rexroth
A Bosch Company

Application Manual

PLC App

PLC Runtime Environment for ctrlX CORE

R911403787, Edition 06

Liability

The specified data is intended for product description purposes only and shall not be deemed to be a guaranteed characteristic unless expressly stipulated in the contract. All rights are reserved with respect to the content of this documentation and the availability of the product.

DOK-XCORE*-PLC********-AP06-EN-P

Table of contents

1 About this documentation

Editions of this documentation

Edition	Date	Note
01	2020-06	First edition Release date for PLC app version PLC-V-0102 and PLC-V-0104
02	2020-12	Release date for PLC app version PLC-V-0106 Revision: • ➦Window – “PLC” • ➦Related documentation
03	2021-06	Release date for PLC app version PLC-V-0108 New: • ➦Flexible memory configuration for remanent PLC data Revision: • ➦Window – “PLC”
04	2021-09	Release date for PLC app version PLC-V-0110 New: • Chapter 6 "Multicore functionality", page 13
05	2022-02	Release date for PLC app version PLC-V-0112 Revision: • ➦PLC App – Basics
06	2022-11	Status of PLC App Version PLC-V-0116 New • ➦Connecting the PLC runtime system to the ctrlX CORE system behavior • ➦Event sources for external event-controlled PLC tasks Revision • ➦Window – “PLC” • ➦Flexible memory configuration for remanent PLC data

2 Important directions on use

2.1 Intended use

2.1.1 Introduction

Rexroth products are developed and manufactured to the state-of-the-art.

The products are tested prior to delivery to ensure operational safety and reliability.

⚠ WARNING	**Personal injury and damage to property due to incorrect use of products!** The products may only be used as intended. Failure to use the products as intended may cause situations resulting in property damage and personal injury.

NOTICE	**Damages resulting from unintended use** Rexroth As the manufacturer does not assume any warranty, liability or compensatory claims for damages resulting from unintended use of the products. The user alone shall bear the risks of an unintended use of the products. Before using Rexroth products, make sure that all the prerequisites for an intended use of the products are met: – Personnel that in any way, shape or form uses Rexroth products must first read and understand the relevant safety instructions and be familiar with their intended use – Leave hardware products in their original state, i.e., do not make any structural modifications. It its not permitted to decompile software products or alter source codes – Do not install damaged or defective products or commission them – It has to be ensured that the products have been installed as described in the relevant documentation

2.1.2 Areas of use and application

Products of the ctrlX series are suitable for Motion/Logic applications.

NOTICE	Products of the ctrlX series may only be used with the accessories, mounting parts, and other components specified in this documentation. Components that are not expressly mentioned must neither be attached nor connected. The same applies to cables and lines. Only to be operated with the hardware component configurations and combinations expressly specified and with the software and firmware specified in the corresponding documentations and functional descriptions.

Products of the ctrlX series are suitable for single-axis as well as for multi-axis drive and control tasks. Device types with different equipment and interfaces are available for using the system in specific applications.

Typical areas of application:

- Building automation
- IoT and Security Gateway or Device
- Handling & Robotic

Controls of the ctrlX CORE series may only be operated under the mounting and installation conditions, in the position of normal use and under the ambient conditions (temperature, degree of protection, humidity, EMC, etc.) specified in the related documentations.

2.2 Unintended use

"Unintended use" refers to using the ctrlX products outside of the above-mentioned areas of application or under operating conditions and technical data other than described and specified in the documentation.

ctrlX products must not be used if they are exposed to following conditions:

- Operating conditions that do not meet the specified ambient conditions. Operation under water, under extreme temperature fluctuations or under extreme maximum temperatures is prohibited
- Applications that have not been expressly authorized by Rexroth

3 Safety instructions

The Safety instructions contained in the available application documentation feature specific signal words (DANGER, WARNING, CAUTION or NOTICE) and, where required, a safety alert symbol (in accordance with ANSI Z535.6-2006).

The signal word is meant to draw the reader's attention to the safety instruction and identifies the hazard severity.

The safety alert symbol (a triangle with an exclamation point), which precedes the signal words DANGER, WARNING and CAUTION, is used to alert the reader to personal injury hazards.

The Safety instructions in this documentation are designed as follows:

⚠ DANGER	In case of non-compliance with this safety instruction, death or serious injury **will** occur.
⚠ WARNING	In case of non-compliance with this safety instruction, death or serious injury **could** occur.
⚠ CAUTION	In case of non-compliance with this safety instruction, minor or moderate injury could occur.
NOTICE	In case of non-compliance with this safety instruction, property damage could occur.

4 Introduction and overview

4.1 PLC App – Basics

Install the “PLC App” to add a PLC runtime environment to the functional scope of the ctrlX CORE control.

The runtime environment is based on “CODESYS Control V3” and is completely integrated in the ctrlX CORE system environment.

PLC programming and debugging is realized via the PC-based Engineering tool ctrlX PLC Engineering.

PLC App licensing

The PLC App operation is subject to a license.

The license model contains three licenses in total which can be use to scale the functional scope, if required.

The “Basic Single license” is required to operate the PLC App.

Based on the "Basic Single License”, the functional scope can be extended by adding “In-App" licenses.

License name	Description	Type/part number
ctrlX PLC Basic Single license	Basic license to operate the PLC App • Operating a PLC task on the target device	SWL-XC*-PLC-PLC**********-BANN R911397817
ctrlX PLC Standard Single License	Additional in-app license Functional extension: • Operating several PLC tasks is possible on the target device Required: • ctrlX PLC Basic Single license	SWL-XC*-PLC-PLC**********-NNNN R911411765
ctrlX PLC Advanced Single License	Additional in-app license Functional extension: • Operating several PLC tasks is possible on the target device • Distribution of the task to several CPU cores is possible Required: • ctrlX PLC Basic Single license • ctrlX PLC Basic Standard Single license	SWL-XC*-PLC-PLC**********-ADNN R911401461

License test

Before starting the loaded PLC program, it is automatically checked if the license required for the specific PLC application is installed on the target system.

If a required license is missing, the PLC program cannot be started!

The "ctrlX PLC Advanced Single" license is an exception whose function allows to start the application even though the license is missing. In this case, the application is automatically stopped after a duration of 30 minutes.

The licensing mechanism is only supported on real ctrlX CORE devices.

For virtual ctrlX CORE devices, a runtime restriction of 4 hours that does not require a license applies from version WRK-V-0112. After the runtime has expired, the control is automatically shut down. However, the control can be restarted and operated for four more hours.

Further information

Documentation

- ctrlX CORE - App basics
- ctrlX CORE - License overview

Reference source

- ctrlX App Store

Web links

- ctrlX CORE - Community
- ctrlX CORE - How to
- ctrlX CORE - Forum

5 Multicore functionality

5.1 Introduction

The multicore function facilitates the use of all CPU cores of ctrlX CORE to simultaneously process PLC IEC tasks.

Advantages:

- Increased execution velocity by parallel processing in case of simultaneous use of the available processor performance
- Complex PLC logics can be divided into different, independent task groups and CPU cores
- Separating the logic application, the communication and additional functions such as Motion or visualization

The multicore functionality is available from version PLC-V-0110 for ctrlX CORE and requires an in-app license per runtime.

related topics:

- Apps and licenses in the ctrlX Store
- License center "Quick Start Guide"
- Multicore and task configuration - Basics and configuration

5.2 Licensing the multicore functionality

related topics:

- License center "Quick Start Guide"
- Apps and licenses in the ctrlX Store

The following license is required to use the multicore functionality on the ctrlX CORE control:

Name	Description	License of the type code	Part number
PLC Advance license	In-app license to enable the PLC multicore functionality on the ctrlX control.	SWL-XC*-PLC-PLC**********-ADNN	R911401461

The PLC Advance license is installed via the web interface of the ctrlX CORE control, see Further documentation

Multicore project - Behavior without PLC Advance license

If no PLC Advance license is installed on the ctrlX CORE control, PLC projects configured for multicore systems are operated in demo mode for 120 minutes. In this case, processing takes place on a processor core.

After the 120 minutes have been expired, the PLC goes to state STOP and reports an exception. The following message is output in the PLC logger: „Multi-core demo mode expired! Reboot of the controller is necessary now!“

Convert existing projects to multicore

If an existing project is to be converted to multicore functionality, please note that the device description file has version V1.10.0.1 or higher.

In case of projects created with a PLC Engineering version < WRK-V-0110, it is required to update the device description file of the control, see command Update Device.

5.3 Multicore in the IEC program

The multicore functionality can result in an increased performance when processing the PLC program by partitioning the IEC tasks and their load to different CPU cores.

In case of projects without multicore functionality, the tasks are processed on CPU kernel # 2.

- User IEC tasks
- Communication tasks
- System tasks

Assign tasks into different CPU cores

Prerequisites:

- The ctrlX CORE control supports the multicore functionality (from device description V1.10.0.1)
- At least two tasks are defined in your application, such as "MainTask" (IEC task) and "LowTask" (IEC task)

The tasks are assigned to the CPU cores via ctrlX PLC Engineering in the Task Groups tab, see ➦ Further documentation.

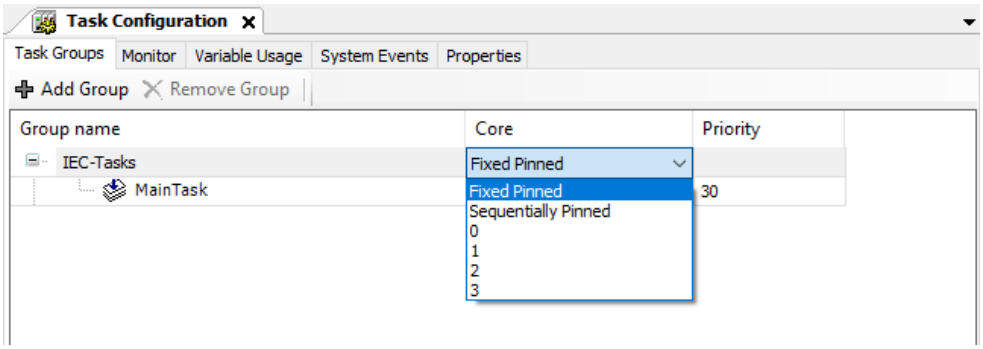

Fig. 1: Task group tab

In the state upon delivery, the "IEC tasks" task group is preconfigured in the "Fixed Pinned" setting in which all tasks are processing in the CPU core #2.

Create another task group to assign the tasks to different cores. Subsequently, select the CPU number used to process the second task group in the "Core" field. Use Drag&drop to drag the tasks to the new task group.

In the "Sequentially pinned" setting, the CPU cores are allocated continuously

Please note, that the ctrlX CORE operating system is running on the CPU cores 0 and 1.

If task groups are running on these cores, the IEC task watchdog should always be enabled.

IEC tasks have a higher priority than the operating system. Thus, they can be slowed down considerably or rendered inoperable in case of high load.

Further information about the multicore application can be found in the PLC Engineering documentation, see ➦ Multicore and task configuration

6 Flexible memory configuration for remanent PLC data

The memory for remanent PLC data is available as pool to all PLC applications that are operated on the control during runtime.

A property of the remanent variables is to retain their values beyond a switch-off process of the control.

Physically, up to 128 kB non-volatile memory is available on the ctrlX CORE control. The memory space can be requested by the apps and can be used for remanent variables. The default value 64 kB is available for variables of type `VAR RETAIN` and `VAR PERSISTENT` for the PLC app and the PLC applications.

From PLC App version PLC-V-0108, the reserved memory size can be set dynamically to up to 120 kB.

Reboot the control in case of a memory size change.

Existing retain and retain persistent data are lost.

Configuring the memory size

1. Opem the ctrlX CORE web interface and navigate to the “PLC” window, see ⮫Documentation
2. In the header, click on ⚙
   ➡ The “Allocate PLC retain memory (Bytes)” dialog opens
3. Enter the desired memory size in bytes (max. 120 kB).
   If the input value is outside the minimum or maximum memory size, the minimum or maximum value is entered.
4. Confirm the dialog
   ➡ The control executes a reboot
   The memory size change is completed

7 Connecting the PLC runtime system to the ctrlX CORE system behavior

The management of the PLC applications and the associated tasks is handled by the scheduler of the PLC runtime system.

To ensure the general system behavior of the ctrlX CORE control, an additional connection to the ctrlX CORE system status has been established. For the PLC app:

- The PLC applications are taken into consideration in the ctrlX CORE system status as follows:
  - Each PLC application is registered with the System Handler of ctrlX CORE Runtime.
  - The system status (Data Layer node system->state) shows the PLC applications currently loaded on the device.
  - The IEC tasks generated via the PLC application are recorded in the task overview of the ctrlX CORE Scheduler, but the task properties cannot be changed in the associated dialog.
- When switching the operating state of the ctrlX CORE control, the PLC applications are handled as follows:
  - **Operating**: All PLC applications on the device are set to the state "RUN".
  - **Setup**: All PLC applications currently running on the device are switched to state "STOP".
  - **Service**: All PLC applications currently running on the device are switched to state "STOP".
- Switching the status of a PLC application:
  - **Operating**: Each PLC application can switch from RUN to STOP and vice versa as required.
  - **Setup**: All PLC applications configured on the ctrlX device are initially in state **STOP** and can be switched to RUN state. As soon as at least one PLC application has been started, the scheduler status changes to "Partial Operating".
  - **Service**: All PLC applications loaded on the device are in state "STOP" and cannot be switched to "RUN".

8 Event sources for external event-controlled PLC tasks

Notes on the configuration

ctrlX PLC Engineering provides several types for selection in the configuration dialog of a PLC task. The task type "External" provides the external events `TASK_EXTERNAL_EVENT_01` to `TASK_EXTERNAL_EVENT_10`. These events are initially not assigned on the control. The following action instruction describes how to configure external events.

Up to ctrlX PLC App version PLC-V-0114, `TASK_EXTERNAL_EVENT_07` was created automatically.

As of ctrlX PLC App version PLC-V-0116, events have to be configured as described below.

Configuring an external event

1. Switch the ctrlX device to the "Setup" operating state using the status buttons in the header
2. Use the side navigation to call the “Scheduler” window.
3. In the window, select a task in the context the event is to be generated in.

   If you want to synchronize your PLC task with the Motion and the EtherCAT communication, please select the task "ctrlXAutomation".

   Optionally, create a new Task with the desired properties.
4. Use the button ⌄ to open the list of callables that are called in the associated task context.
5. Use the button ⊕ to open the dialog for adding a callable and select **plc-external-event** with the desired Run-Index.
   - ➡ The dialog for selecting the event is displayed and provides the arguments **TASK_EXTERNAL_EVENT_01** to **TASK_EXTERNAL_EVENT_10** for selection.
6. Select the event and delete all other entries so that only one argument is displayed.

   The selection of multiple arguments or the multiple use of an argument in different tasks is not possible.
7. Switch the ctrlX device back to the operating state "Operating".
   - ➡ The events are generated now.
8. Finally, assign the previously configured event to the desired PLC task ia the task configuration in ctrlX PLC Engineering.
9. Load your program to the controller and check if the PLC task is called.

Use case

A typical use case is, for example, the synchronization of a PLC task with the EtherCAT Master.

The synchronization is achieved by extending the task "ctrlXAutomation" by a Callable of type "plc-external-event" with a higher run index. First the EtherCAT Master is processed and subsequently, the external event for processing the PLC task is generated.

9 ctrlX UI – Elements

9.1 Navigation

9.1.1 Side navigation – PLC App

Install the “PLC” app on the control and the following entries are added to the ctrlX CORE side navigation.

Side navigation – “PLC”

In the side navigation, the entry “PLC” is added. Select this entry to go to the window“ Status”. Information on projected PLC applications is provided, see ➥ Chapter 9.2.1 Window – “PLC” on page 21.

Side navigation – “Automation”

The window “Automation” shows the tile “PLC”. Information about the operating state of the configured PLC applications can be found via the tile. Via links, navigation to the window “Status” or ctrlX PLC Engineering is possible to edit the respective program.

9.2 Windows

9.2.1 Window – “PLC”

Manage the PLC applications in the “PLC” window and the respective memory to manage the remanent data on the control (`VAR RETAIN` / `VAR PERSISTENT`).

Displays:

- Name of the application
- Operating state of the application
- Application diagnostics
- Interfaces to change the operating state or PLC application reset

The following PLC application variants are not supported:

- Device application
- Child application

Call:

In the ctrlX CORE web interface:

“side navigation → PLC”

Window elements

GUI element	Description
Header “PLC”	The header contains buttons to control the operating state of all configured PLC application(s): ● ▷ = Start applications ● ☐ = Stop applications ● = Reset all applications with the following reset options: – Reset warm – Reset cold – Reset origin ● = Starts "ctrlX PLC-Engineering", the PC-based software tool for programming the integrated PLC. **Note**: If no PLC project has previously been stored on the controller via project synchronization, the dialog for project synchronization opens, see: ➦Web documentation Otherwise, a new project with enabled project synchronization is created. ● = Opens the dialog “Allocate PLC retain memory (Bytes)” for changing the memory size, see ➦Change size of memory for remanent data
Table “PLC”	Table column “Name” (name of the PLC application)
	Table column “State” (status of the PLC application) ● “STOP” = PLC application is stopped ● “RUN” = PLC application is started
	Table column “Diagnostics” Diagnostic messages: ● “Exception” = The application is in error state. Measure: For more details please open ctrlX PLC Engineering and check the "PLC Log“ and the "Call tree". ● “ForceVariablesActive” = The function "Force Values" is active in the application. Measure: To stop forcing, please execute the “Unforce values” command in ctrlX PLC Engineering. ● “FlowControlActive” = In the application, the "Flow control“ mode is active. Measure: To deactivate the Flow control, please execute the "Flow control" command in ctrlX PLC Engineering. ● “RetainMismatch” = Application loaded with "retain mismatch“. Measure: To run the application, a "Reset Cold" is required, see "Actions" below.

GUI element	Description
	Table column “Actions”: Buttons to control the operating state: ● ▷ = Starting the PLC application ● □ = Stopping the PLC application ● ↻ = Reset the PLC application with the following options: – Reset Warm – Reset Cold – Reset Origin

Further information

- ➦Chapter 9.1.1 Side navigation – PLC App on page 21

10 Related documentation

10.1 Overview

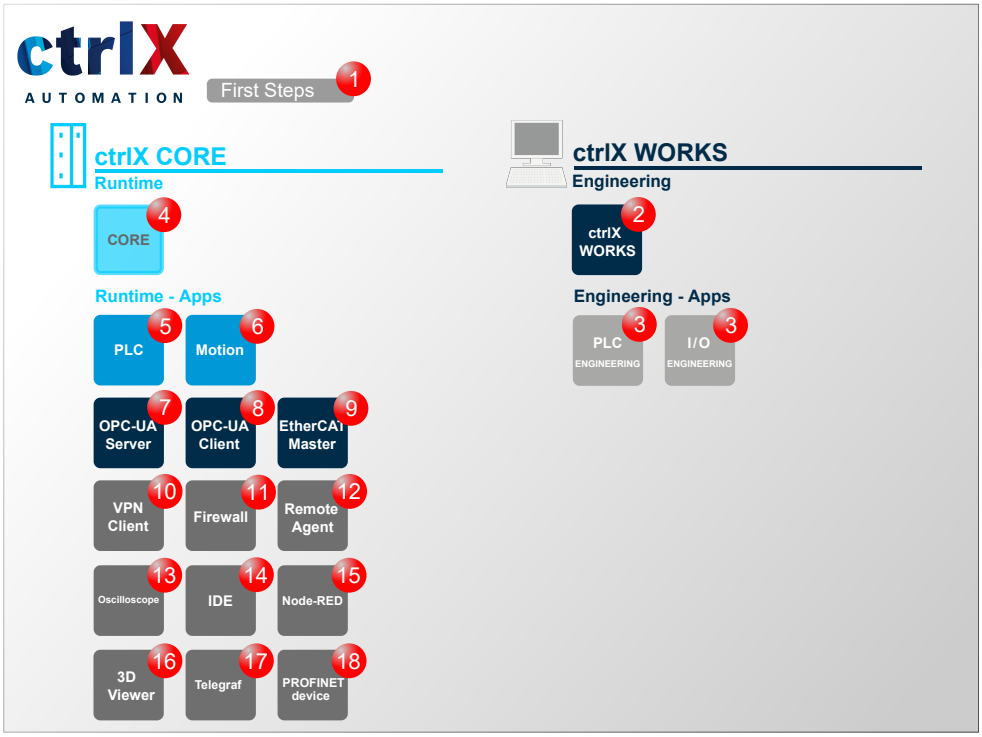

Fig. 2: Overview on further documentations

10.2 ctrlX AUTOMATION

No.	Documentation
1	**ctrlX WORKS First Steps** Quick Start Guide ➦ Web documentation link Ordering information: • DOK-XWORKS-F*STEP*****-QURS-EN-P • R911403760

10.3 ctrlX WORKS

No.	Documentation
2	**ctrlX WORKS Basic System** Application Manual ➦ Web documentation link Ordering information: • DOK-XWORKS-**********-APRS-EN-P • R911403761
3	**ctrlX PLC Engineering - PLC Programming System** Application Manual ➦ Web documentation link Ordering information: • DOK-XPLC**-ENGINEERING-APRS-EN-P • R911403764
3	**ctrlX PLC Engineering - PLC Libraries** Reference ➦ Web documentation link Ordering information: • DOK-XPLC**-LIBRARY****-RERS-EN-P • R911403766

10.4 ctrlX CORE

No.	Documentation
4	**ctrlX CORE - Runtime** Application Manual ➦ Web documentation link Ordering information: • DOK-XCORE*-BASE*******-APRS-EN-P • R911403768
	ctrlX CORE - Diagnostics Reference ➦ Web documentation link Ordering information: • DOK-XCORE*-DIAG*******-RERS-EN-P • R911403770

10.5 ctrlX CORE apps

No.	Documentation
5	**PLC App - PLC Runtime Environment for ctrlX CORE** Application Manual ➦ Web documentation link Ordering information: • DOK-XCORE*-PLC********-APRS-EN-P • R911403787

No.	Documentation
6	**Motion App - Motion Runtime Environment for ctrlX CORE** Application Manual ➦ Web documentation link Ordering information: • DOK-XCORE*-MOTION*****-APRS-EN-P • R911403791
7	**OPC UA Server App - OPC UA Server for ctrlX CORE** Application Manual ➦ Web documentation link Ordering information: • DOK-XCORE*-OPCUA*SERV*-APRS-EN-P • R911403778
8	**OPC UA Client App - OPC UA Client for ctrlX CORE** Application Manual ➦ Web documentation link Ordering information: • DOK-XCORE*-OPCUA*CLIEN-APRS-EN-P • R911403781
9	**EtherCAT Master App - EtherCAT master for ctrlX CORE** Application Manual ➦ Web documentation link Ordering information: • DOK-XCORE*-ETHERCAT***-APRS-EN-P • R911403773
10	**VPN Client App - Remote Support Software for ctrlX CORE** Application Manual ➦ Web documentation link Ordering information: • DOK-XCORE*-VPN********-APRS-EN-P • R911403775
11	**Firewall App - Security Functions for ctrlX CORE** Application Manual ➦ Web documentation link Ordering information: • DOK-XCORE*-FIREWALL***-APRS-EN-P • R911403783
12	**Remote Agent App - ctrlX Device Portal Connection for ctrlX Devices** Application Manual ➦ Web documentation link Ordering information: • DOK-XCORE*-REMOTE*AG**-APRS-EN-P • R911403785

No.	Documentation
13	**Oscilloscope App - Oscilloscope Function for ctrlX Devices** Application Manual ➥ Web documentation link Ordering information: • DOK-XCORE*-OSCI*******-APRS-EN-P • R911409806
14	**IDE App - Integrated Development Environment** Application Manual ➥ Web documentation link Ordering information: • DOK-XCORE*-IDE********-APRS-EN-P • R911410625
15	**Node RED App - Graphic Programming for ctrlX CORE** Application Manual ➥ Web documentation link Ordering information: • DOK-XCORE*-NODE*RED***-APRS-EN-P • R911403789
16	**3D Viewer App - Browser-based 3D Kinematic Simulation for ctrlX CORE** Application Manual ➥ Web documentation link Ordering information: • DOK-XCORE*-3D*VIEWER**-APRS-EN-P • R911416124
17	**Telegraf App - Server Agent for Collecting Data in the Data Layer** Application Manual ➥ Web documentation link Ordering information: • DOK-XCORE*-TELEGRAF***-AP01-EN-P • R911416836
18	**PROFINET device App - PROFINET device for ctrlX CORE** Application Manual ➥ Web documentation link Bestellinformationen: • DOK-XCORE*-PROFINET***-AP01-EN-P • R911417857

11 Service and support

Our worldwide service network provides an optimized and efficient support. Our experts provide you with advice and assistance. You can contact us **24/7**.

Service Germany

Our technology-oriented Competence Center in Lohr, Germany, is responsible for all your service-related queries for electric drive and controls.

Contact the **Service Hotline** and **Service Helpdesk** under:

Phone:	**+49 9352 40 5060**
Fax:	**+49 9352 18 4941**
Email:	➦service.svc@boschrexroth.de
Internet:	➦http://www.boschrexroth.com

Additional information on service, repair (e.g. delivery addresses) and training can be found on our internet sites.

Service worldwide

Outside Germany, please contact your local service office first. For hotline numbers, refer to the sales office addresses on the internet.

Preparing information

To be able to help you more quickly and efficiently, please have the following information ready:

- Detailed description of malfunction and circumstances
- Type plate specifications of the affected products, in particular type codes and serial numbers
- Your contact data (phone and fax number as well as your e-mail address)

12 Index

rexroth
A Bosch Company

Bosch Rexroth AG
Bgm.-Dr.-Nebel-Str. 2
97816 Lohr a.Main
Germany
Tel. +49 9352 18 0
Fax +49 9352 18 8400
www.boschrexroth.com/electrics

R911403787