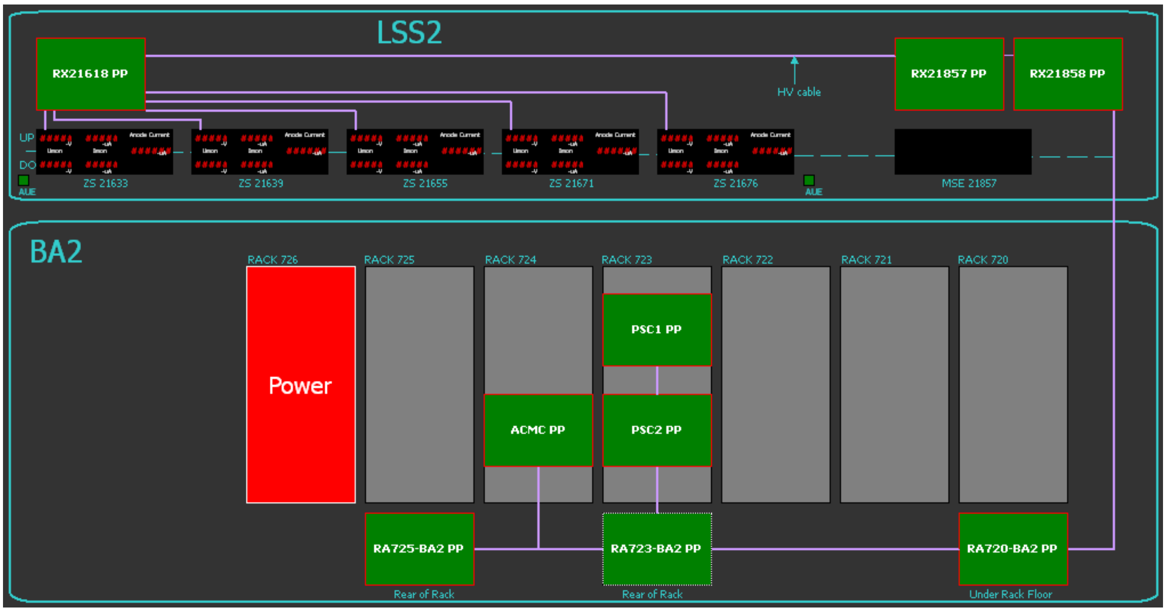


Figure 11 SCADA view of the CPC cable controller system that shows exact geographical location for each HV cable connected in the ZS system

The fundamental behind the CPC system is to interlock the ZS when a cable presence is faulty or a HV cable is truly disconnected due to maintenance, thus the operator cannot perform a RESTART of the system. The SCADA view associated with the CPC allows the operator to trace distinctively where the fault lies and in which geographical location the fault has occurred. When an HV cable is removed this is flagged up immediately on the screen and will point toward the patch panel concerned, these are:

- RA725-BA2 PP (Patch panel located under flood board)
- ACMC PP (Patch panel located in RACK 725)
- PSC1 PP & PSC2 PP (Patch panel located in RACK 723)
- RA723-BA2 PP (Patch panel located under floor board nearby RACK 723)
- RA720-BA2 PP (Patch panel located under floor board nearby RACK 720)
- RX21858 (Patch panel located inside LSS2 at the upstream location of the ZS installation)
- RX21857 (Patch panel located inside LSS2 at the upstream location of the ZS installation)
- RX21618 (Patch panel located inside LSS2 at the downstream location of the ZS installation)

The system operator can simply click on the system that flashes in RED and this will lead to another page which reveals the mapping of the HV connections of the corresponding patch panel. Once the cable has been correctly identified and reconnected the user can RESET the interlock and START the system up.

7. The ACMC (Anode Current Measurement Controller)

The anode current measurement system is dedicated to acquiring the ZS tanks anode current measurements. The anode current measurements correspond to the following:

$$Ic = Itd + Itup + Igen$$

With:

Ic = Anode Current

Itd=Ion trap down current

Itup=Ion trap up current

Igen=Generator current

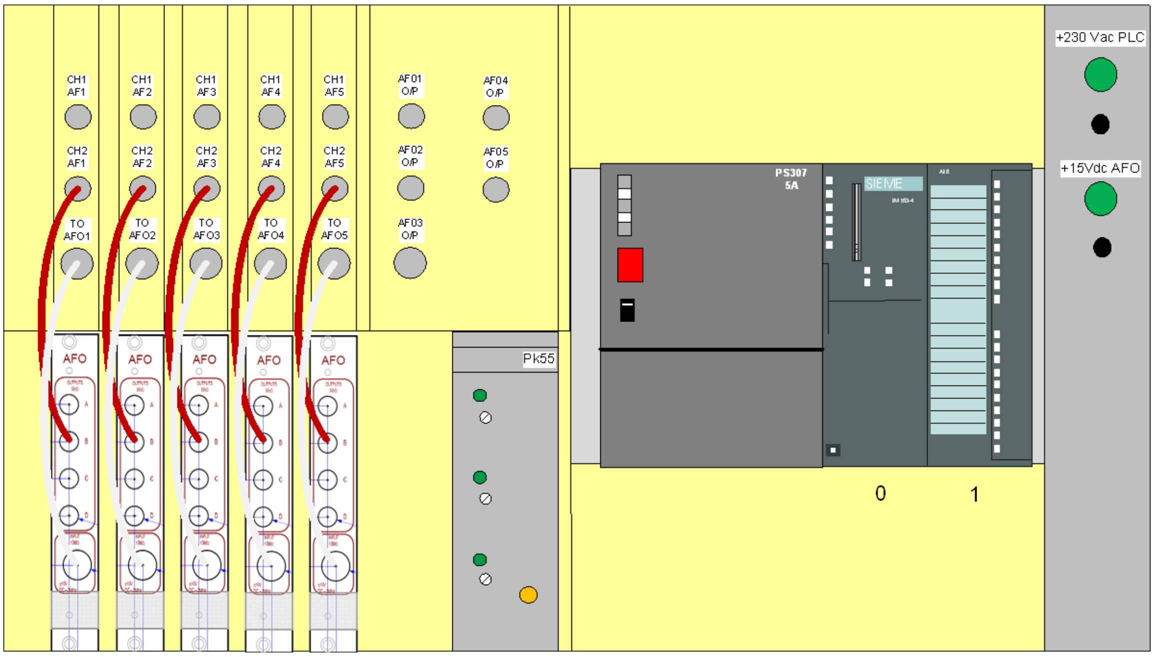


Figure 12 Frontal view of the ACMC chassis

This chassis contains 5 AFO cards (Analogue Fan Out), which are electronic modules that re-route each anode current from a single septa tank into a multiple output signal path configuration (FAN-OUT), hence the signals can be picked off and distributed to several applications. The other feature of the AFO is that it offers galvanic protection to the Siemens ADC card. The Siemens AI8 (ADC) converts the anode current signal into a digital scalar value which is treated by the CPU.

8. PDC (Power distribution controller)

The power distributor controller topology distributes power to all the ZS electronic sub-systems of which the ion traps supplies. Is also supplies power to the HV Pentak system, the servo motor system and the 3M (insulating liquid of the HV cable feed troughs). It has the following layout:

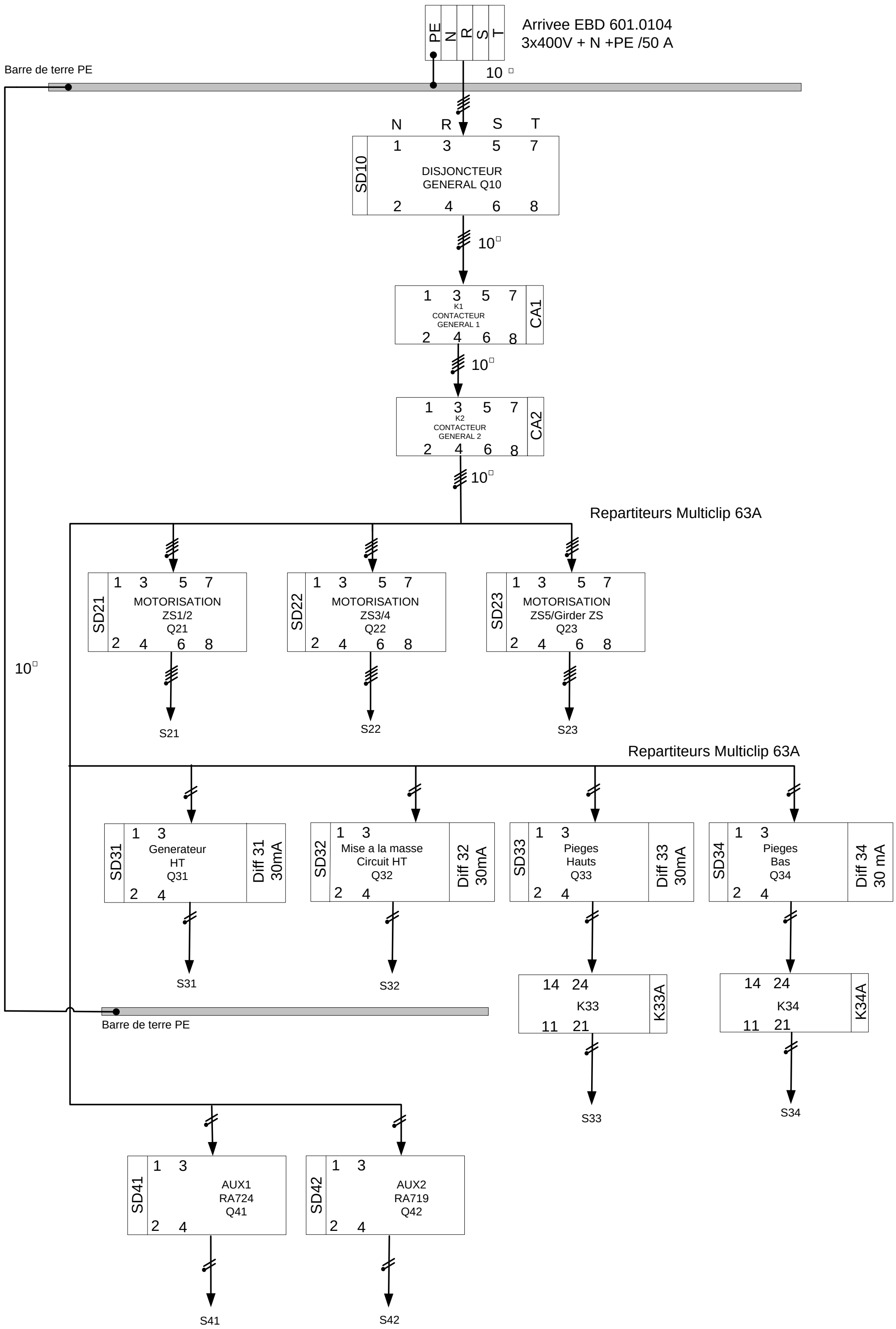


Figure 13 ZS PDC electrical distribution system block diagram

The PDC system is totally controlled via automation PLC I/O’s and is part of the PLC chain of the system.

Here are the following components of the PDC with their functionality described and referenced:

Components	Intensity A/Mono	Reference
F10 phase presence	N.A	Siemens (5TT3421)
Q10 Main CB	40A	Merlin Gerin (C60L/C40A)
K1 contactor general 1	40A	Siemens (5TT57402)
K2 contactor general 2	40A	Siemens (5TT57402)
Q21 CB Motors ZS1/2	16A	Merlin Gerin (C60L/B16A)
Q22 CB Motors ZS3/4	16A	Merlin Gerin (C60L/B16A)
Q23 CB ZS5/Girder ZS	16A	Merlin Gerin (C60L/B16A)
Q31 CB HV generator	22A	Merlin Gerin (C60L/B22A)
Q32 CB Earthing switch	22A	Merlin Gerin (C60L/B22A)
Q33 CB Ion traps UP	22A	Merlin Gerin (C60L/B22A)
K33 contactor Ion traps DOWN	16A	Siemens (5TT3078)
Q34 CB Ion traps UP	22A	Merlin Gerin (C60L/B22A)
K34 contactor Ion traps DOWN	16A	Siemens (5TT3078)
Q41 CB Aux1	10A	Merlin Gerin (B60L/B10)
Q42 CB Aux2	10A	Merlin Gerin (B60L/B10)

PDC PLC control table

DEVICE	PLC command	PLC acquisition	Hardware and control
F10 phase presence	No	Yes	
Q10 Main CB	No	Yes	SD10
K1 contactor general 1	Yes	Yes	CA1
K2 contactor general 2	Yes	Yes	CA2
Q21 CB Motors ZS1/2	No	Yes	SD21
Q22 CB Motors ZS3/4	No	Yes	SD22
Q23 CB ZS5/Girder ZS	No	Yes	SD23
Q31 CB HV generator	No	Yes	SD31
Q32 CB Earthing switch	No	Yes	SD32
Q33 CB Ion traps UP	No	Yes	SD33
K33 contactor Ion traps DOWN	Yes	Yes	K33A
Q34 CB Ion traps UP	No	Yes	SD34
K34 contactor Ion traps DOWN	Yes	Yes	K34A
Q41 CB Aux1	No	Yes	SD41
Q42 CB Aux2	No	Yes	SD42

When an AUE is pushed this opens both K1 and K2 general contactors. On release of an AUE, and once the interlock is RESET via the OP, the operator has to also reset the safety relay inside the PDC housing by turning a key switch. Only then can the safety relay interlock be reset via the operator panel and the PDC can be turned ON. The safety relay has the following characteristics:

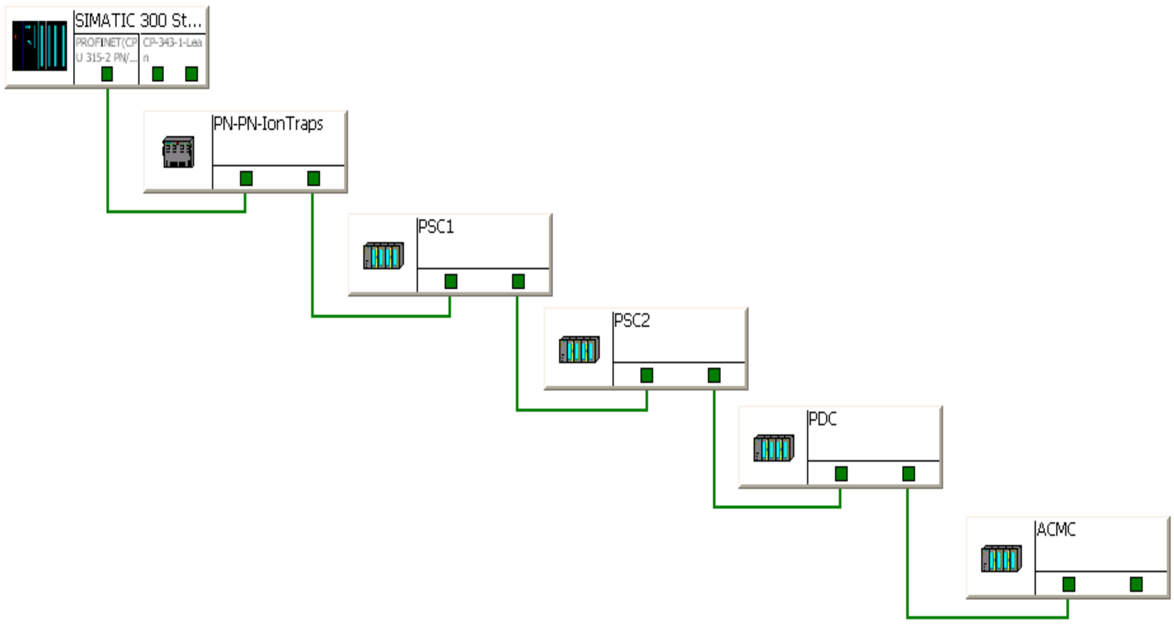
It is an XPS-AC security type relay. It was designed for the following purposes:

- Enhances the safety of personnel, reducing injuries and downtime.
- Isolates emergency e-stops and other safety control components improving reliability.
- Manual RESET option implemented by switch-key.

9. Siemens PLC industrial automation, PROFINET

Industrial communication plays a decisive role in all areas of automation technology. PROFINET, the open Industrial Ethernet standard, offers outstanding advantages that improve the response capability and reliability of control processes. Modular machine concepts and maximum flexibility in the creation of automation structures are the key to shorter response times. Fast baud rates boosts the performance of the system. PROFINET was a key choice here for improving communication speed (specially applicable to servo loops) but was also a new ground to be explored in PLC bus inter connectivity and consequently also brought up to date the PLC control architecture to modern standards in the case of the ZS control.

<u>The PROFINET topology of the ion trap PLC sub-systems:</u>



<u>The ion traps profinet network connects all the following items:</u>

- CPU 315 2PN/DP & CPC controller
- PN-PN coupler unit
- PSC1 deported I/O power supple controller
- PSC2 deported I/O power supply controller
- PDC deported I/O control for electrical distribution
- ACMC deported I/O system for anode current measurements

<u>Note</u>: Other PROFINET network exist also for the HV generator control I/O's and servo motor system for the anode and cathode displacement system/girder for each ZS tank.

10. System remote viewing and control

All local views for the ion trap control system exits also in WinCC V7.0 and web navigator format. This allows for remote monitoring of the state of the system and parmater surveillance, with additional advantages such as long term trend archiving of the ion traps voltage and current regulation.

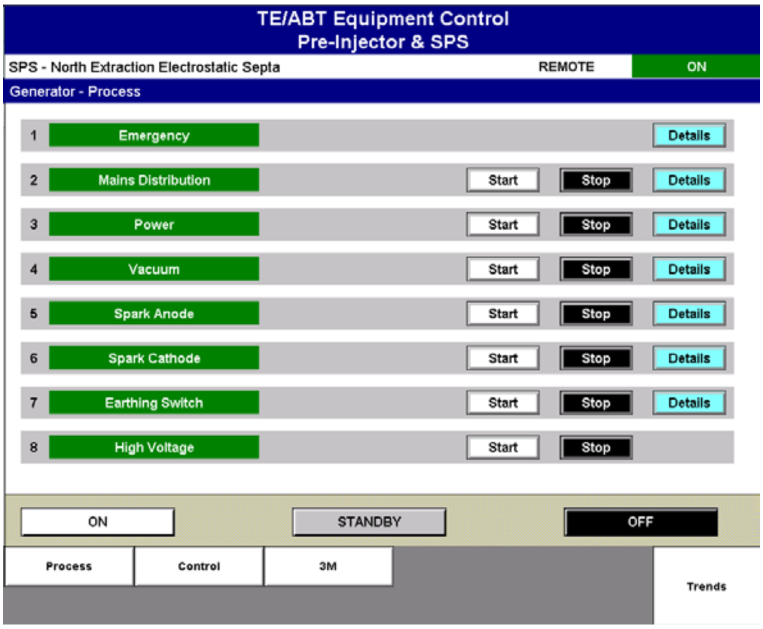


Figure 14 View of the ZS control steps via web navigator WinCC V7.0

Each ZS tank has an ion trap trend window associated with it, the trend parameters are:

Figure 15 View of a ion trap trend window for ZS tank 1

- U ion trap UP – Black
- I ion trap UP - Red
- U ion trap DO - Green
- I ion trap DO - Blue
- I anode current - Grey

Fesa applicative layer

There is also a FESA applicative layer that collates all the important PLC parameters of the ion traps system to allow the middleware layers transcribe these to CCC applications. By default the Ion traps are set to -100 uA Max value, this is hard coded inside the applicative layer software on the FESA shared server system. The front-end computer is nxsba2.

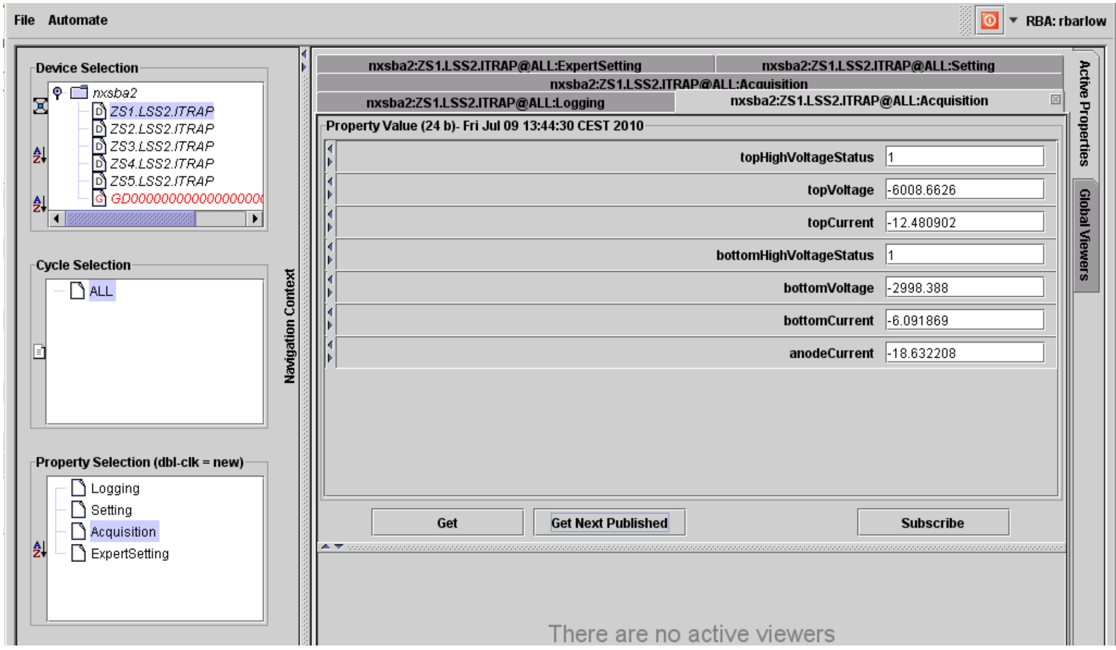


Figure 16 Ion traps FESA applicative window

11. The NAOS/OASIS signal remote viewing system for the ZS septa

The ZS electrostatic septa also has a NAOS system to allow for remote viewing of the ion traps analogue signals. The system has the following signals routed to it via RG50 coaxial cables and these are fed to a multiplexer system (MUX VXI) that can treat low impedance signals and high impedance signals. However the scope cards in the present NAOS system only allow impedance swapping on channel selection, hence when the channel is not selected the system is by default set to 50 Ohms termination. To overcome this, signals are routed via isolating amplifiers with unity gain. The amplifier cards are the type (LEP 882-8077-300A). They offer programmable gains, large signal response and dual output (50 Ω, 1 MΩ). The preferred settings for the ion traps signals is to have these set to unity gain, route via the 50 Ohms output and trim the offset of the card to baseline value.

The NAOS crate (CFV-BA2-saos02) contains the following set of cards:

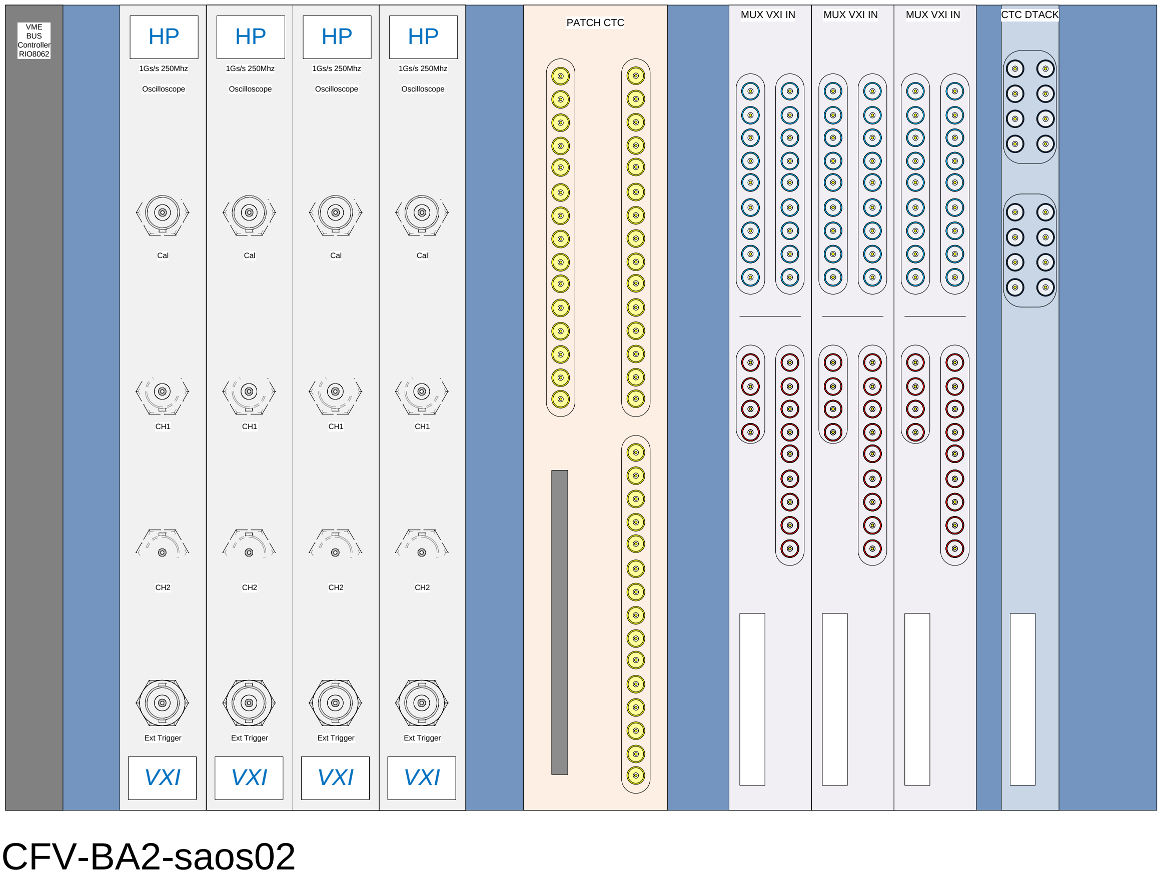


Figure 17 Frontal view of the NAOS remote signal viewing system in BA2

The NAOS system comprises all the following elements :

- VME bus controller RIO 8062
- VXI, HP oscilloscope card, 1Gs/s, 250 MHz (4 of)
- PATH CTC card
- MUX VXI in, 3 OF
- CTC DTACK card

NAOS system functional block diagram:

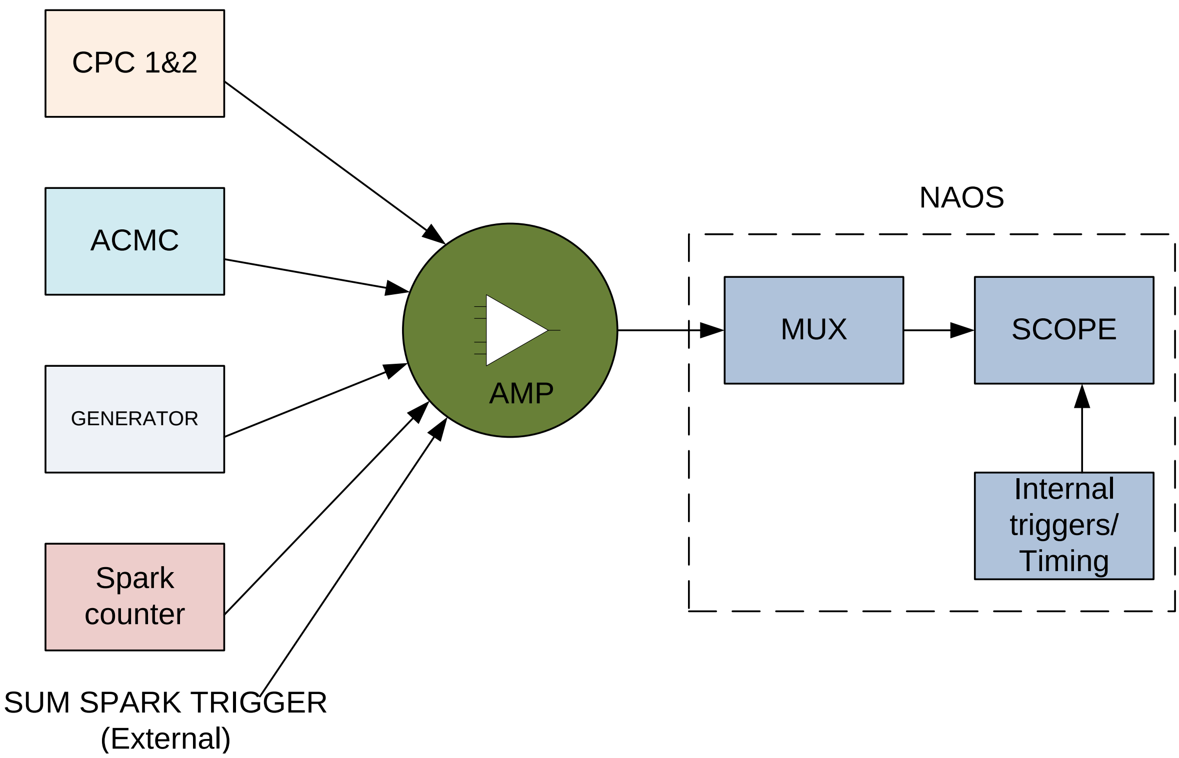


Figure 18 NAOS system functional block diagram

The system has 3 main triggers, these are:

SX.POSTMORTEM-TS -> Sum of sparking (External)
SIX.AMC-TS -> SPS injection cycle (Internal)
SIX.SCY-TS - > LHC super cycle (Internal)

Here is a list of all the NAOS signals brought to the OASIS interface:

NAOS/OASIS BA2 signals		
Signal num	System	OASIS name
1	ACMC	SE_2_ZS1.Ianode-ZS
2	ACMC	SE_2_ZS2.Ianode-ZS
3	ACMC	SE_2_ZS3.Ianode-ZS
4	ACMC	SE_2_ZS4.Ianode-ZS
5	ACMC	SE_2_ZS5.Ianode-ZS
6	SPARK COUNTERS	SE_2_ZS1.sparkA-AS
7	SPARK COUNTERS	SE_2_ZS2.sparkA-AS
8	SPARK COUNTERS	SE_2_ZS3.sparkA-AS
9	SPARK COUNTERS	SE_2_ZS4.sparkA-AS
10	SPARK COUNTERS	SE_2_ZS5.sparkA-AS
11	CPC	SE_2_ZS1.ItrapBottm-AS
12	CPC	SE_2_ZS2.ItrapBottm-AS
13	CPC	SE_2_ZS3.ItrapBottm-AS
14	CPC	SE_2_ZS4.ItrapBottm-AS
15	CPC	SE_2_ZS5.ItrapBottm-AS
16	SPARK COUNTERS	SE_2_ZS1.sparkHT-AS
17	SPARK COUNTERS	SE_2_ZS2.sparkHT-AS
18	SPARK COUNTERS	SE_2_ZS3.sparkHT-AS
19	SPARK COUNTERS	SE_2_ZS4.sparkHT-AS
20	SPARK COUNTERS	SE_2_ZS5.sparkHT-AS
21	CPC	SE_2_ZS1.ItrapTop-AS
22	CPC	SE_2_ZS2.ItrapTop-AS
23	CPC	SE_2_ZS3.ItrapTop-AS
24	CPC	SE_2_ZS4.ItrapTop-AS
25	CPC	SE_2_ZS5.ItrapTop-AS
26	GENERATOR	SE_2_ZS.Imeasgene-AS
27	GENERATOR	SE_2_ZS.Umeasgene-AS

12. Conclusion

The commissioning of the new ZS electrostatic septa system in BA2 just after it's refurbishment during the course of 2009 was deemed a success. The entire system underwent total renovation (after 30 years of service) and is mainly controlled with the help of modern industrial automation systems (SIEMENS technology & high quality hardware components). The ion trap system has proven to be effective and reliable since its debut, mainly due to the use of quality parts (Heinzinger power supplies, Delta Elektronica power supplies) which has shown it's dividends towards the good running of the complete ZS system. During the course of April 2010, studies were carried out making strong usage of the ion traps control to aid the understanding of the internal sparking phenomena inside the anode/cathode structures of each ZS tank in relation with e-cloud effects provoking out gassing in the vacuum medium of the tanks. A 3 days long SPS MD was dedicated towards this. The results from this MD will alter the design of the ion trap bulkhead system and type of power supplies used towards future developments of ZS system upgrades. These studies where essential in understanding the effects of electron cloud & beam coupling. Ultimately there will be a test bench developed and installed in the LSS6 tunnel in which ZS tank development studies will be carried out with SPS beam and SPS high intensity LHC type beam to help machine physicists assess the sparking effects and e-cloud problems which could otherwise affect beam quality and destroy ZS tanks due to excessive out gassing. It has been deemed crucial to improve ZS performance for the future and with the current new ZS system in BA2, a first step towards this has been accomplished with the use of modern industrial control and interface tools that operators and machine physicists can use to control and understand the electrostatic septa behaviour.

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