# Automatic Configuration of Motors at the **European XFEL**



Florian Sohn, Wajid Ehsan, Gabriele Giovanetti, Dennis Goeries, Ivars Karpics, Konstantin Sukharnikov European XFEL GmbH, Schenefeld, Germany

### Introduction

Research at the European XFEL scientific facility relies heavily on the use of more than 3000 motors to move components within the various scientific setups. To facilitate flexible experimental setups and to save resources, motors are relocated within the European XFEL and reused at various locations as part of the operation of scientific instruments. Typically, each motor has more than 150 configurable parameters and needs to be configured at each new location. In this contribution, a software tool for the automatic configuration of motors is presented, which aims to achieve the following main goals:

# **The Motor Configurator**

The motor configurator software tool has been implemented to eliminate the necessity for manual reconfigurations and allows

- Minimize time spent by staff to configure motors,
- Minimize mistakes due to manual configuration of motors,
- Protect against hardware damage due to accidental misconfigurations of motors.

The software tool is based on the SCADA system Karabo [1,2], which is developed at European XFEL. Karabo provides a high-performance, reliable, and user-friendly environment to configure and control a plethora of hardware devices. One outstanding feature of Karabo are so-called scenes, easily configurable, multi-purpose graphical user interfaces that can be shipped with Karabo-based software tools. The motor configurator software includes a scene to provide a user-friendly graphical user interface.

## **Technical background**

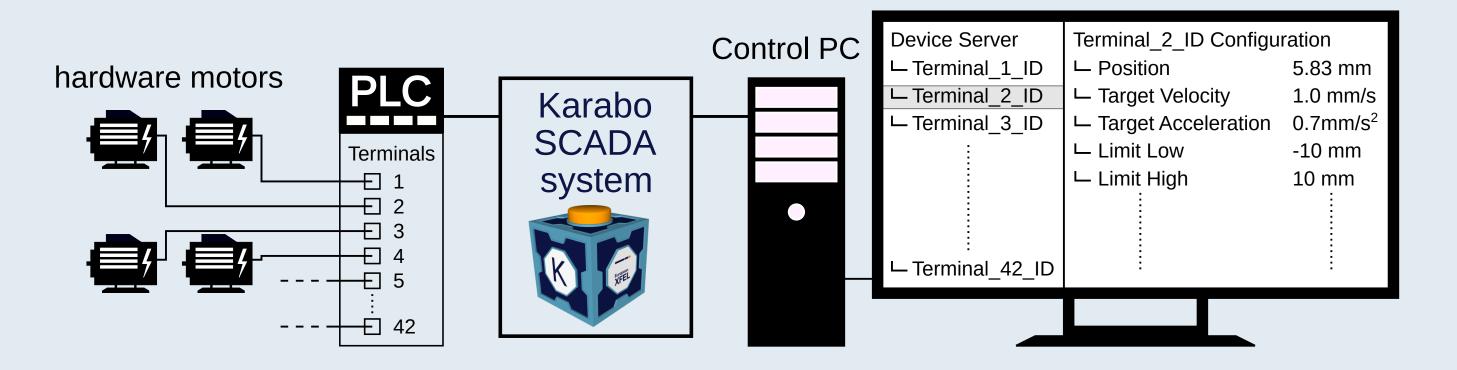
For the integration of a hardware device in Karabo a software **device class** is written, which provides access to hardware features. Within Karabo, each individual hardware device is represented in terms of an **instance** of the respective device class. For each device instance, a **configuration**, i.e. a set of operational parameters for the hardware device, is held by the control system.

- to apply stored configuration presets to motors
- monitoring of the configuration of active, i.e. online, motors, including highlighting and displaying deviations from the assigned preset

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1 FXE_SMS_USR/MOTOR/UM02	um02,svetina_det_1,kappa_Z	um02	1 enableSWLimitLow	✓ True ✓ True	✓ True	all	14 FXE_XTD9_MONO-1/MOTOR	/TY		No changes	
2 FXE_SMS_USR/MOTOR/UM03	svetina_gonio_aroundX,kappa_X	svetina_gonio_aroundX	2 encoder.maxPositionLagValue	✓ True ✓ True	✓ True	all	15 FXE_SMS_USR/MOTOR/UM1	.8		Changes detected	
3 FXE_SMS_USR/MOTOR/UM04	liquidjet_kohzu_ZA04A,svetina_gonio_Y,.	liquidjet_kohzu_ZA04A	3 enableSWLimitHigh	✓ True ✓ True	✓ True	all	16 FXE_XTD9_MONO-2/MOTOR	/TX		No changes	
4 FXE_SMS_USR/MOTOR/UM06	svetina_gonio_Z,kappa_phi	svetina_gonio_Z	4 swLimitLow	✓ True	✓ True	all	17 FXE_SMS_USR/MOTOR/UMO			Changes detected	
5 FXE_SMS_USR/MOTOR/UM07	svetina_gonio_X,kappa_kappa	svetina_gonio_X	5 swLimitHigh	✓ True ✓ True	✓ True	all	18 FXE_OGT2_PSLIT/MOTOR/B	LADE1_IN_OUT		No changes	
6 FXE_SMS_USR/MOTOR/UM08	svetina_magnet_Y	svetina_magnet_Y	6 mc2.referenceVelocity	✓ True ✓ True	✓ True	all	19 FXE_SMS_USR/MOTOR/UM1	.5		No changes	
7 FXE_SMS_USR/MOTOR/UM09	svetina_target_Z	svetina_target_Z	7 activeController	✓ True ✓ True	✓ True	all	20 FXE_XTD9_MONO-1/MOTOR	/TX		No changes	
8 FXE_SMS_USR/MOTOR/UM10	svetina_target_X	svetina_target_X	8 mc2.moveDirection	✓ True ✓ True	✓ True	all	21 FXE_OGT2_PSLIT/MOTOR/B			No changes	
9 FXE_SMS_USR/MOTOR/UM11	svetina_Dmirror_rot,kappa_chi	svetina_Dmirror_rot	9 mc2.maxVelocity	✓ True ✓ True	✓ True	all		~		Changes detected	
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12 FXE_SMS_USR/MOTOR/UM15 svetina_gonio_aroundZ svetina_gonio_aroundZ		Username	Username			Showing the configuration and changes for FXE_SMS_USR/MOTOR/UM01.					
13 FXE_SMS_USR/MOTOR/UM16	svetina_det_2	svetina_det_2	Get From Git Push To Gi	it Log out git user		Changes		Show Configurati	on		1
14 FXE_SMS_USR/MOTOR/UM17	liquidjet_vertical,svetina_Dmirror_X	liquidjet_vertical									
15 FXE_SMS_USR/MOTOR/UM18	liquidjet_alongbeam,svetina_sample_Z	liquidjet_alongbeam					ation (Wed 27 Sep 2023, 15:25:07)		d Configuration (Thu 13 Jul 20	23, 13:14:29)	
16 FXE_SMS_USR/MOTOR/UM19	liquidjet_horizontal,svetina_sample_Y	liquidjet_horizontal				commissionin gearRatio	1.0		<b>nissioning</b> arRatio 28.	144444	
17 FXE_SMS_USR/MOTOR/UM20	svetina_sample_X	svetina_sample_X				spindlePito		sp	indlePitch 0.4		
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			oonfigu	ration							
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Features				comparison dialog							
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							<b>Note</b> : Press <b>Apply</b> to request to reconfigure the displayed configuration changes.				
							✓ Apply ● Cancel				

user-friendly GUI interface

Most motors at European XFEL are connected to **programmable logic** controllers (PLCs), one motor to one PLC terminal. Within Karabo each PLC terminal receives a unique identifier, the terminal ID. An instance of the correct device class for the connected hardware is automatically created after information about the detected hardware has been forwarded from the PLC to Karabo. Importantly, a configuration is assigned to a terminal ID, but cannot be assigned to the connected hardware directly.



## **Operational requirements for exp. setups**

As motors are relocated between and within experimental setups, the assignment of motors to PLC terminals is subject to changes due to motors being

- a preset configuration is created from the current configuration of a motor
- motor parameters table: select subset of parameters to be saved in preset, restrict configuration comparison to a subset of parameters
- 1-to-1 mapping table to assign stored configurations to terminal IDs
- comparison table: indicate mismatch between current configuration of motor and stored configuration
  - monitoring mode: compare online and stored configurations periodically
  - display differences between stored and online configurations
  - allow to easily apply a stored configuration to a motor
- central database for configurations allows to synchronize stored configurations over multiple installations of the software
  - version control allows to restore previous configurations
  - currently uses git/gitlab as a backend
- preset organization: store multiple different presets for a terminal and select one preset to be used for comparisons with online configurations
- Device 'locking': In case of mismatch between preset and online configuration disable control of motor to prevent motor movements and protect against hardware damage

## **Conclusion and future work**

The motor configurator software tool is heavily used for setting and monitoring configurations of motors at European XFEL. Major benefits of the tool are

reassigned to different PLC terminals,

added to or removed from the setup.

Even if a motor driver of the same type as the previous setup is connected to a PLC terminal, the previous configuration for the PLC terminal in Karabo might not be suitable due to a motion stage with different mechanical and electrical requirements being connected to that driver. Hence, a reconfiguration of the parameters of a terminal ID is necessary upon each exchange of the connected hardware device. Due to the number of motors in a scientific component and the number of parameters in a motor configuration, manual reconfigurations are time-consuming and error-prone.

a significant reduction in time needed to configure motor setups,

- a reduced likelihood of motor misconfigurations,
- a reduced likelihood of damage to hardware components.

For convenient modification of existing configuration presets, a configuration editor can be added in future work.

#### References

[1] Hauf, Steffen, et al. "The Karabo distributed control system." Journal of synchrotron radiation 26.5 (2019): 1448-1461. [2] https://github.com/European-XFEL/Karabo

European XFEL GmbH, Florian Sohn, Holzkoppel 4, 22869 Schenefeld, Germany, Phone +49 40 8998 6572, florian.sohn@xfel.eu www.xfel.eu

