TeePee
Thermal Control and Pressure Monitoring

R.Reiss

M. Duchateau, G. Fischer, J.L. Lizon

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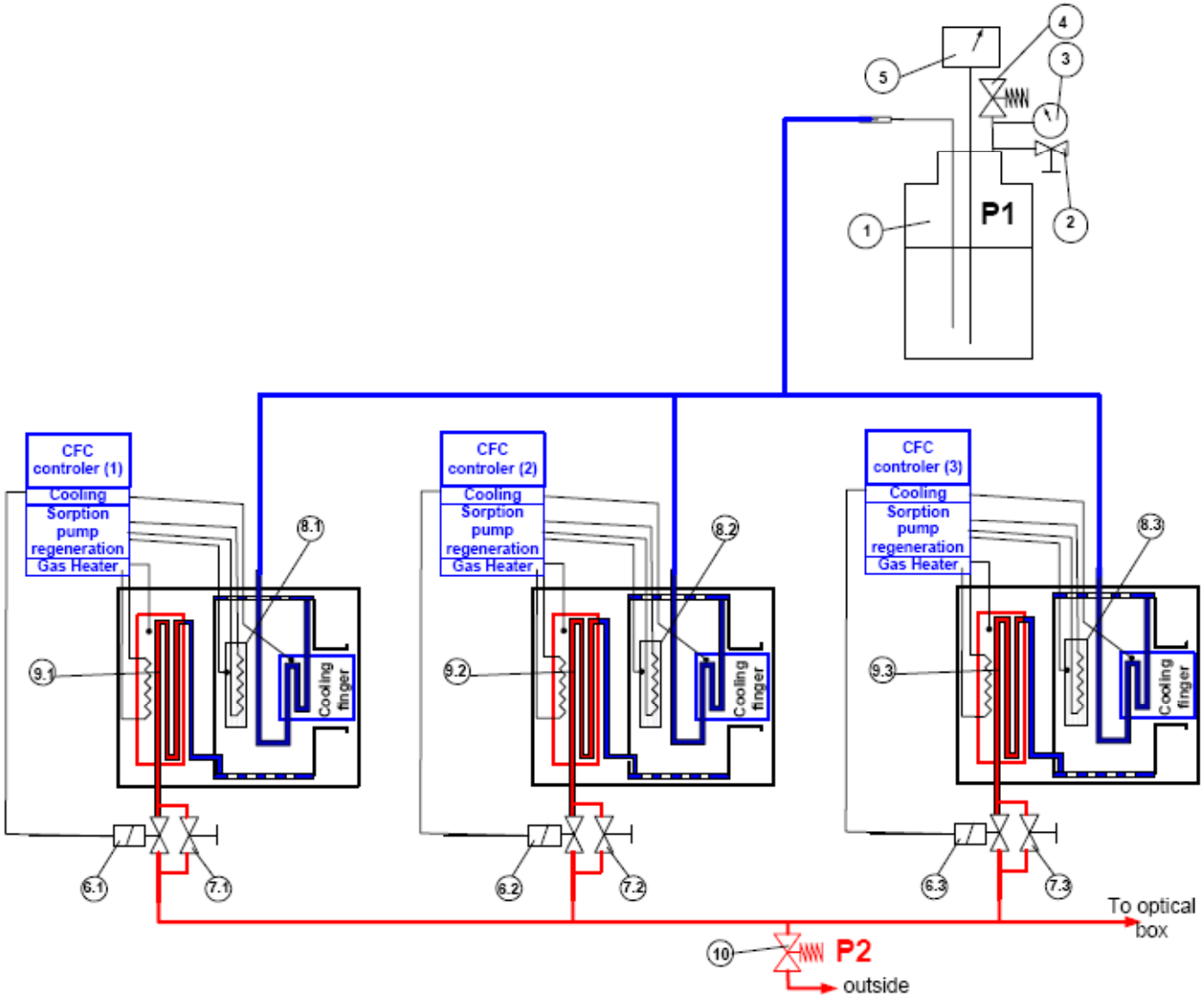
Overview

- MUSE Vacuum Cryogenic and System (VCS)
- JUMO Imago 500
  - Process Automation Controller
- TeePee
  - Temperature control and Pressure monitoring
- Telemetry
- Status

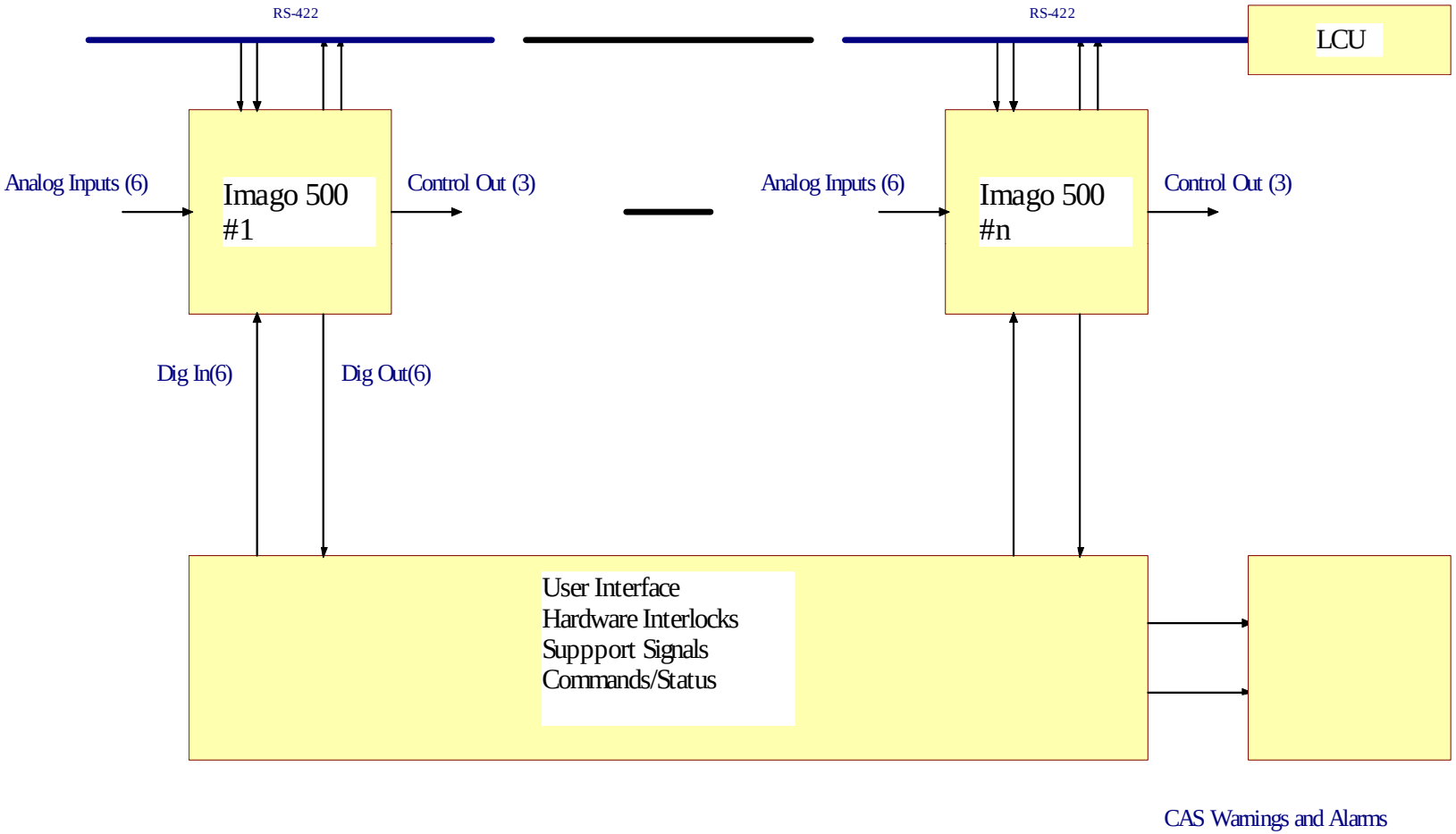
MUSE Vacuum and Cryogenic System (VCS)



MUSE VCS Summary

- 24 Detector Vessels (DV)
  - 24 Detector Heads (DH)
  - 24 Continuous Flow Cryostats (CFC)
- DH sensors and actuators
  - 2 detector sensors (main & spare) ⇒ heater resistors
- CFC sensors and actuators
  - Cold Plate sensor (PT100) ⇒ LN2 valve
  - Exhaust Gas Sensor (PT100) ⇒ heater resistor
  - Sorption Pump Sensor (PT100) ⇒ heater resistor
  - Edwards Wide Range Gauge (WRG)
- Digital I/O (control inputs, alarm and status outputs)
- Telemetry

VCS Block Diagram

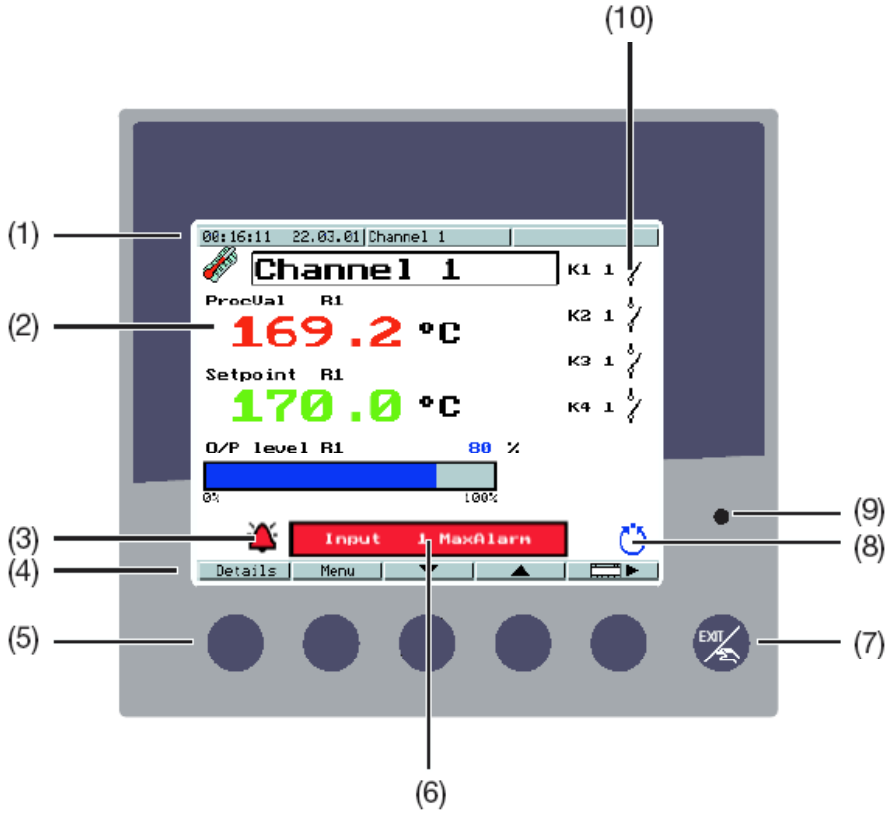


Solution

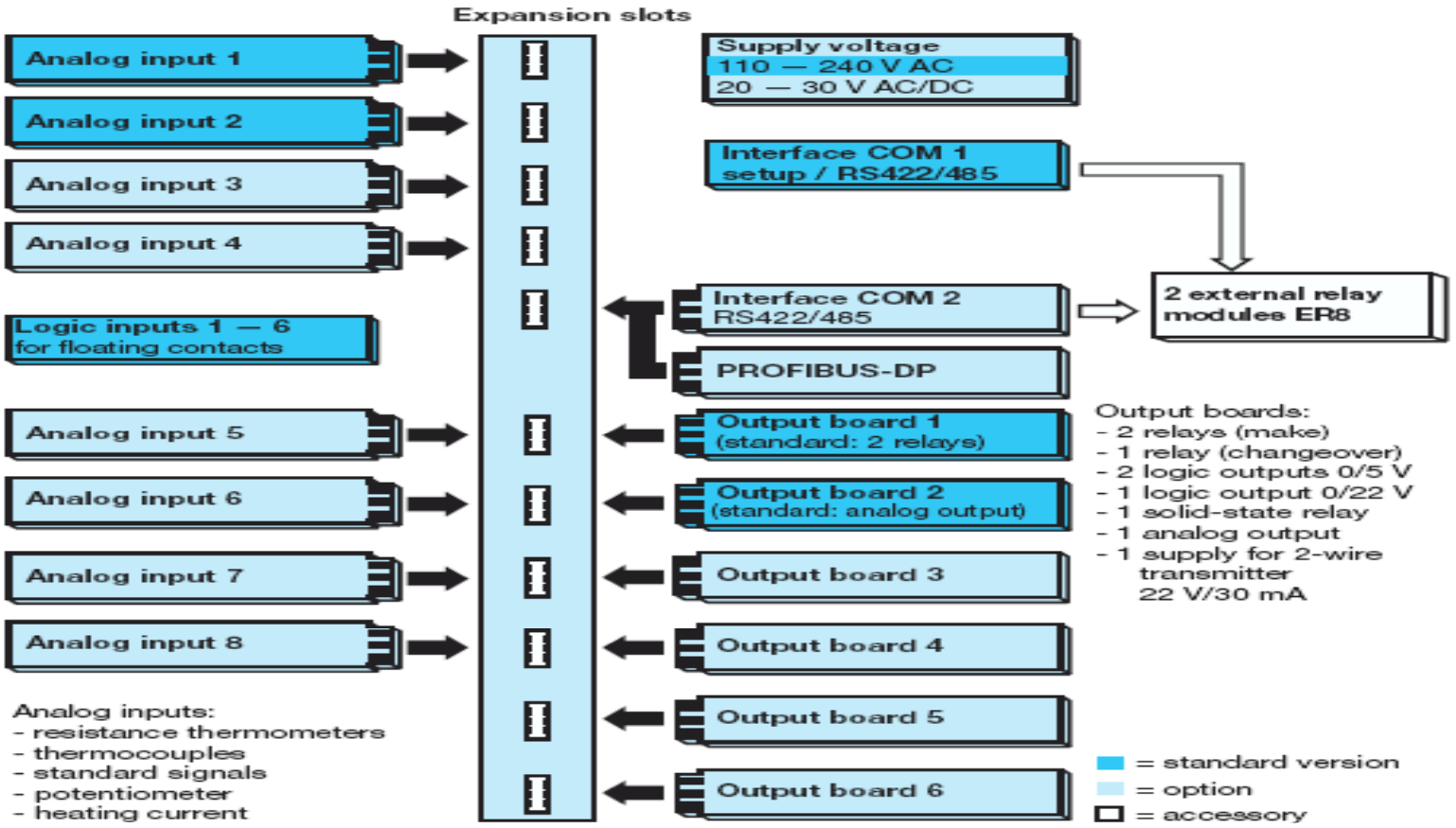
- Industrial Programmable Automation Controller
  - JUMO Imago 500
    - Flexible hardware (select from various I/O modules)
    - Flexible setup via PC software
    - 2 comm. ports with MODbus protocol
- TeePee
  - 19-inch 3HU rack
    - 2 Imago 500
    - Power supplies
    - Front panel switches
    - Back panel connectors
    - Opto-isolated solid-state relays

Imago 500 Frontpanel

1. Status line
2. Color screen (configurable)
3. Info/alarm symbol
4. Current meaning of softkeys
5. Keys
6. Info/alarm display
7. EXIT/manual key
8. Operating mode/state
9. Power LED
10. Status indicators for outputs (configurable)



Expansion slots



Imago 500 Features

- Modular hardware design
- 4 flexible controllers in 1 unit
  - 2 parameter sets per controller; P, I, PD, PI, PID
- Auto tuning, sensor break detection
- 16 limit comparators, logic variables, 4 timers
- Ramp up/ramp down
- Dynamic changeover of setpoints, parameters
- Recording
  - 4 analog, 3 binary values
  - Duration up to several weeks
- Large display, freely configurable

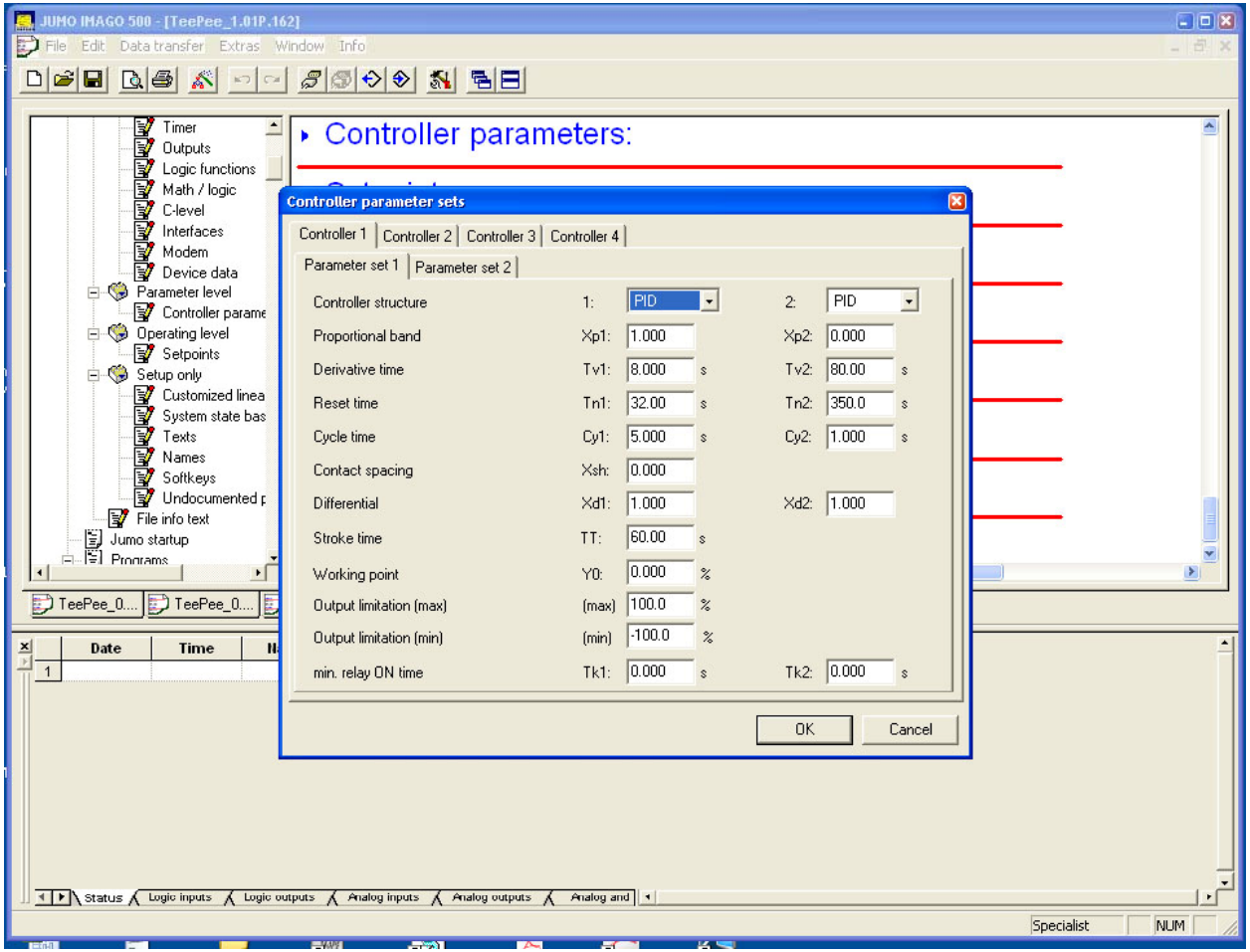
Imago 500 Features

- Mathematical functions (for internal and external signals)
  - +, - *, /
  - sin(), cos(), tan()
  - sqrt(), exp(), x**y
  - log(), ln()
  - max, min (any number of variables)
  - fraction, integer
- Logic functions
  - AND, OR, XOR, NOT

Setup via PC

- JUMO Imago 500 Setup Program
  - Setup
  - Program editor (setpoint profiles)
  - Startup (simple visualisation) for optimization of control parameters
  - Down-/upload via RS232

PC Software


JUMO IMAGO 500 - [TeePee_1.01P.162]
File Edit Data transfer Extras Window Info
Timer
Outputs
Logic functions
Math / logic
C-level
Interfaces
Modem
Device data
Parameter level
Controller parame
Operating level
Setpoints
Setup only
Customized linea
System state bas
Texts
Names
Softkeys
Undocumented p
File info text
Jumo startup
Programs
Controller parameters:
Controller parameter sets
Controller 1 Controller 2 Controller 3 Controller 4
Parameter set 1 Parameter set 2
Controller structure 1: PID 2: PID
Proportional band Xp1: 1.000 Xp2: 0.000
Derivative time Tv1: 8.000 s Tv2: 80.00 s
Reset time Tn1: 32.00 s Tn2: 350.0 s
Cycle time Cy1: 5.000 s Cy2: 1.000 s
Contact spacing Xsh: 0.000
Differential Xd1: 1.000 Xd2: 1.000
Stroke time TT: 60.00 s
Working point Y0: 0.000 %
Output limitation (max) (max) 100.0 %
Output limitation (min) (min) -100.0 %
min. relay ON time Tk1: 0.000 s Tk2: 0.000 s
OK
Cancel
TeePee_0....
TeePee_0....
Date
Time
1
Status
Logic inputs
Logic outputs
Analog inputs
Analog outputs
Analog and
Specialist
NUM

TeePee

- Operates 2 MUSE DVs
- 2 JUMO Imago 500
- Power supplies (heaters, valves, WRGs)
- Solid state relays
- Communications ports (RS-422, MODbus)
- CAS Alarm outputs
- Digital I/O for Master Controller

TeePee


JUMO IMAGO 500
CFC-NR 2
Achtung!
Schutzfolie erst nach Inbetriebnahme entfernen
Attention!
Protective plastic film remove only after line-up
LOCAL <-> REMOTE
WARM
COLD
JUMO IMAGO 500
CFC-NR 1
JUMO IMAGO 500
CFC-NR 2

TeePee Features

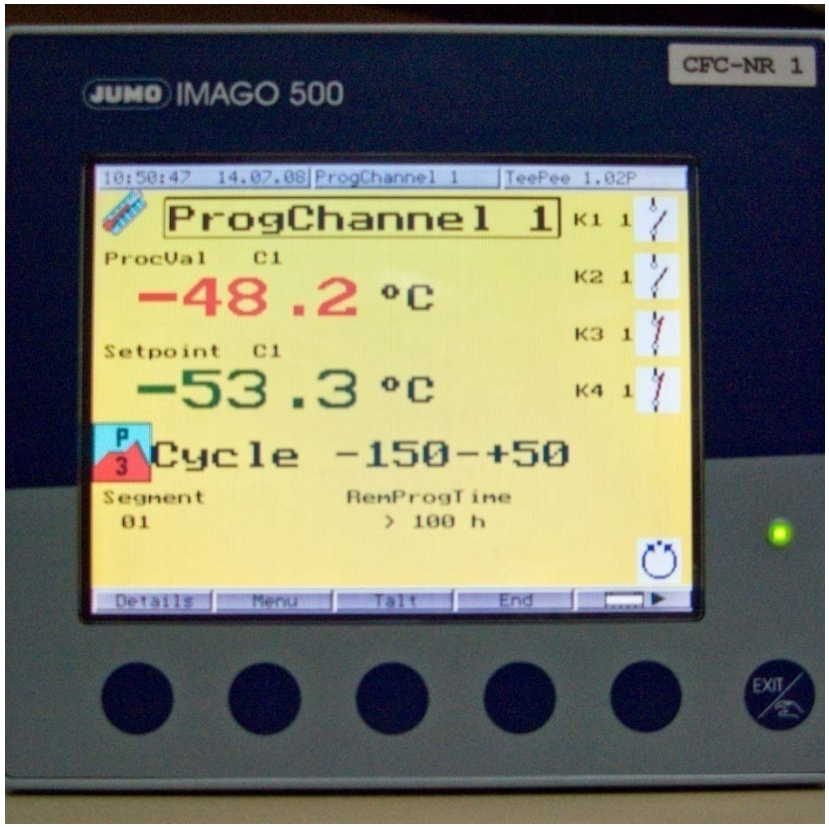
- 4 independent control loops for each DV
- Cool-down/warm-up
  - Separate for each CCD
  - Slew rate set to 2°C/min.
- Automatic sequence for sorption pump regeneration
- Interlocks for each DV (examples)
  - CCD too cold or too warm (-120..+50°C)
    - Disable cooling or heating
  - Cold plate too cold or too warm -195..+50°C)
    - Disable cooling or heating
  - Sensor break
    - Switch to spare sensor
  - Pressure too high (>10^{-2} mbar)
    - Disable cooling, warm up detector

Features cont.

- Edwards WRG pressure monitoring
  - Display linearization using built-in math functions
- Temperature Profile Generator (lab use only)
  - Stress tests
  - Aging
  - Supports loops
  - Setup via PC SW

Basic display

- Basic screen display
  - Process value
  - Setpoints
  - Output level
  - Status

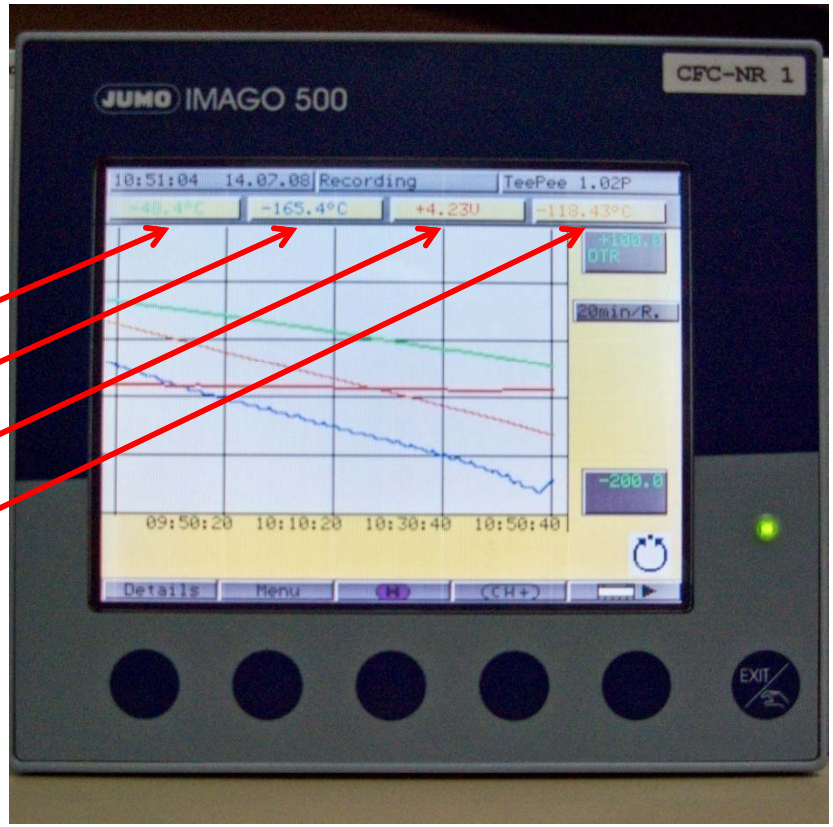


Custom display

- Customized screen display
  - 5 temperatures
  - 4 setpoints
  - 4 deviations from setpoint
  - 4 output level indicators
  - vacuum pressure

Recording display

- Recording screen display
  - 4 analog values
  - 3 binary values
  - Zoom in/out
  - Cursor to read values and time



Telemetry

- Via PC (RS-422)
  - JUMO Imago 500 setup program (rudimentary)
  - JUMO PCC and PCA3000
    - Retrieval and analysis of recorded data (4 analog and 3 binary signals only)
  - LabView Virtual Instrument
    - Virtually unlimited number of variables can be recorded and displayed
- Via Linux
  - See Claudio‘s presentation

Status

- TeePee Prototype in operation since 2Q/2008
  - Initial tests of MUSE DV
- HW design finalized
- Production of more units underway
- Setput V1.0 completed
  - Supports standard CCD DHs and CFCs, modifications for other applications are possible.

Performance

- Excellent stability of CCD temperature
- Excellent control loop settling
- Excellent recovery after power failure
  - After power-up setpoint is set to process value
  - From here ramp up/down to last set value
- Simple user interface
- Fail-safe design
- Reference design:
  - MAD cooling controller for 3 Peltier cooled CCDs
  - In operation since 1Q/2007

More Information

- Imago 500 data sheets, operating instructions and interface descriptions:
  - http://www3.jumo.de/pio/JUMO/en_UK/prd/70.3590/jumo-imago-500-universal-profile-controllers-generators.html