Design specifications and test of the HMPID's control system prototype in the ALICE experiment

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HMPID Control System

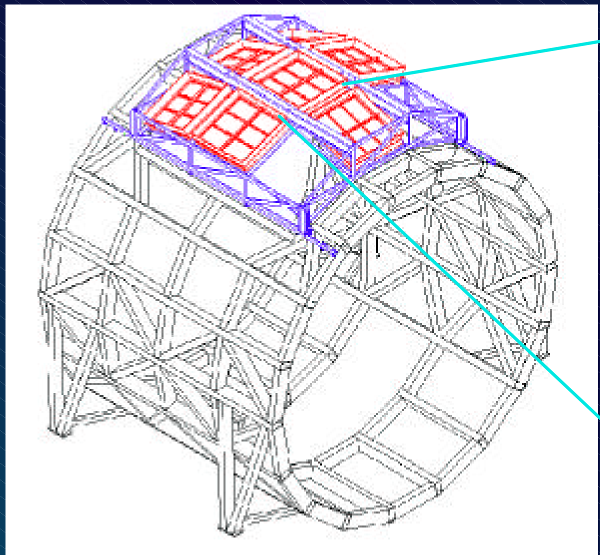
Design

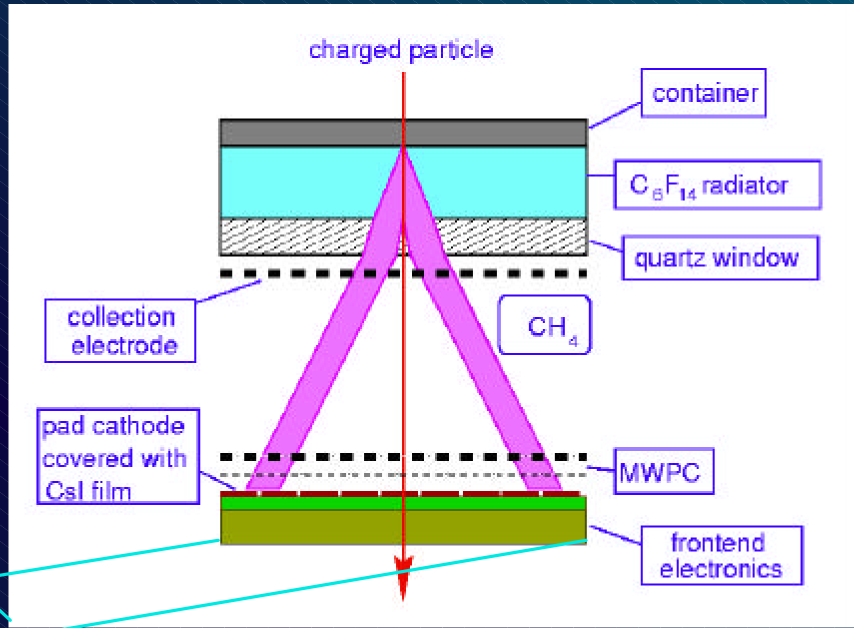
Implementation and tests

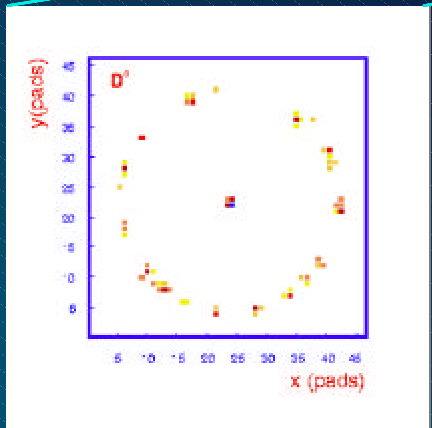
Conclusions

HMPID, the RICH Cherenkov detector

High Momentum Particle Identification Detector

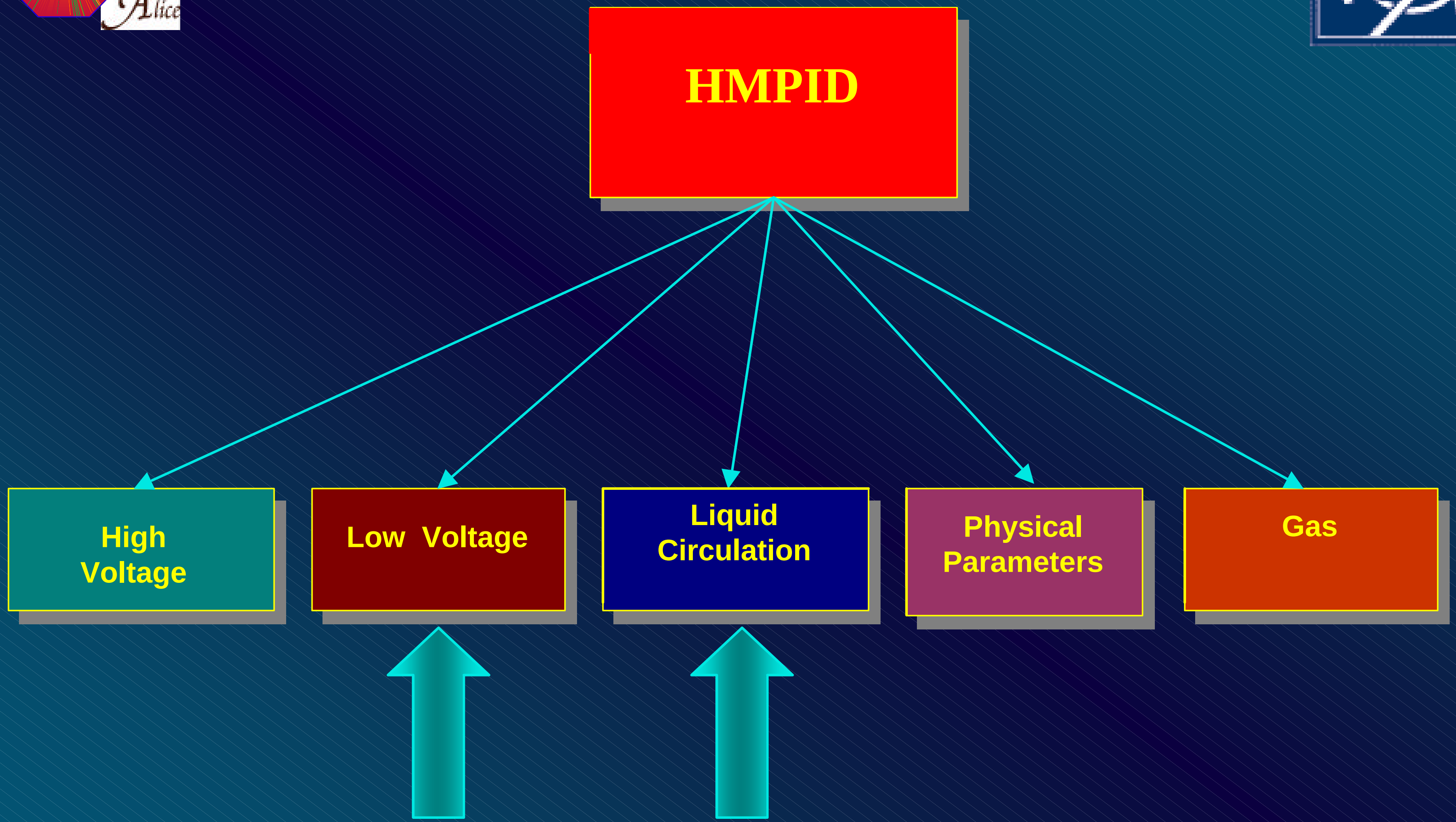




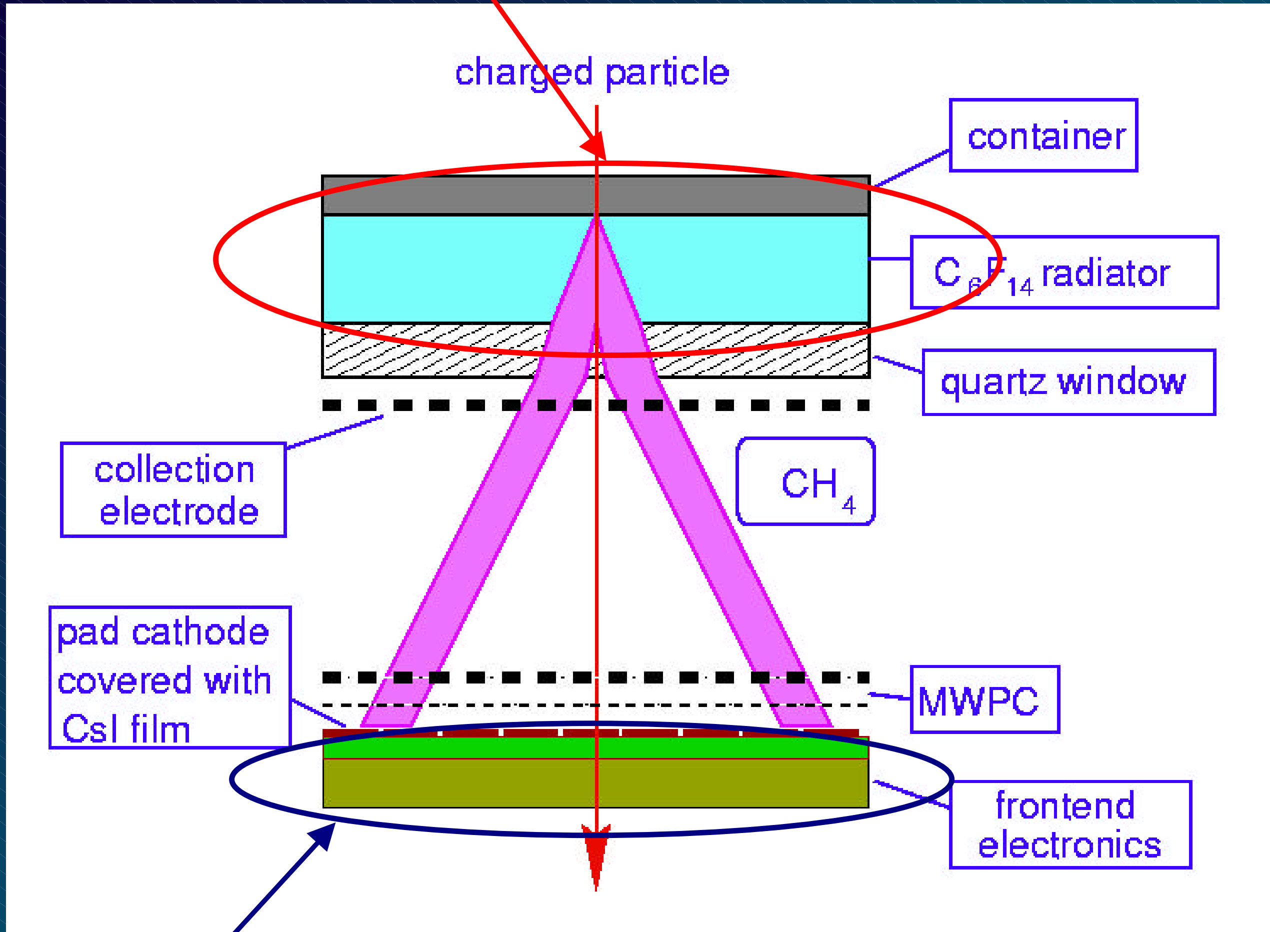


$$\cos \vartheta = \frac{1}{n\beta}$$

HMPID's Subsystems

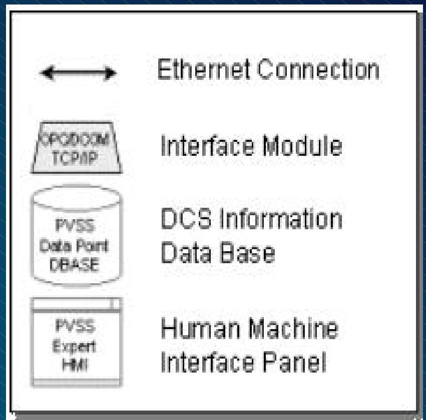


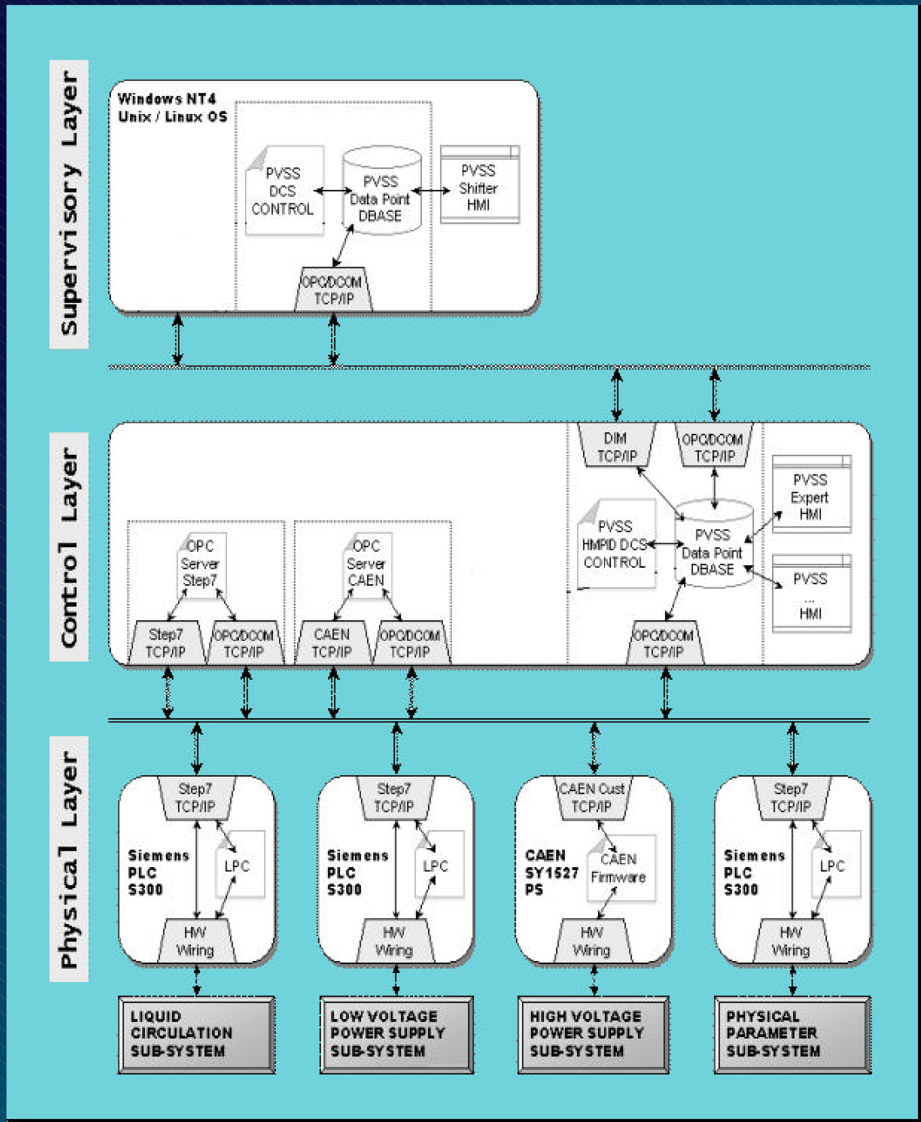
Liquid Circulation System



Low Voltage System

Software Architecture of the HMPID's control





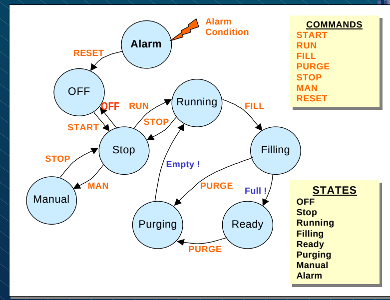
LPC = Local Process Control

HMI = Human Machine Interface

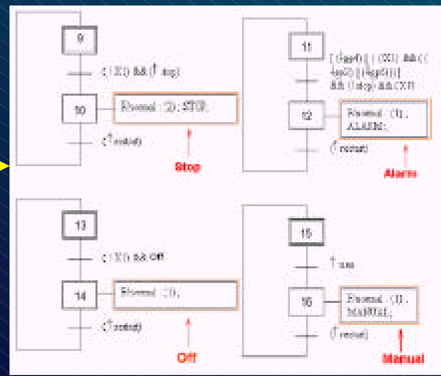
OPC = OLE for Process Control (Microsoft)

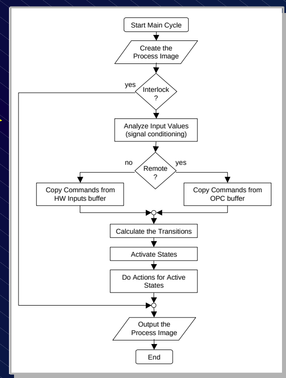
DCOM = Distributed Component Object Model (Microsoft)

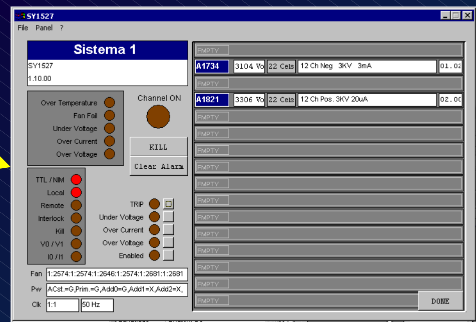
The Control System Design



1. Definition of the Requirements List
2. Description of the process as a finite state machine
3. GRAFCET modeling
4. Coding of grafcet into Instruction List
5. Check of the parameters read by PLCs
6. Coding of the Man-Machine Interfaces into SCADA PVSS environment.

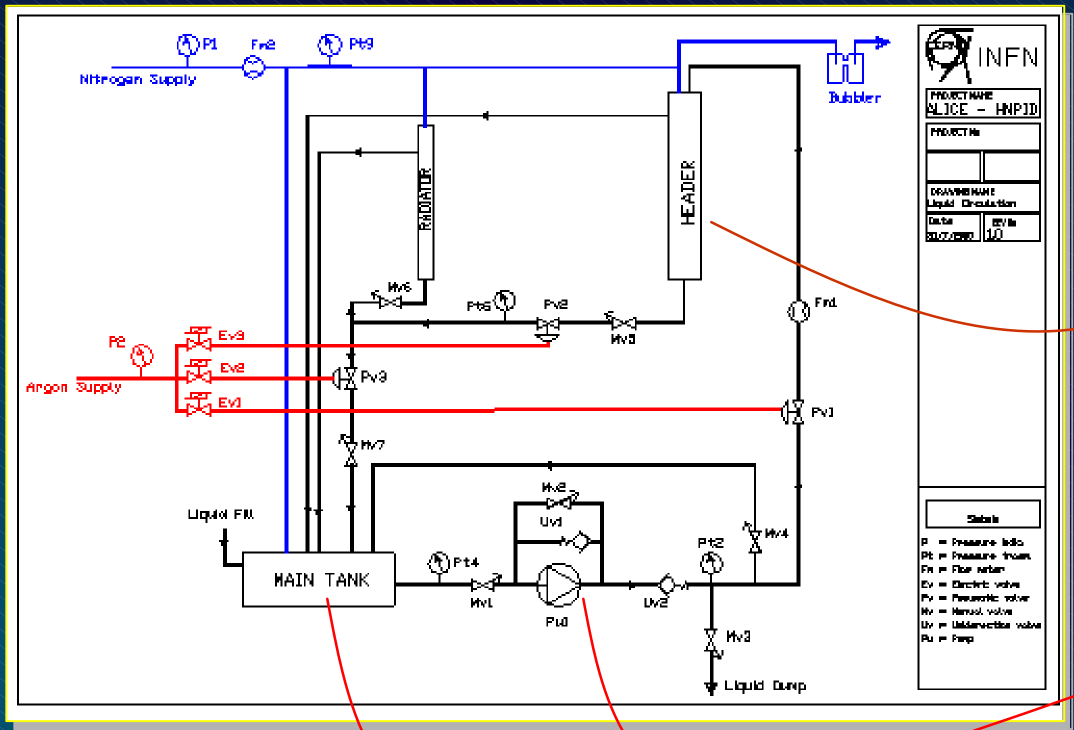


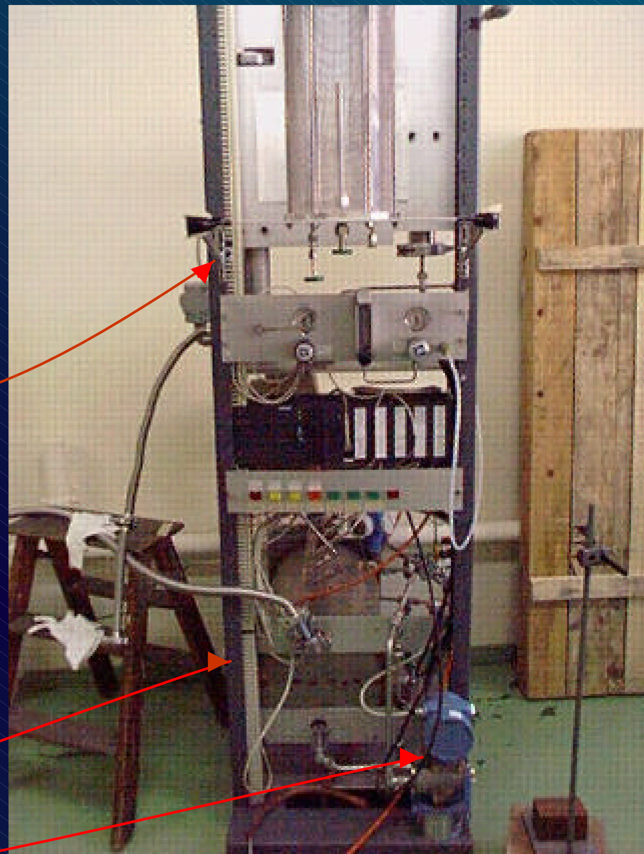




The Circulation System

Prototype Lab 1-R-033





Radiator: Neoceram-quartz 140×45×1 cm

The Transitions Diagram

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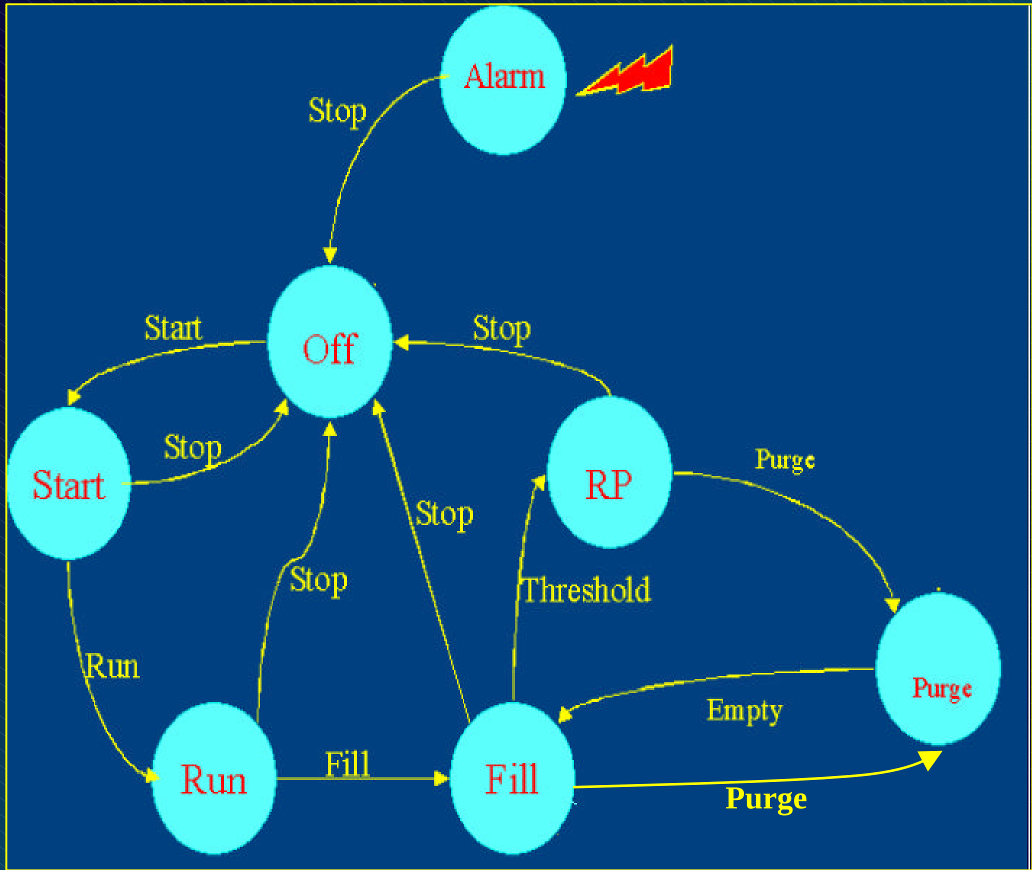

Commands

Start

Stop

Fill

Run

Radiator Purge

Header Purge

States

Start

Off

Alarm

Fill

Run

RP

Radiator Purge

Header Purge

The Circulation System Grafcet

1. Definition of the Requirements List
2. Description of the process as a finite state machine
3. **GRAFCET modeling**
4. Coding of grafcet into Instruction List
5. Check of the parameters read by PLCs
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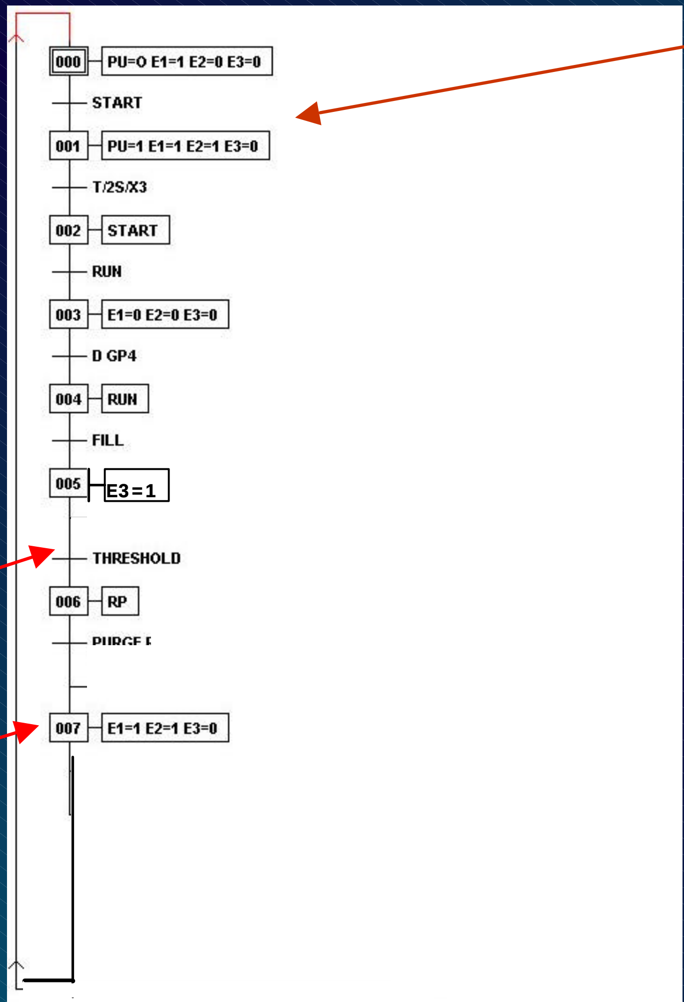
Normal



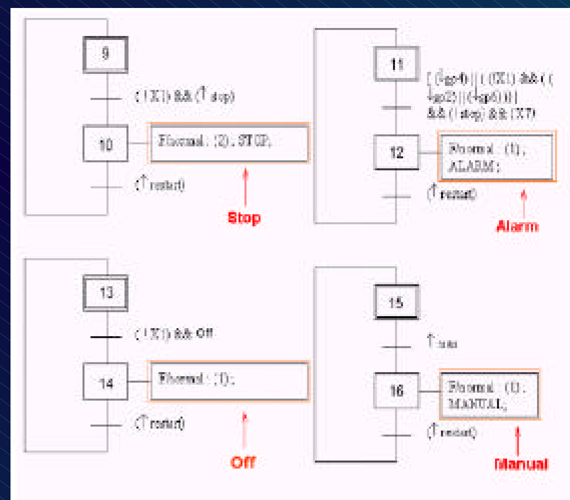
ACTION

TRANSITION

STATE

E3=1

Master



The Variable Table (VAT)

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Process Input Word

"Brute" value

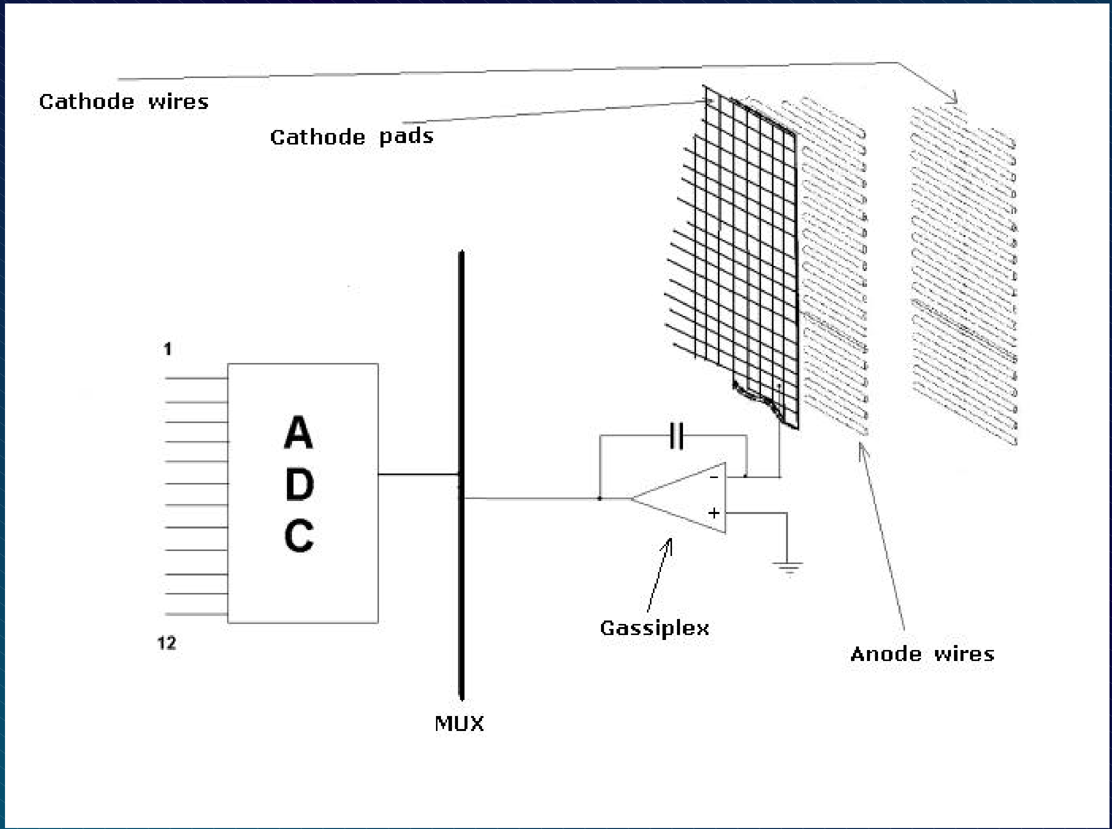
Memory Double Word

[mA] [mbar] [mm] [l]

PIW	288	"Pt4"	DEC	14788
MD	30	"Pt4 reading [mA]"	REAL	8.55
MD	40	"Pt4 Pressure [mbar]"	REAL	40.75
MD	50	"Column Height [mm]"	REAL	115.84
MD	60	"Tank Volume [L]"	REAL	8.18
PIW	296	"Pt6"	DEC	14148
MD	70	"Pt6 reading [mA]"	REAL	12.18
MD	80	"Pt6 Pressure [mbar]"	REAL	23.43
PIW	300	"Pt9"	DEC	13438
MD	90	"Pt9 reading [mA]"	REAL	11.76
MD	100	"Pt9 Pressure [mbar]"	REAL	972.07

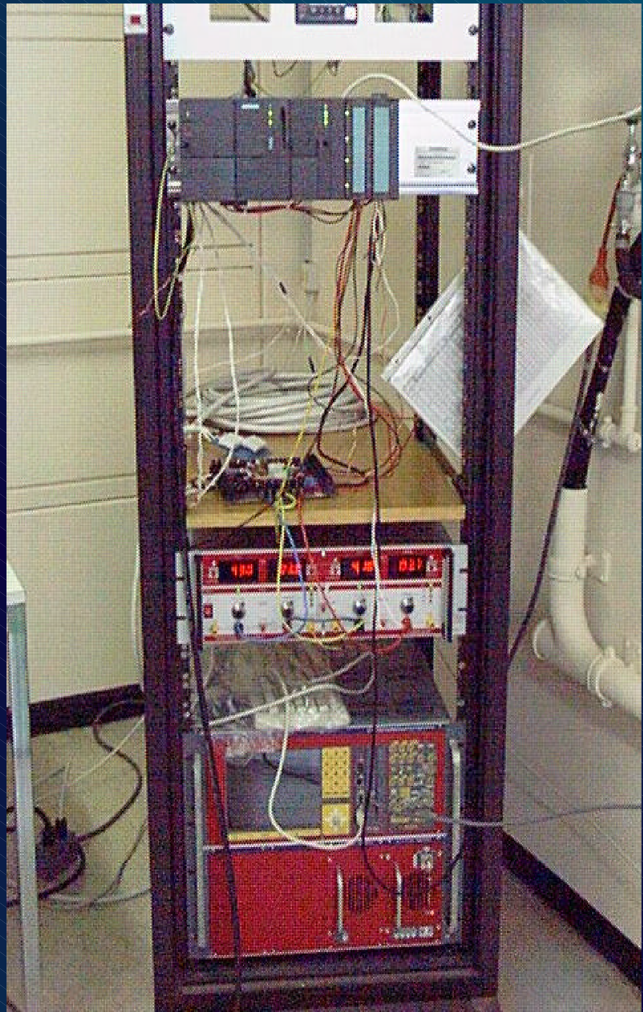
Operating states also tested: starting/stopping the system, filling the header, filling the radiator, purging the system and simulation of alarm conditions.

The Low Voltage System

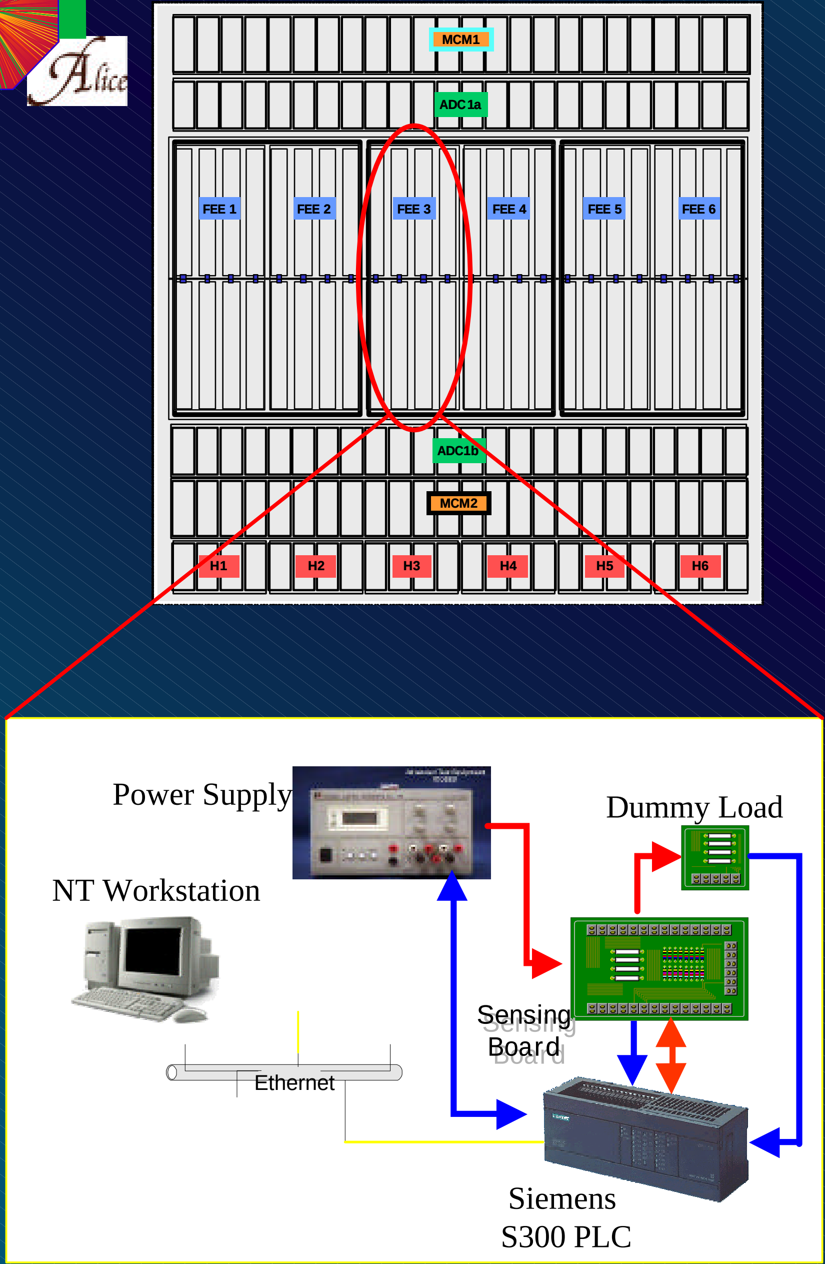


MWPC: 150×150×8 cm

Prototype Lab 1-R-033

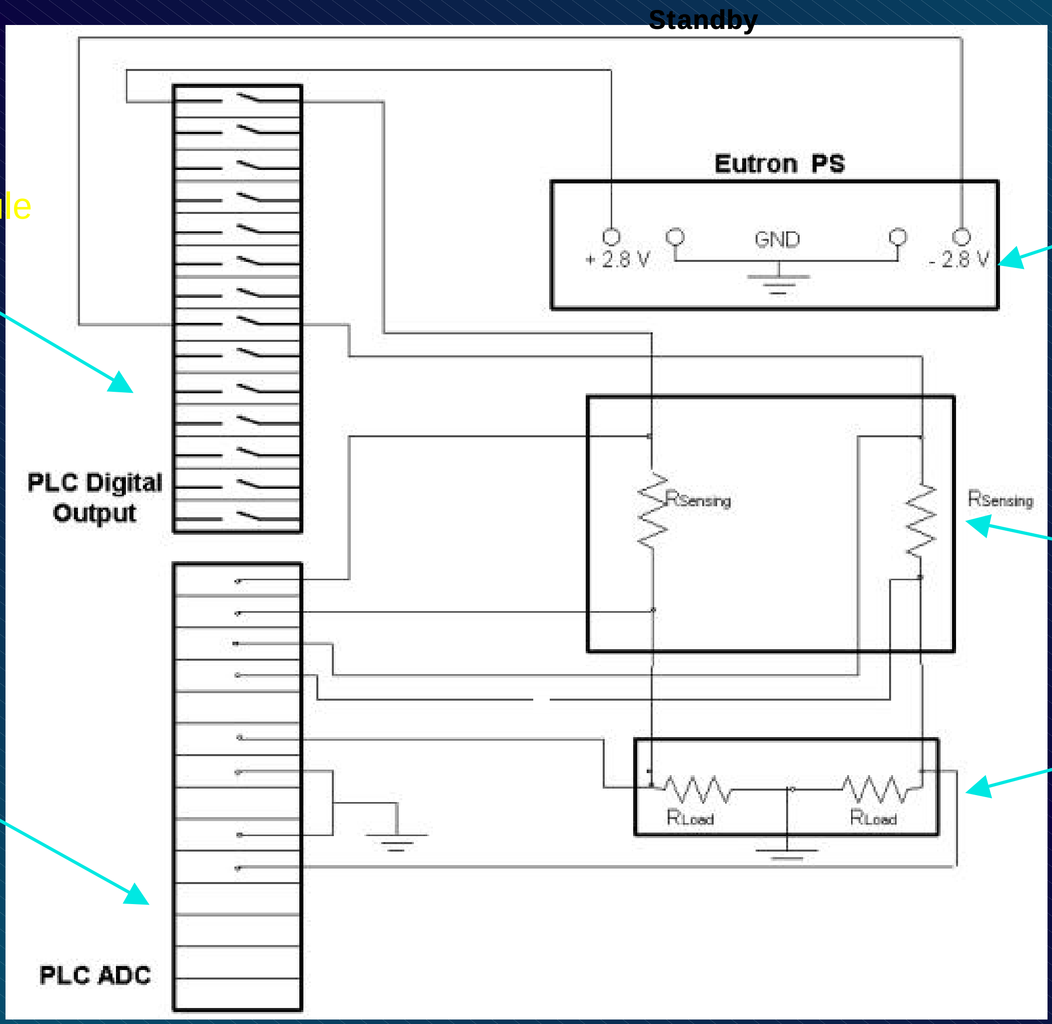


The LV Segmentation



2 MCM Segments
2 ADC Segments
6 FEE Segments, 480 Gassiplex each
6 HV Segments, 48 wires each

The Test Bench schematics



PLC Siemens

Digital Output Module

PLC Siemens

ADC Module

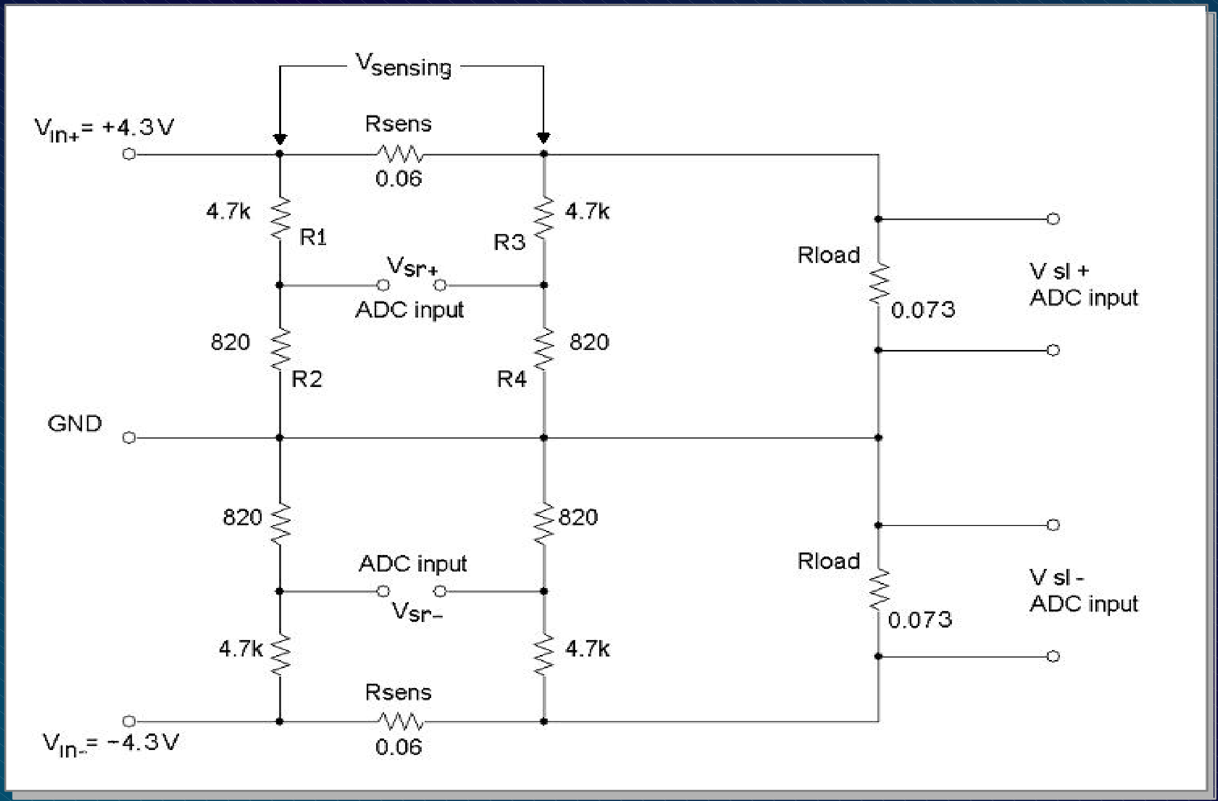
Eutron Power Supply:

0-8V, 20 A

Sensing Board

Dummy Load

Sensing Board



$$V_{sr+} = V_{+s} - V_{-s} = V_{in+}\left(\frac{R2}{R1+R2} - \frac{R4}{R3+R4}\right) + V_{sensing}\left(\frac{R4}{R3+R4}\right)$$

$$V_{sr+} = V_{ped} + V_{sensing}\frac{R4}{R3+R4} \Rightarrow V_{sensing} = \left(V_{sr+} - V_{ped}\right)\frac{R3+R4}{R4}$$

ADC Siemens U_{CM}= 2.5V

Sensing Board

U_{CM}= (Vin+Vo)/2 ≈ 3.9 V

Network Reduction Ratio:

A= R4/(R3+R4)= 0,325

$$d = \frac{LSB}{A \cdot R_S} = 2{,}8mA$$

Single GASSIPLEX fault detection (23 mA)

Low Voltage Models

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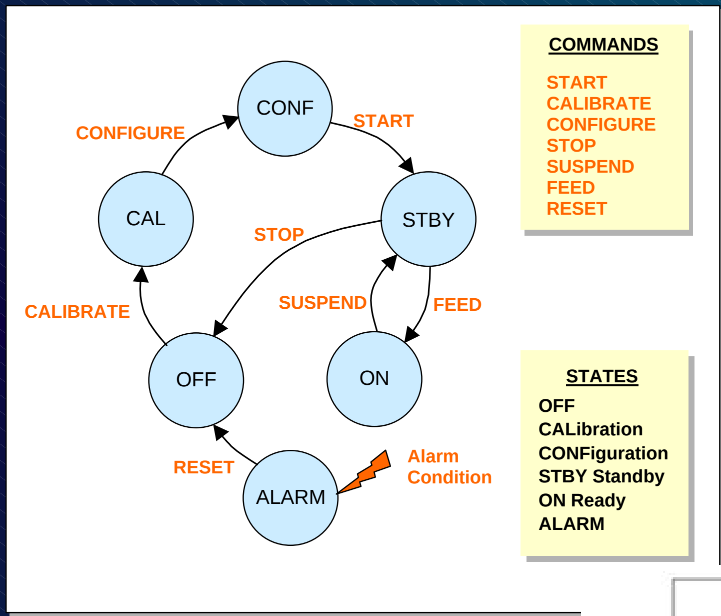

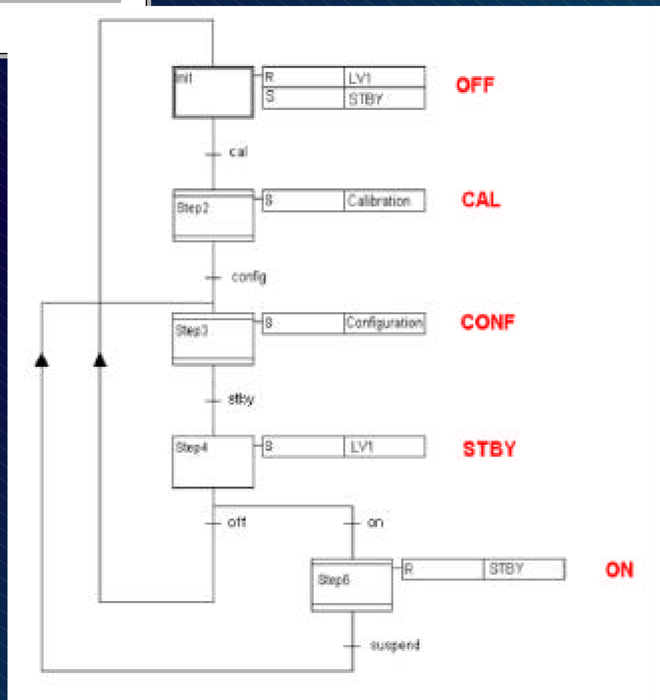

Reading of the PLC Variables (VAT)

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Process Input Word

$V_{sensing}/R_{Sensing}$

PIW	288	"V sensing + ADC"	---	DEC	8872
PIW	290	"V sensing – ADC"	---	DEC	-14440
PIW	292	"V load + ADC"	---	DEC	15496
PIW	294	"V load – ADC"	---	DEC	-15496
MD	100	"I load +"	---	REAL	3.737275
MD	108	"I load -"	---	REAL	-4.101968
MD	132	"V load +"	---	REAL	2.802372
MD	124	"V load -"	---	REAL	-2.802372
MD	20	"V sensing + input ADC"	---	REAL	25.67129
MD	28	"V sensing - input ADC"	---	REAL	-41.7824

[A]

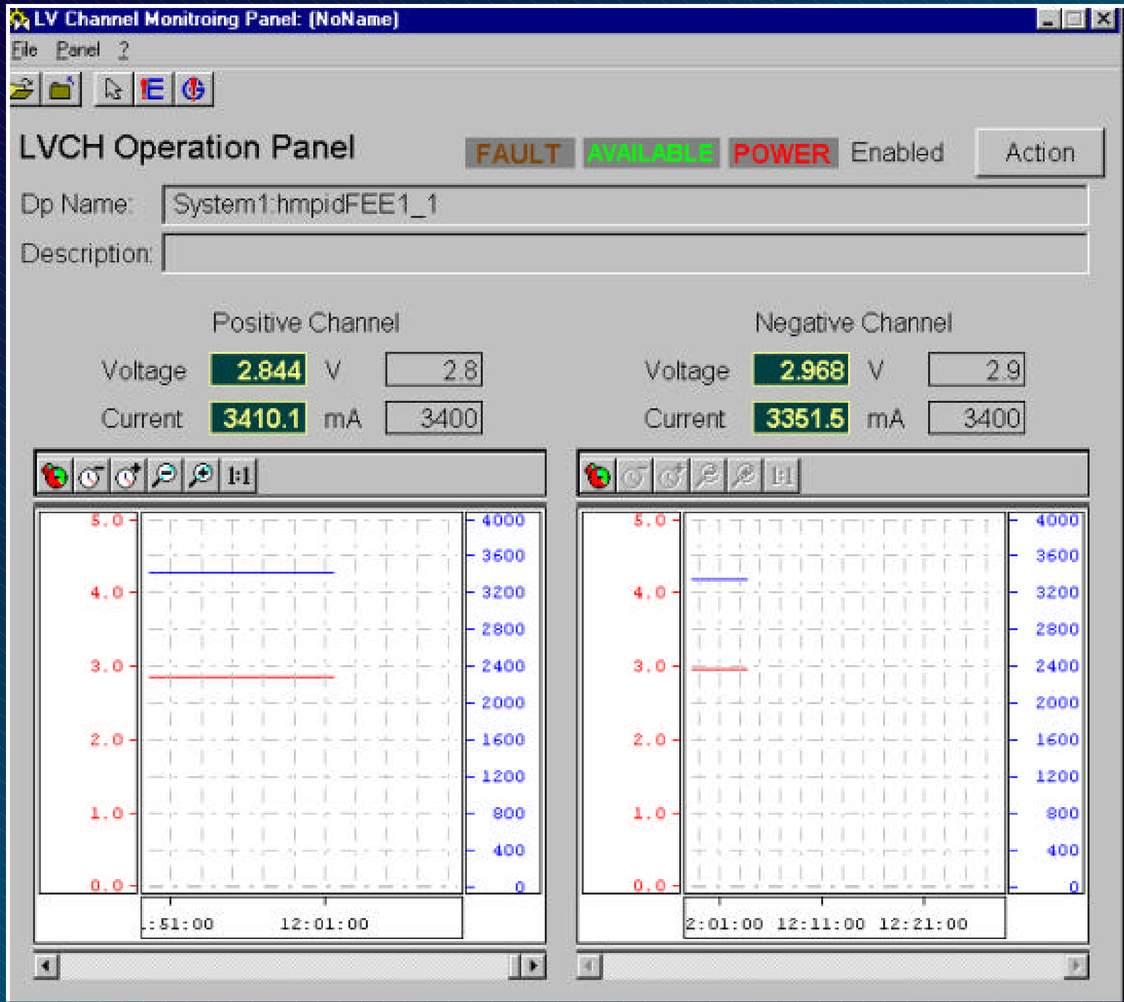
[V]

[mV]

Memory Double Word

$V_{sr}-V_{Ped}/A$

Trend diagrams



SCADA

Supervisory Control And Data Acquisition

Man Machine Interfaces

1.Definition of the Requirements List

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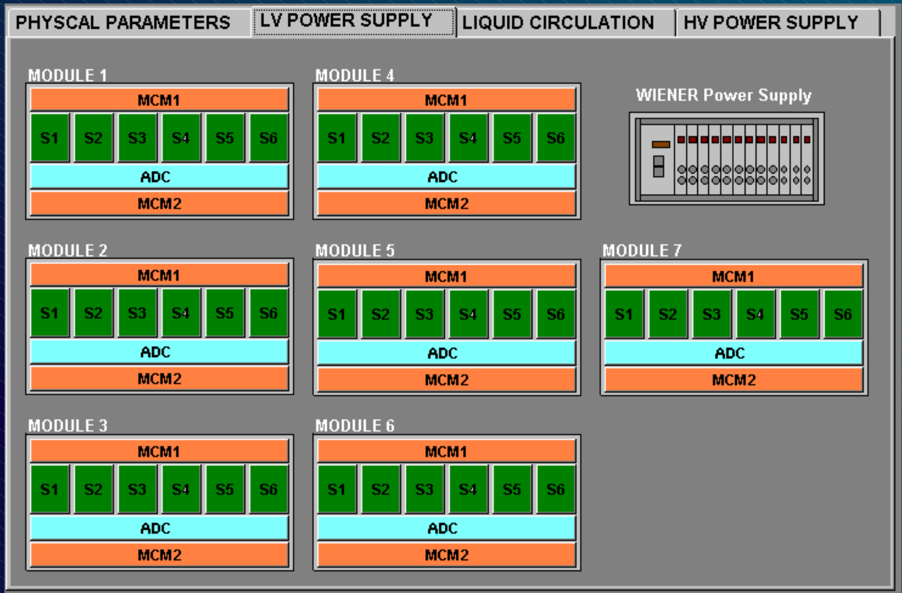

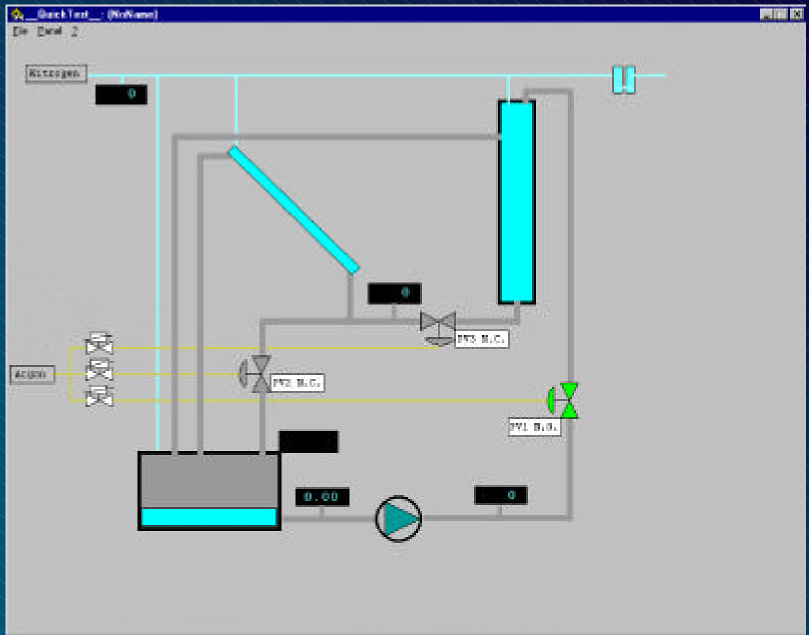

LIQUID

Circ. Sys.

LV Sys.

CONCLUSIONS

The methodology adopted hereby is **<u>effective</u>** and **<u>time saving</u>:**

- The Requirements List lets us fulfill the system designer's desires
- GRAFCET lets non-specialists also understand the way the controls work (making debugging easier than ever)
- GRAFCET lets also programming the SCADA.
- The method aims to fix common bases for the whole DCS design.

Next steps:

√ Integrating the control of Liquid and Low Voltage System into a coherent, detector-oriented man-machine interface (following the JCOP frameworks philosophy)

√ Defining a systematic procedure for alarms handling

√ Defining a systematic procedure for measuring the critical parameters

TACK SA MYCKET !

(Thank you!)