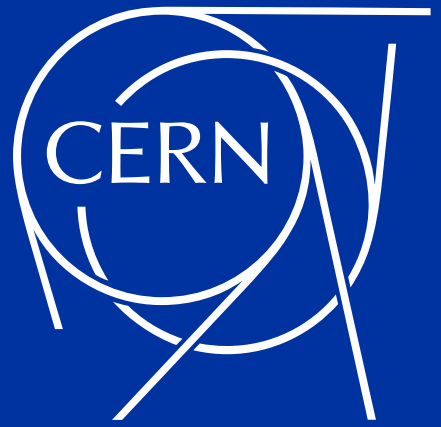


MPP meeting #199:

WIC delay for switching off equipment for the PS

Richard Mompo on behalf of the WIC team

27 November 2020

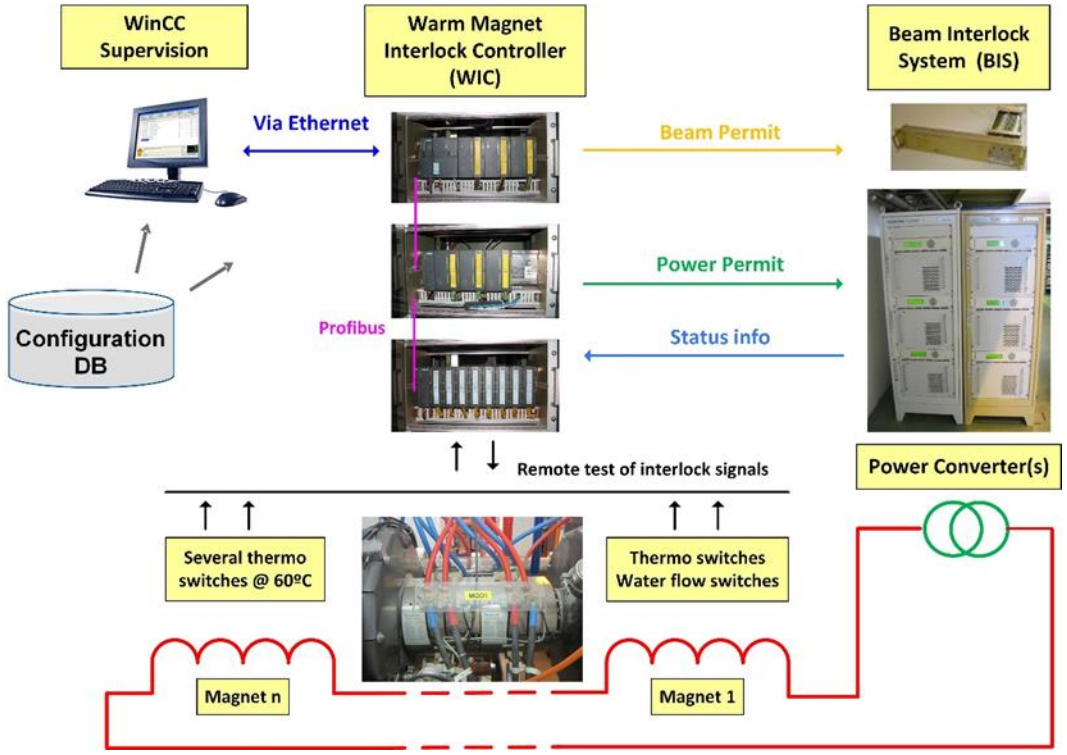
Introduction

The WIC system is a generic solution (originally) designed for the protection of resistive magnets

It is a PLC based system (Siemens)

It was first implemented in the SPS-LHC transfer lines, the LEIR and the LHC in 2004-2005

It is now deployed in the whole CERN accelerator complex



- It collects inputs from thermo-switches, flow switches, internal PC faults

- It provides Permits to the power converter and beam interlock system

Recently, we added inputs from other systems: PLCs, vacuum gages…

The principle

In case of a magnet overheating, the WIC will:

1. Request a Beam Dump to the BIS (circular acc.) or Inhibit the next beam (transfer lines)
2. After a configurable delay (typically 1,2s), remove the "Power Permit" to the power converters

In case of a PC failure, the WIC will:

1. Request a Beam Dump to the BIS

This delay between the beam dump and removing the "Power Permit" was introduced to allow a clean beam extraction before ramping down the magnets

The response time of the WIC is not an issue for the protection of resistive magnets

This delay is common to all circuits connected to a given WIC

Extension to other equipment

Since 2016 (ELENA project), other types of equipment are protected by the WIC

This trend increased during LS2

Machine	Eq. type
ELENA	Septum (TE-ABT)
ELENA	Ion switch (TE-ABT)
ELENA	Electron Cooler (BE-BI) ?
ELENA	Electrostatic Components (BE-APT) ?

Machine	Eq. type
LHC	Beam Beam Compensation Wires (BE-BI)

Machine	Eq. type	Eq. name
PSB	Septum (TE-ABT)	BI.SMV10
PSB	Bumper (TE-ABT)	BI.BSW
PSB	Septum (TE-ABT)	BE.SMH15L1
PSB	Septum (TE-ABT)	BT1.SMV10
PSB	Septum (TE-ABT)	BT4.SMV10
PSB	Septum (TE-ABT)	BT2.SMV20

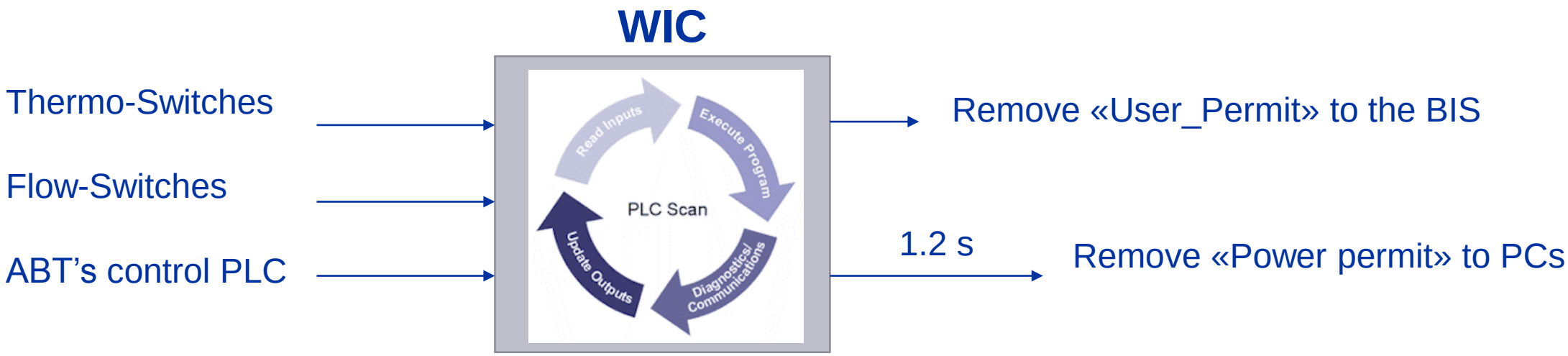
Other cases ?

No BIS connection

Machine	Eq. type	Eq. name
PS	Septum (TE-ABT)	PE.SMH16
PS	Septum (TE-ABT)	PE.SMH57
PS	Septum (TE-ABT)	PE.SMH61
PS	Bumper (TE-ABT)	PE.BSW57.61
PS	Septum (TE-ABT)	PI.SMH26
PS	Septum (TE-ABT)	PI.SMH42

Identified as critical
(high current density)

Standardized interface for all Septa and Bumpers



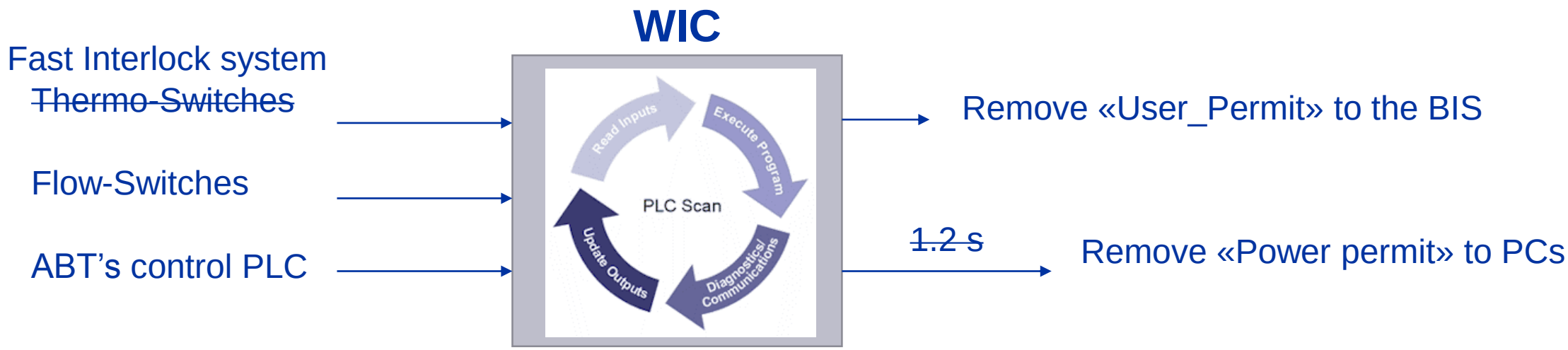
The TS and FS signals are received directly from the tunnel and connected, in parallel, to:

- ABT's control PLC
- The WIC

by means of safety relays

=> ABT's control PLC is NOT introducing any extra delay.

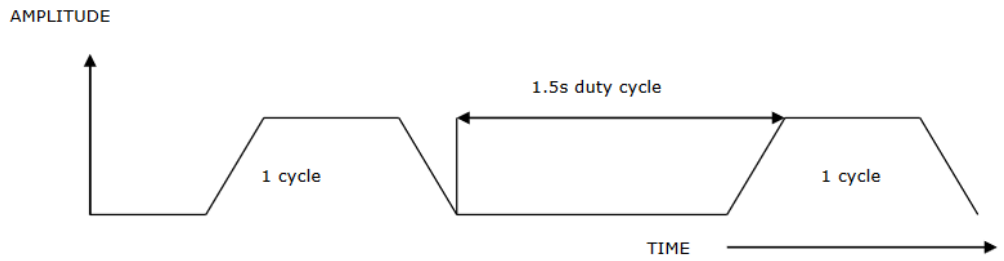
Special case of the PE.SMH57



The Irms max of this septum is 5 kA when the power converter can deliver 10 kA in continuous mode.

A dedicated "Fast Interlock system" was put in place (ABT) that measures the voltage and the current to calculate its internal temperature.

It sends an interlock signal at the end of a pulse to avoid switching off the PC during a pulse.



PS duty cycle: 600ms plateau @ 10kA

SMH57 THIN SEPTUM MAGNET FAST INTERLOCK SYSTEM by Roger Barlow

Special case of the PE.SMH57

Because of its high current density, the response time of the WIC becomes an issue.

A general rule of thumb is to assume that the PLC could take as long as twice the maximum cycle time to respond. But this assumption is not correct !

The response time of a PLC depends on 3 parameters:

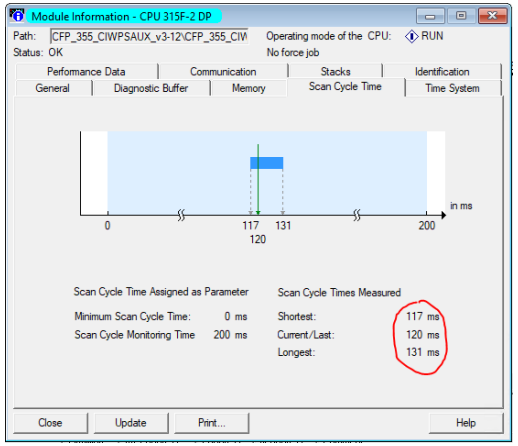
1. PLC cycle time => btw 117 and 131 ms
2. Profibus cycle time => btw 5,8 and 28,1 ms
3. I/Os sampling rate => btw 3 to 5 ms

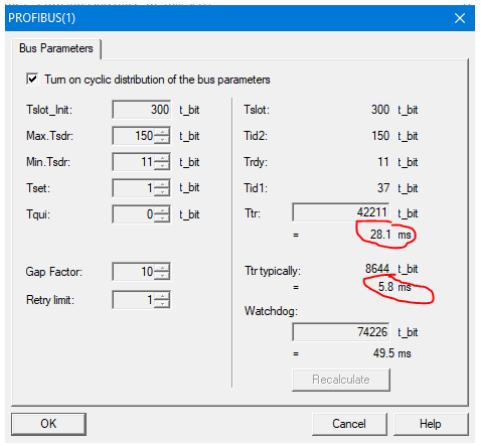
This gives a response time for the PS WIC : btw 140 ms and 340 ms

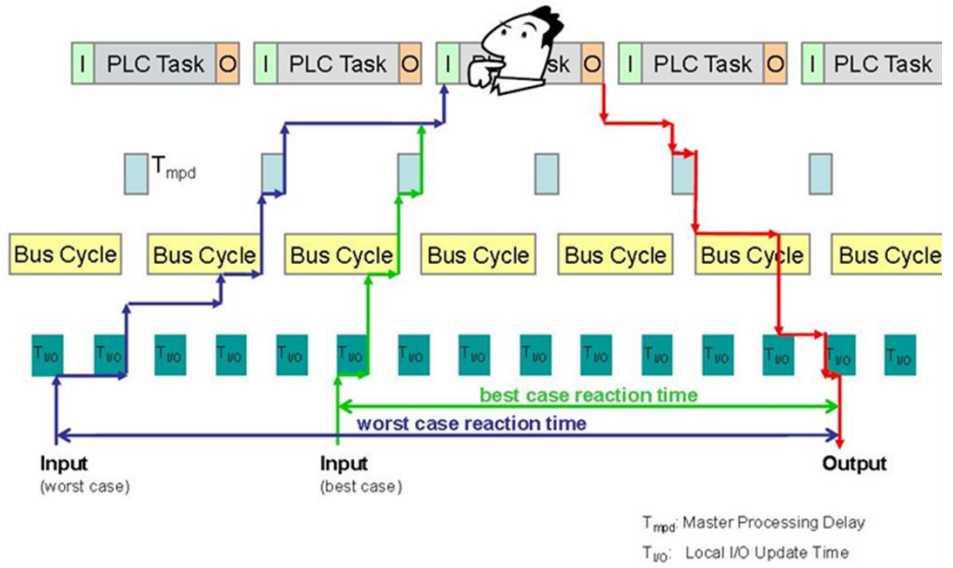
Adding the 1.2 s delay is problematic for TE-ABT

Therefore, we made an exception in the PS and removed this delay

But this affects also all other circuits of the PS (next slide)







List of power converters connected to the “PS_Aux” WIC

Bldg. 355
PR.RODN
PR.RDHZ05.OC
PR.RXNO
PR.RBGI84MAIN
PR.RBGI84TRIM
PR.RDHZ60.OC
PR.RBGI82MAIN
PR.RBGI82TRIM
PR.RDVT02
PR.RDVT04
PR.RDVT08
PR.RDVT12
PR.RDVT20
PR.RDVT22
PR.RDVT24
PR.RDVT30
PR.RDVT34
PR.RDVT38
PR.RDVT44
PR.RDVT54
PR.RDVT64
PR.RDVT70
PR.RDVT74
PR.RDVT76
PR.RDVT80
PR.RDVT88
PR.RDVT94
PR.RDVT98

Bldg. 365
PE.RBSW12
PE.RBSW14
PE.RBSW20
PE.RBSW22
PE.RBSW23
PE.RBSW57
PE.RQKE16
PI.RBSW26
PI.RBSW40
PI.RBSW41
PI.RBSW42
PI.RBSW43
PI.RBSW44
PI.RQLB
PR.RDHZ18.OC
PR.RONO39
PR.RONO55
PR.RQSE
PR.RQTRDB.A
PR.RQTRDB.B
PR.RQTRJ.TR.A
PR.RQTRJ.TR.B
PR.RXNO39
PR.RXNO55
PR.RXSE

+

PE.RSMH16
PI.RSMH26
PI.RSMH42
PE.RSMH57
PE.RBSW57
PE.RSMH61

Conclusions and discussion

The delay of 1.2 s between the beam dump and removing the "Power Permit" was implemented by default for all WIC systems

- Even for installations with no BIS connection

Recently, this delay was removed for the WIC installation in the PS, on request of TE-ABT

- Remains the WIC reaction time (140 ms to 340 ms)… Is it acceptable for the PE.SMH57 ?
- Is it an issue for the other circuits connected to this same WIC ?
- If we switch off an "AUX" power converter during a pulse (which was the case before with a delay)?

It is technically feasible to set different values for each WIC (all machines) considering:

- Whether it's a circular machine or a transfer line
- If they protect any sensitive equipment (Ex: ELENA)
- Is there a need for this ?

Thank you for your attention

Proton chain

Machine:	Nb. of PLCs	BIS connection
LHC	8	Yes
LHC-SPS transfer lines	4	Yes
SPS	7	Yes
TT10	1	Yes
PS – TT2	2	No
PSB ejection lines	1	Yes
PSB rings	4	Yes
PSB injection lines	1	Yes
Linac 4 + TL	2	Yes

Ion chain

Machine:	Nb. Of PLCs	BIS connection
Leir	1	No
Linac3	1	No

Experimental areas

Machine:	Nb. Of PLCs	BIS connection
Hie-Isolde	2	No
Elena	1	No
Awake	1	Yes
East Area	1	No
HiRadMat	2	Yes
TT20	1	No

Ttr

(Target Rotation Time)

The target rotation time is the maximum length of time available for a token pass. During this time, all active nodes (DP-masters, etc.) are able to send once (token). The difference between the target rotation time and the actual hold time of a node determines the length of time remaining for the other active node (programming device, additional DP masters, etc.) masters to send data frames.

Typical Ttr

The typical data cycle time is the average response time on the bus when all the configured slaves are exchanging data with the DP master. None of the slaves reports any diagnostic messages and there is no additional message frame communication on the bus with programming devices or other active nodes, etc.

This time is for informational purposes only and is not transferred to the nodes.