Hall A SoLID Solenoid
Flow Controls and Monitoring of Current Leads

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Schematic of Controls Overview Instrumentation for Leads Flow – Proposed

MPS

current transducer

CL B CL A

Turret

GHe MFC for CL A

GHe MFC for CL B

LHe pot

I-set and I-true readback

I-course CH-15

GHe

1756-IF16 ADC input module

1756-CNB ControlNet module

1756-CNB ControlNet module

1756-L72 PLC controller

PID control

MVI-94 ASCII

1794-ACN15 flex I/O

SoLID Current Leads Flow Overview – Controls
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Ethernet
ControlNet
control
serial
backplane
backplane
readout
readout

CL = current leads
MFC = mass flow controller
• Reference parameters from Oxford Operations Manual
  – Lead flow range is 45–50 L/min at no current
  – Lead flow 66 L/min at 3266 A

• Current lead flow range as a function of current is calculated from the formulas below:
  – $Flow = 45 + 6.43 \times I_{max}$ to $50 + 4.9 \times I_{max}$ L/min
    ▪ Units for coefficients shown in $F=f(I_{max})$ relations are L/min*KA
    ▪ Normal expected current through the leads is $I_{max} = 3.250$ KA
    ▪ Flow range required is 65.8–65.9 L/min
  – Final value will be determined after testing
Current Leads GHe Flow Calculation – Cont.

Current Leads Flow = f(I_max)

- Flow = 45 + 6.43*I_max
- Flow = 50 + 4.90*I_max
PLC Controls

- Calculation of flow set value based on current through leads

Start

Read Set_I_MPS, I_Coarse, and I_True

Select max value and save to I_max

Read power supply status

Is power supply ON?

YES

Flow_Increase_factor = value entered by user

NO

Set Flow_Increase_factor = 1

Calculate flow rate [L/min] using equation

\[ M_{\text{Flow_Set}} = 50 + 4.90 \times I_{\text{max}} \times \text{Flow_increase_factor} \]
• Conversion of flow set value to voltage for valve actuators of current leads A and B

X = A or B

Start

Read M_Flow_Set and m_flow_CL_X

Use m_flow_CL_X as PV for PID control instruction; set PID parameters and limits

Store output value of PID control instruction to CL_X_auto [L/min] - valve aperture

Read entered flow set for manual mode

Read entered max and min flow limits for manual mode

Is set flow within set limits?

YES

Use entered flow set – valve aperture

NO

Use max allowed value

In auto mode?

YES

Use CL_X_auto

NO

Use flow set entered by user

Convert flow values to equivalent voltage

Store selected value on Setpt_M_Flow_X [V] and set ADC channel
Monitoring – HMI Screens

- Current leads flow will be monitored on CCR Expert and Turret Temperature screens

- Expert control will be performed on a third screen
Tasks Status

• PLC Programming
  – Modified PLC program
  – Final tuning of PLC ADC modules to be done during testing

• HMI and CSS monitoring
  – Flow indicators added to Turret and CCR HMI screens
  – Lead Flow Controls Expert screen – In progress
  – CSS BOY screens – In progress
Tasks Status

• Instrumentation
  – New mass flow controllers not acquired

• Documentation
  – A00000-16-03-0221 electrical drawing – In progress
• Development of flow controls and monitoring of current leads is progressing smoothly
Thank You