



Instrumentation & Measurement Group
Department of Electrical and Electronic Engineering

DArT Slow Control

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DArT general meeting at LSC
21 April 2022

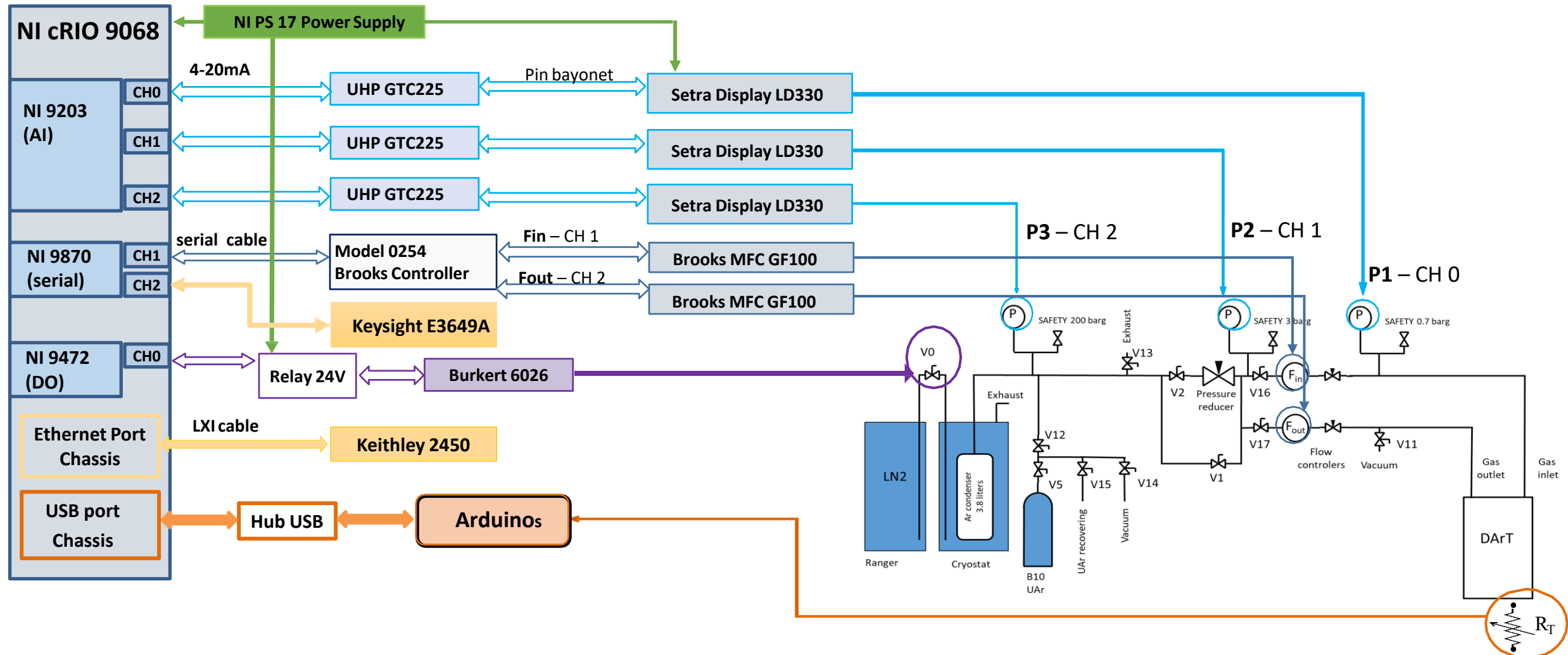


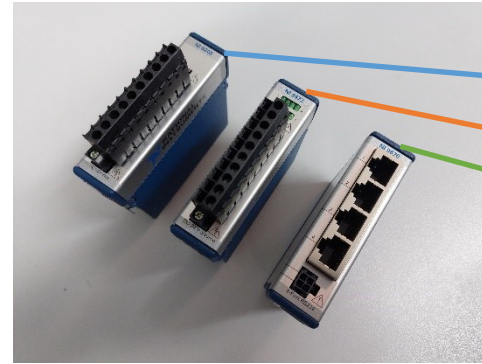
- DArT - cRIO Connection Scheme
- NI cRIO 9068 and Modules
- Functionalities scheme
- DArT Slow Control project
 - Front Panel tabs
 - Remote monitoring: Web Page



DArT - cRIO Connection Scheme

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NI 9203: analog input

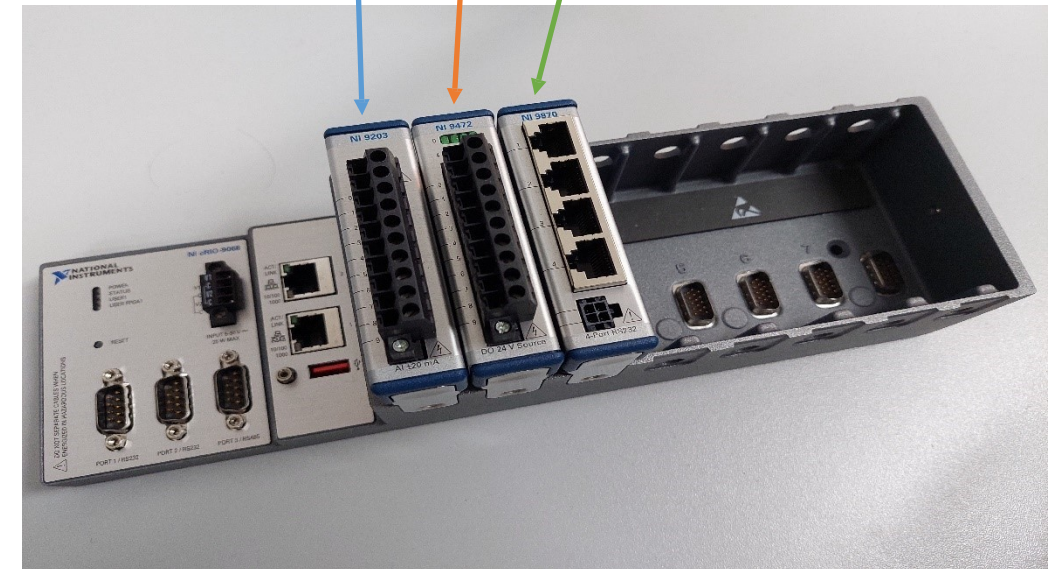
NI 9472: digital output

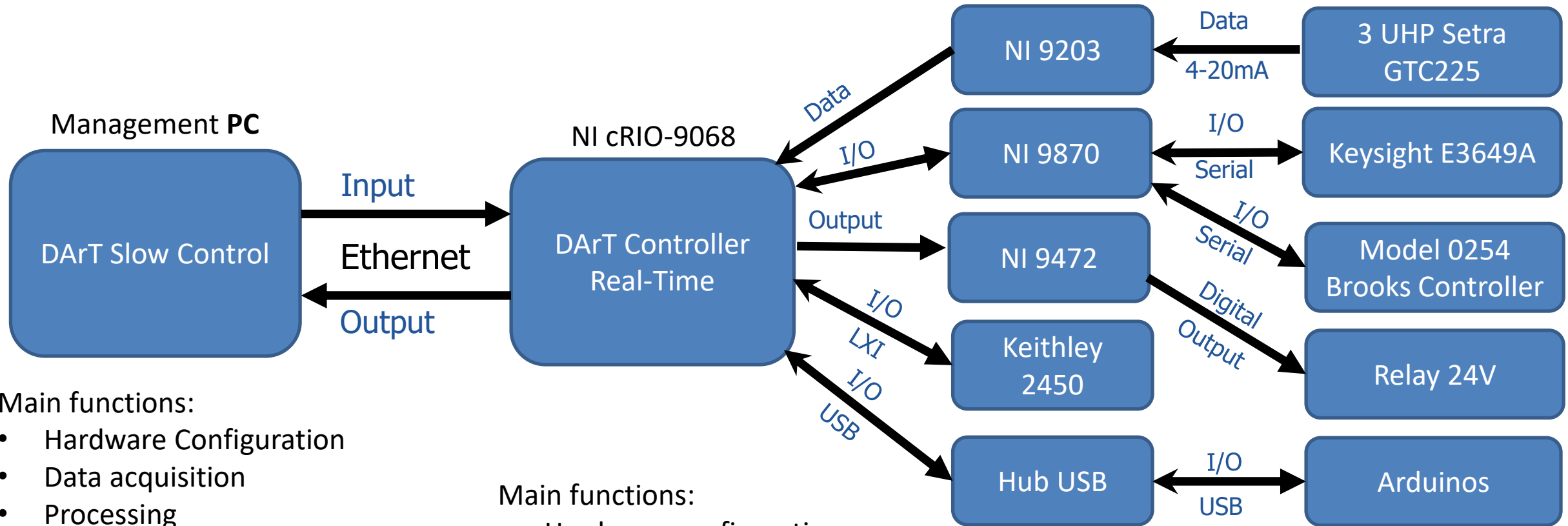
NI 9870: serial communication

Controller with chassis NI CompactRIO-9068

The chassis of the cRIO-9068 is equipped with 3 modules:

- Slot 1: NI 9203 for the 4-20 mA currents acquisition
- Slot 2: NI 9472 for the generation of digital outputs
- Slot 3: NI 9870 for the serial communications



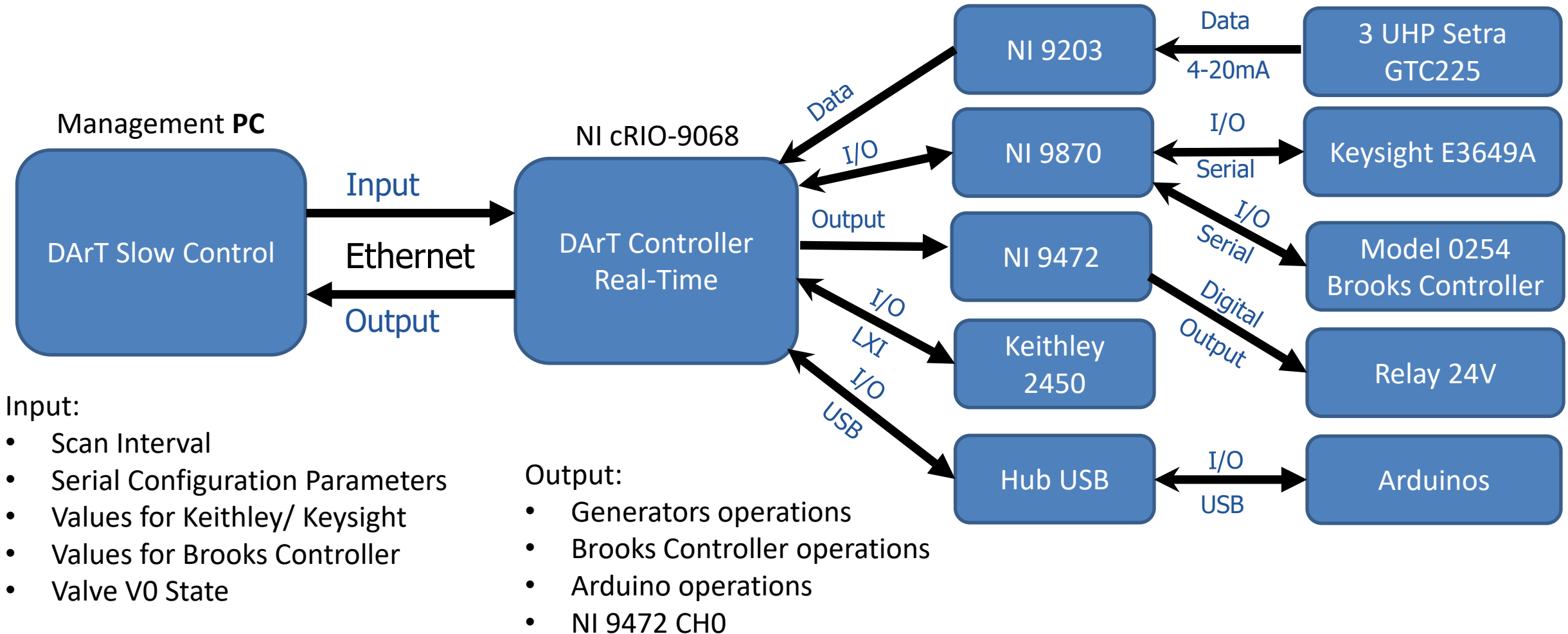


Main functions:

- Hardware Configuration
- Data acquisition
- Processing
- Data and log storage

Main functions:

- Hardware configuration
- Data acquisition
- Shared Variables management





DArT Slow Control Initial Settings

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Initial Settings | DArT System | VISA/LXI Power Supply | Brooks Controller | Arduino | Alarms Configuration | File Settings | Error Log | Operations History | Email | Acquired Data | Usage Control

cRIO-IP Address

Scan Interval [ms]

User

Power Supply Initial Values Settings

Keithley 2450 (LXI Communication)

Minimum Amplitude DC [V]

Maximum Amplitude DC [V]

Step Amplitude DC [V]

Current Limit [A]

Keysight E3649A (Serial Communication)

Amplitude DC ch1 [V]

Current Limit ch1 [A]

Amplitude DC ch2 [V]

Current Limit ch2 [A]

Email Data Server - Initial Settings

Outgoing Mail Server (SMTP)

SMTP Port

Email

Password

Save File?

Save Error Log?

Brooks Controller - Initial Values

Channels

Flow Setpoint

Start Button

Mailing List | **Alarms and Warnings Setup**



DArT Slow Control Initial Settings

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The screenshot displays the 'Initial Settings' window of the DArT Slow Control software. The interface includes a top navigation bar with tabs: Initial Settings, DArT System, VISA/LXI Power Supply, Brooks Controller, Arduino, Alarms Configuration, File Settings, Error Log, Operations History, Email, Acquired Data, and Usage Control. The main content area is divided into several sections:

- cRIO-IP Address:** 10.131.1.33
- Scan Interval [ms]:** 1000
- User Initial Setting:** Enter user name here
- Power Supply Initial Values Settings:** Includes settings for Kethley 2450 (LXI Communication) and Keysight E3649A (Serial Communication).
 - Kethley 2450:** Minimum Amplitude DC [V] (0), Maximum Amplitude DC [V] (-32.6), Step Amplitude DC [V] (0.5), Current Limit [A] (0).
 - Keysight E3649A:** Amplitude DC ch1 [V] (3.4), Current Limit ch1 [A] (0), Amplitude DC ch2 [V] (1.6), Current Limit ch2 [A] (0).
- Brooks Controller - Initial Values:** Channels (0, 1, 2), Flow Setpoint [ml/min] (0.000).
- Start Button:** A large red button labeled 'START'.
- Email Data Server - Initial Settings:** Includes fields for Outgoing Mail Server (SMTP), SMTP Port (587), Email (xxxx@gmail.com), and Password.
- Mailing List - Alarms and Warnings Setup:** A table for configuring alarm thresholds for various parameters.
- Alarms and Warnings Setup Table:**

Name	LoLo	Lo	Hi	HHI
P1[bar]	0.00000	0.00000	0.00000	0.00000
P2[barg]	0.00000	0.00000	0.00000	0.00000
P3[barg]	0.00000	0.00000	0.00000	0.00000
Fin[ml/min]	0.00000	0.00000	0.00010	0.00000
Fout[ml/min]	0.00000	0.00000	0.00000	0.00000
T 01[K]	0.00000	0.00000	0.00000	0.00000
- Save File? Save Error Log?:** Two green 'ON' buttons.
- Right Panel (highlighted):** A vertical stack of controls for various parameters, each with 'min' and 'max' values:
 - Scan Interval [ms] min/max: 0/500, 0/5000
 - Minimum Amplitude DC [V] min/max: 0/-32.6, 0/0
 - Maximum Amplitude DC [V] min/max: 0/32.6, 0/0
 - Step Amplitude DC [V] min/max: 0/0.01, 0/2
 - Current Limit [A] min/max: 0/0, 0/5
 - Amplitude DC ch1 [V] min/max: 0/0, 0/5
 - Current Limit ch1 [A] min/max: 0/0, 0/5
 - Amplitude DC ch2 [V] min/max: 0/0, 0/5
 - Current Limit ch2 [A] min/max: 0/0, 0/5
 - Flow Setpoint [ml/min] min/max: 0/-500 to 500, 0/500 to 500

Allowed ranges to set
(these controls will be hidden)



DArT Slow Control Initial Settings

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Initial Settings | DArT System | VISA/LXI Power Supply | Brooks Controller | Arduino | Alarms Configuration | File Settings | Error Log | Operations History | Email | Acquired Data | Usage Control

cRIO-IP Address: 10.131.1.33

Scan Interval [ms]: 1000

User Initial Setting: Enter user name here

Power Supply Initial Values Settings


Keithley 2450 (LXI Communication)

Minimum Amplitude DC [V]: 0

Maximum Amplitude DC [V]: -32.6

Step Amplitude DC [V]: 0.5

Current Limit [A]: 0




Keysight E3649A (Serial Communication)

Amplitude DC ch1 [V]: 3.4

Current Limit ch1 [A]: 0

Amplitude DC ch2 [V]: 1.6

Current Limit ch2 [A]: 0



Brooks Controller - Initial Values

Channels: 0, 1, 2

Flow Setpoint [ml/min]: 0, 0.000, 0.000

Start Button: START

Email Data Server - Initial Settings

Outgoing Mail Server (SMTP): smtp.gmail.com

SMTP Port: 587

Email: xxxxx@gmail.com

Password: *****

Save File?: ON

Save Error Log?: ON

Mailing List Alarms and Warnings Setup

Name	LoLo	Lo	Hi	HiHi
P1[bar]	0.0000	0.0000	0.0000	0.0000
P2[barg]	0.0000	0.0000	0.0000	0.0000
P3[barg]	0.0000	0.0000	0.0000	0.0000
Fin[l/min]	0.0000	0.0000	0.0000	0.0000
Fout[l/min]	0.0000	0.0000	0.0000	0.0000

Save File? ON OFF

Save Error Log? ON OFF

"Blinking" control – ON: [bell icon] and OFF: [lock icon]

"Email" control – ON: [mail icon] and OFF: [lock icon]



DArT Slow Control DArT System

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Initial Settings | DArT System | VISA/LXI Power Supply | Brooks Controller | Arduino | Alarms Configuration | File Settings | Error Log | Operations History | Email | Acquired Data | Usage Control

Run Start Time: 13:12:04.0
08/03/22

User: Enter user name here

Scan Interval [ms]: 1000

Current Date: dd/mm/yy

Current Time: hh:mm:ss.ms

V0 Update Button: New Setting?

V0

LN2

Cryostat

Ar condenser

B10 UAr

UAr recovering

Exhaust

Vacuum

Vacuum

Pressure riducer

P3[barg]: 0.000000

V13

V2

P2[barg]: 0.000000

V16

Fin[mL/min]: 0.000000

V17

Fout[mL/min]: 0.000000

V1

V18

P1[bar]: 0.000000

V11

Vacuum

GAS outlet

GAS inlet

DAr

T-01[K]: 0.000000

T-03[K]: 0.000000

T-02[K]: 0.000000

T-04[K]: 0.000000

Alarms Configuration

History

Stop Button: STOP

Data Saving Chosen Option: ON

Error Log Saving Chosen Option: ON

Shared Variable Generators Read

Amplitude DC Keithley 2450 [V]: 0

Error Out Keithley 2450

status: code: 0

source:

Shared Variable Brooks Controller Read

Programmed values Output ports: 0

Programmed values Input ports: 0

Global Programmed values:

Response Flow SP: 0

Flow Value Channels: 0

Error Out Brooks Controller

status: code: 0

source:

Error Out Shared Variables

status: code: 0

source:



DArT Slow Control

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DArT System – visual warnings and status indicators

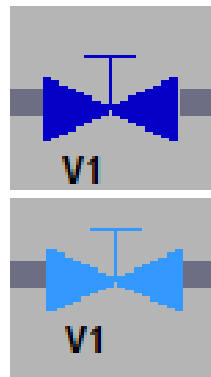
Blinking:

- Red for HiHi (too high value)
- Orange for "Hi" (high value)
- Light blue for "Lo" (low value)
- Blue for "LoLo" (too low value)



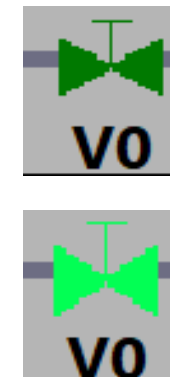
“Manual” **Valve Status** Indicators:

- Blue: the valve is closed
- Light blue: the valve is open



V0 Valve Control:

- Green: the valve is closed
- Light green: the valve is open

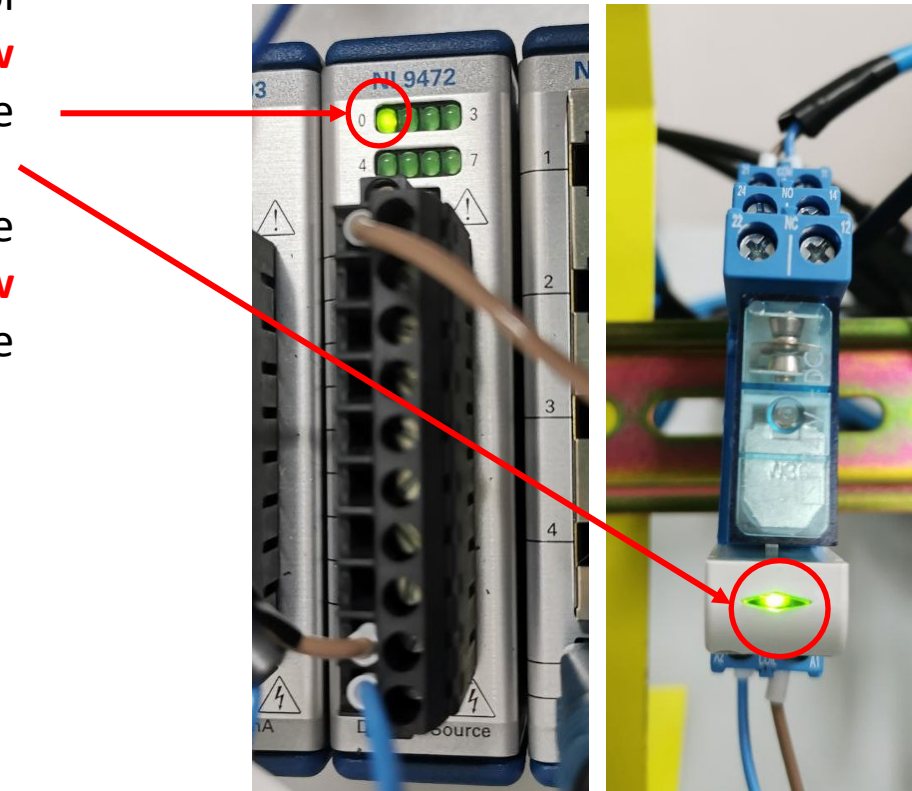
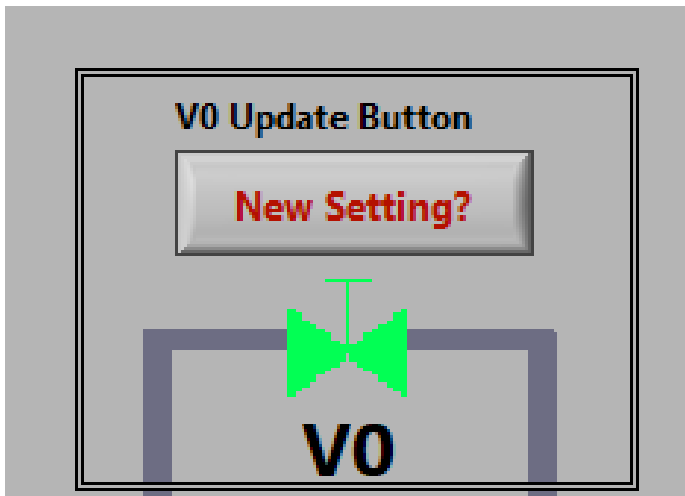




DArT Slow Control

V0 operation - Relay 24V

- The user needs to hit the “V0” button to open it (the valve control becomes “on” and bright green) and then the button “**New Setting?**” to confirm: the LED 0 of the NI-9472 turns “on” and the LED of the Finder 95.05, commanding the relay, turns also “on”.
- Same procedure to close the valve: the user hits the “V0”, the valve button becomes “off” (dark green), then the button “**New Setting?**” to confirm: the LED 0 of the NI-9472 and the LED of the Finder 95.05 become also “off”.





DArT Slow Control VISA/LXI Power Supply and Brooks Controller

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Initial Settings | DArT System | VISA/LXI Power Supply | Brooks Controller | Arduino | Alarms Conf


Shared Variable Generators Write

Keithley 2450 (LXI Communication)

Maximum Amplitude DC [V]

Step Amplitude DC [V]

Current Limit [A]




Keysight E3649A (Serial Communication)

Amplitude DC ch1 [V]

Current Limit ch1 [A]

Amplitude DC ch2 [V]

Current Limit ch2 [A]



Generators Setting Update Button

New Setting?

Initial Settings | DArT System | VISA/LXI Power Supply | Brooks Controller

Shared Variable Brooks Controller Write

Channels

Flow Setpoint

Brooks Setting Update Button

New Setting?



DArT Slow Control Arduino – in progress

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The screenshot displays a control interface for four Arduino boards, arranged in a 2x2 grid. Each board's configuration is shown in a separate panel. The top row shows the 'Info' and 'Base Info Cluster' for each board, including details like firmware version (383), board ID (0xBADC0FEE), board address (0x7), board type (0x3), gas type (Argon), and calibration switch (On). The bottom row shows the 'Variable Data ASRLx:INSTR' for each board, including mode (Calibration), error code (0), ADC counts, voltage (2417 mV), temperature (2147483648 K), and level temp (2147483648 K). The interface also includes a 'Shared Variable Error Out Arduino Read' section on the right, showing error status and code for each board.



DArT Slow Control Alarms Configuration

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Initial Settings | DArT System | VISA/LXI Power Supply | Brooks Controller | Arduino | **Alarms Configuration** | File Settings | Error Log | Operations History | Email | Acquired Data | Usage Control

Alarms configurations

Mailing List | **Alarms and Warnings Setup**

Show Last Save

Error Out Warning Config File
status code
✓ 0
source

Error Out Handling Dialog Queue
status code
✓ 0
source

Error Out Error Queue
status code
✓ 0
source

Configuration File Folder Name Path Configuration File
DArT Configuration File

Undo Show Last Save Save



DArT Slow Control File Settings

Initial Settings | DArT System | VISA/LXI Power Supply | Brooks Controller | Arduino | Alarms Configuration | **File Settings** | Error Log | Operations History | Email | Acquired Data | Usage Control

Default File Name: DArT Data Acquisition | File Folder Name: DArt Acquisition File | File Name: DArT Data Acquisition 01-12-21

Path File:

Header Variable: 0 | Day | Time[h:m:s.ms] | P1[bar] | P2[barg] | P3[barg] | Fin[ml/min] | Fout[ml/min] | T-01[K]

Header Alarm: 0 | Alarm_P1_HiHi | Alarm_P1_Hi | Alarm_P1_Lo | Alarm_P1_LoLo | Alarm_P2_HiHi | Alarm_P2_Hi | Alarm_P2_Lo | Alarm_P2_LoLo

TDMS | **CSV**

Property Names: 0 | Title | Author | File creation date | Description

Title: DArT Acquisition

Description: Data acquisition and writing test on TDMS file

Data Group Name Variable: Measured data | Data Group Name Alarm: Alarm registered

Error Out Writing File: status: | code: 0 | source:

Error Out Close File TDMS: status: | code: 0 | source:

Error Out Close File CSV: status: | code: 0 | source:

Tab TDMS & CSV



DArT Slow Control Error Log

Initial Settings | DArT System | VISA/LXI Power Supply | Brooks Controller | Arduino | Alarms Configuration | File Settings | **Error Log** | Operations History | Email | Acquired Data | Usage Control

Default Error Log: DArT Error Log
Error Log Folder Name: DArT Error Log
Error Log Name: DArT Error Log 01-12-21

Path Error Log:

Header Error Log: 0 | Status | Code

Complete Header Error Log: 0 | Day | Time[h:m:s.ms] | Status | Code

Error Out Error Log

status	code
<input checked="" type="checkbox"/>	0

source

Error Out Close Error Log

status	code
<input checked="" type="checkbox"/>	0

source



DArT Slow Control Operations History – in progress

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Initial Settings | DArT System | VISA/LXI Power Supply | Brooks Controller | Arduino | Alarms Configuration | File Settings | Error Log | **Operations History** | Email | Acquired Data | Usage Control

Default Operations History File Name:

Operations History File Folder Name:

Operations History File Name:

Path Operations History File:

Operations History Header

	Date [d/m/y]	Time [h:m:s.ms]	User	Control Name	Old Value	New Value	
--	--------------	-----------------	------	--------------	-----------	-----------	--

Error Out Operations History

status	code
<input checked="" type="checkbox"/>	<input type="text" value="0"/>

source



DArT Slow Control Email Server

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Initial Settings | DArT System | VISA/LXI Power Supply | Brooks Controller | Arduino | Alarms Configuration | File Settings | Error Log | Operations History | **Email**

Email Data Server

Outgoing Mail Server (SMTP)

SMTP Port

Email

Password

Error Out Email

status	code
<input checked="" type="checkbox"/>	<input type="text" value="0"/>

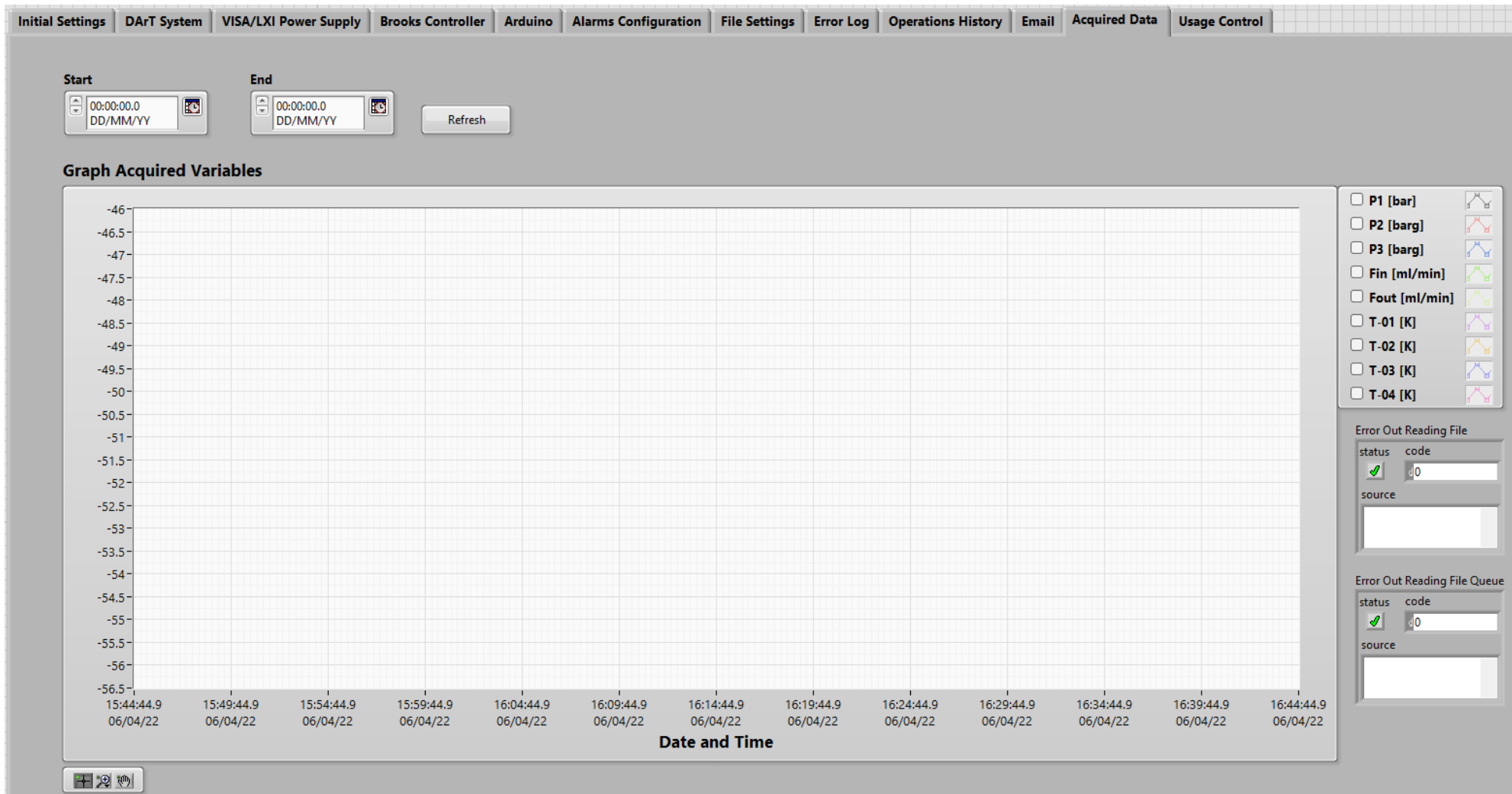
source



DArT Slow Control

Trends of the Acquired Data

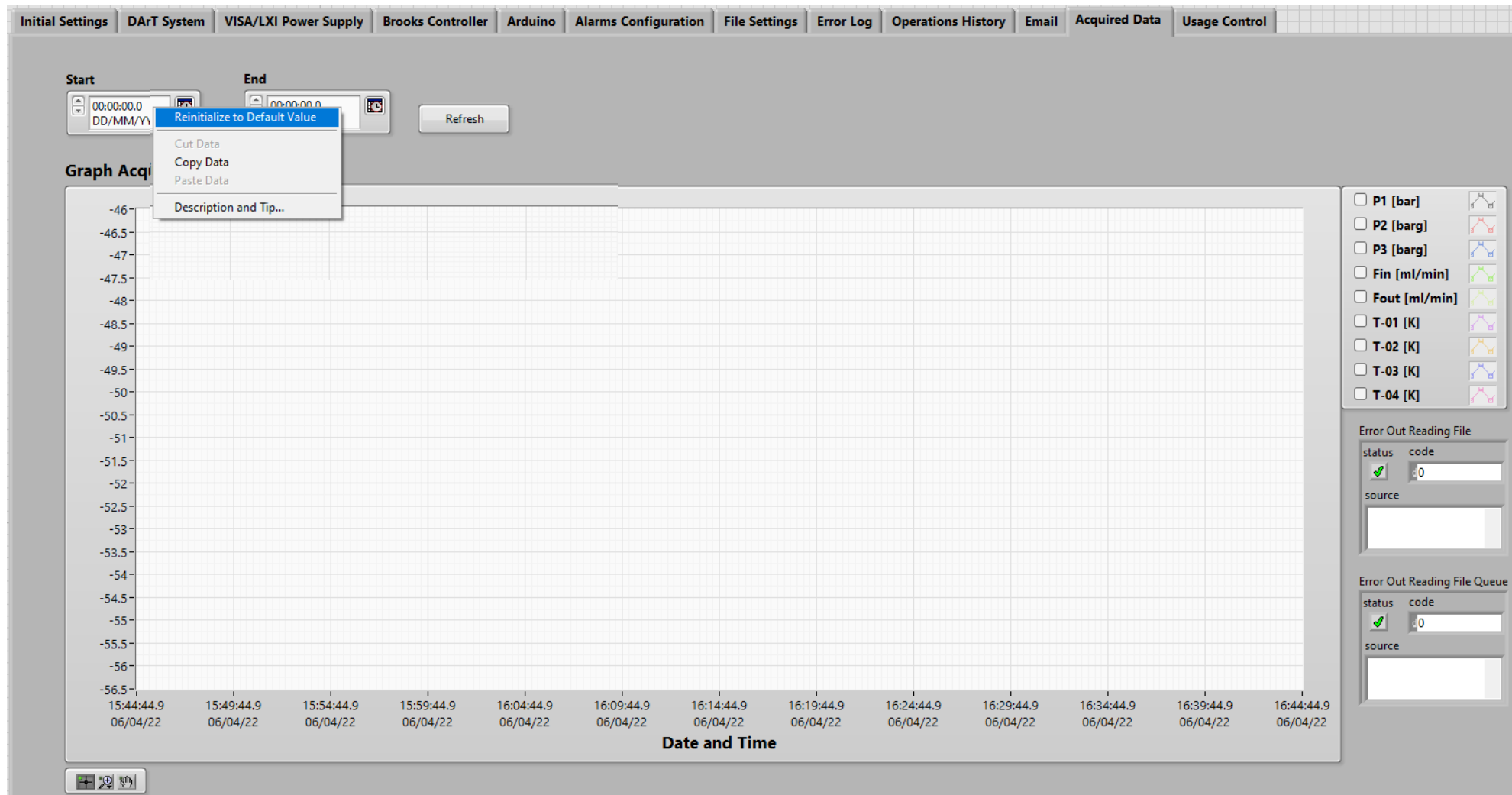
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DArT Slow Control

Trends of the Acquired Data






DArT Slow Control Usage Control

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Initial Settings | DArT System | VISA/LXI Power Supply | Brooks Controller | Arduino | Alarms Configuration | File Settings | Error Log | Operations History | Email | Acquired Data | Usage Control

cRIO Disk

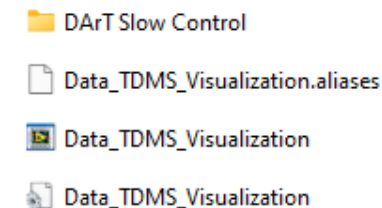
Disk Full 

Disk Critical %	80 %	CPU Load %	0 %
Disk Free [B]	0 B	Engine State %	0
Disk Unavailable [B]	0 B	Disk Filled %	0 %
Disk Total [B]	0 B	HW Scan Utilization %	0 %



DArT Slow Control Main Functionalities

- Data acquisition and processing with slightly adjustable run time (around 1 s)
- Visualization of current measured data and trends at the request of the user
- Security check of the operations
 - Variables acquired outside the defined ranges: high/low (warning) or too high/low (alarm) values are reported
 - Measurements and Event logging associated with date and time
 - **Variables limited in ranges in the Slow Control and in the cRIO**
 - **Tracking of user operations in a file: date, time, user, variable, old and the new values are saved**
- Files (data and error log saved on files changed periodically every week):
 - CSV (Comma Separated Values)
 - TDMS (Technical Data Management Streaming)





DArT Slow Control Web Page

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System status can be monitored remotely through a web page.

Users can connect using the link: <http://10.131.1.34:8001/Web Page - DArT Slow Control.html>

The web page allows the users **to see exactly** what the operator is viewing in the application.

The screenshot displays the DArT Slow Control web interface. At the top, there is a navigation menu with tabs: Initial Settings, DArT System, VISA/LXI Power Supply, Brooks Controller, Arduino, Alarms Configuration, File Settings, Error Log, Operations History, Email, Acquired Data, and Usage Control. The main area features a central process flow diagram with components like LN2, Ar condenser, B10 UAr, UAr recovering, Pressure reducer, Fin, Fout, Vacuum, and DAr. The diagram includes various valves (V01-V18) and pressure gauges (P1, P2, P3). On the left, there are input fields for User, Run Start Time, Scan Interval [ms], Current Date, and Current Time, along with a V0 Update Button and a Stop Button. On the right, there are several control panels for Shared Variable Generators Read, Shared Variable Brooks Controller Read, and Error Out Keithley 2450, each with status and code indicators. At the bottom right, there are two ON buttons for Data Saving Chosen Option and Error Log Saving Chosen Option. The interface is designed for remote monitoring and control of the DArT system.



DArT Slow Control

Latest requests – in progress

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1. Acquire gas system sensor values
 1. Keep the history of the system
2. Safety watch.
 1. Look for critical sensor values.
 2. If any is out of range warn operator and related people.
3. Distribute information and system status.
 1. To an unrestricted number of viewers
4. Allow operators to set parameters.
 1. Only operators can modify parameters
 2. Two operators for safety.
 3. Keep track of operations.
5. Automatic procedures to ease the operation.
 1. Automatic filling with UAr.
 2. Automatic emptying
 3. Bottle replacement and cleaning
 4. UAr recovering



Thank you for your attention

Any questions?