EHBS integration in the control system

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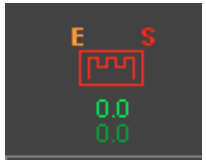
on behalf of the Cryogenics Controls Project members (EN/ICE – TE/CRG)

EH Integration (Analog object)



CRYO SCADA

CIET

PLC

FEC

AL

AL

TS_2

TS_1

Analog

AO

Analog setpoint

EH

Ethernet Comms.

DI

AI

Analog feedback

Status

15

0

OverTemp

IOError

OverTemp

IOError

Analog feedback
Status

Analog setpoint

EH Electronics Board

Wfip Comms.

AL: Alarm
DI: Digital Input
AI: Analog Input
AO: Analog Output

TS: Temporary Stop
FS: Full Stop

EHBS Integration (AnaDO object)

CRYO SCADA

CIET

AL

AL

AL

FS

TS_2

TS_1

AnaDO

DO

Activation

AO

Analog setpoint

EH

FEC

PLC

DI

AI

Analog feedback

Status

15

0

OverTemp

IOError

OverTemp

IOError

Status

Analog feedback

On/Off

Enable/Disable

Analog setpoint

EH Electronics Board

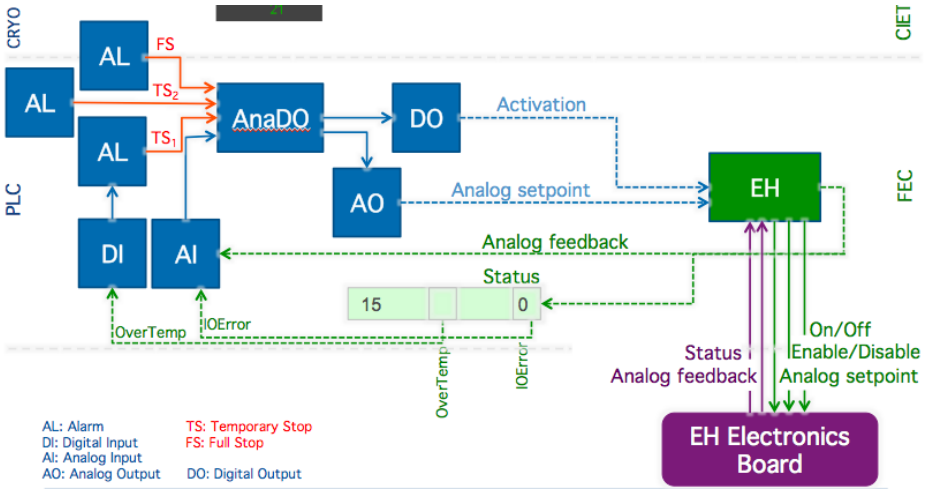
AL: Alarm
DI: Digital Input
AI: Analog Input
AO: Analog Output

TS: Temporary Stop
FS: Full Stop
DO: Digital Output

EH vs. EHBS

- **Availability**
  - EH
    - Automatic recovery when conditions are fulfilled
  - EHBS
    - Need explicit action to recover in several situations
- **Safety (Self-protection)**
  - EH
    - Not safe state when Wfip communication fails
  - EHBS
    - Handshake protocol (one direction): watchdog to get in a safe state when lost of Wfip communications

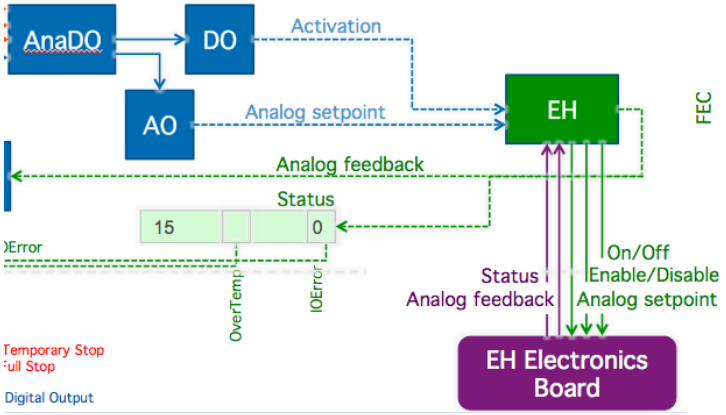
EHBS Status



- Integration with :
  - TS on *overtemp*
  - FS* (*Fullstop*) if 3 times of TS *overtemp* during the last 2 hours.
  - *IOError* signal when all anomalous conditions.
- Consequences:
  - **Operation**: In case of a card severe error (other than ***overtemp***) the operator will only see an "E" in the widget but not an alarm.
  - In case of card malfunction the control and/or operator will only realize when the perturbed by the collateral effect in the process.
- All 8 sectors deployed: ~ 60 EHBS per sector.

*FS needs a manual action of an operator: ACK alarm

Integration Principles



- Principles
  - The card must protect itself if possible (The FEC & PLC must protect otherwise)
  - The card (and the FEC software) must enlarge availability as much as possible
    - Card: Recovering automatically when a problem disappears.
    - FEC: Detecting the problem and enabling the card back when the problem disappears
  - All the complexity of the card must be hidden to the control system and/or operator
    - Activation by successive pulses (~15 seconds each)
    - Activation (**PLC command**) vs. On/Off and Enable/Disable (**CARD commands**)
    - Relays blocking (Off command when operating in AC mode)
    - Operation around the switching AC/DC point

Components failure Analysis

Case	PLC	FEC	Card	Action
(1) PLC		✔		Set SP=0 (after 2 min)
(2) FEC			✔	Protection (after 30 s)
(3) Ethernet: switch and/or cable		✔		Set SP=0 (after 2 min)
(4) WFip repeater, PCI card and/or cable			✔	Protection (after 30 s)
(5) WFip agent			✔	Protection (after 30 s)

Improvement proposals

- Operation requirement: Need of an alarm (BEEP) when a heater is not working properly (To define!)
- Solutions:
  1. Keeping the current control system objects. Customize the IOError information and include this condition in the existing ***FullStop*** (FS).
     - Pros: No need of changing specs (update in DB). Only downloading new code.
     - Cons: Cases 8,9,10,11,12 (Card auto-recovery by itself) will not be set as IOError for the PLC -> No Interlock (full stop). Those cases will not be noticed by operation.
  2. Include new objects to make a dedicated ***FullStop*** alarm
     - Pros: Clear separation between errors which need *FS* (manual ACK) and *IOError* information for all the remaining anomalous situations (Cases 8,9,10,11,12)
     - Cons: Full generation: Cryo controls (~60 Dis and 60 Alarms per sector)

Protection cases: Solution 1

Case	Card auto-recovery	TS	FS	IOError
(1) Card reset / Power-up	No			
(2) Overtemp (load)	No	✔	✔*	✔
(3) Watchdog**	No			
(4) Disable: Input	No			
(5) On/Off: Input	No			
(6) Heatsink (card)	No		✔	✔
(7) Relay error	No		✔	✔
(8) Vref out of bounds	Yes			
(9) ADC conversion error	Yes			
(10) Unstable setpoint on the crate	Yes			
(11) Unstable addressing on the crate	Yes			
(12) Thermocouple ref. out of bounds	*This is handled by the FEC code.*			

* FS after 3 times TS in 2 hours.
** Watchdog is not detected until comms recover

Protection cases: Solution 2

Case	Card auto-recovery	TS	FS	IOError
(1) Card reset / Power-up	No	✔		✔
(2) Overtemp (load)	No	✔		✔
(3) Watchdog**	No	✔	✔*	✔
(4) Disable: Input	No			
(5) On/Off: Input	No			
(6) Heatsink (card)	No		✔	✔
(7) Relay error	No		✔	✔
(8) Vref out of bounds	Yes	✔		✔
(9) ADC conversion error	Yes	✔		✔
(10) Unstable setpoint on the crate	Yes	✔		✔
(11) Unstrable addressing on the crate	Yes	✔		✔
(12) Thermocouple ref. out of bounds	*This is handled by the FEC code.*			

* FS after 3 times TS in 2 hours.
** Watchdog is not detected until comms recover

Protection cases: Solution 3 (1 + CIET Alarms)

Case	Card auto-recovery	CIET alarm	TS	FS	IOError
(1) Card reset / Power-up	No	✔			
(2) Overtemp (load)	No	✔	✔	✔*	✔
(3) Watchdog**	No	✔			
(4) Disable: Input	No				
(5) On/Off: Input	No				
(6) Heatsink (card)	No	✔		✔	✔
(7) Relay error	No	✔		✔	✔
(8) Vref out of bounds	Yes	✔			
(9) ADC conversion error	Yes	✔			
(10) Unstable setpoint on the crate	Yes	✔			
(11) Unstrable addressing on the crate	Yes	✔			
(12) Thermocouple ref. out of bounds	*This is handled by the FEC code.*				

* FS after 3 times TS in 2 hours.
** Watchdog is not detected until comms recover

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