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1 Foreword

1.1 Notes on the documentation

This description is only intended for the use of trained specialists in control and automation engineering who are familiar with the applicable national standards.
It is essential that the documentation and the following notes and explanations are followed when installing and commissioning the components.
It is the duty of the technical personnel to use the documentation published at the respective time of each installation and commissioning.

The responsible staff must ensure that the application or use of the products described satisfy all the requirements for safety, including all the relevant laws, regulations, guidelines and standards.

Disclaimer

The documentation has been prepared with care. The products described are, however, constantly under development.
We reserve the right to revise and change the documentation at any time and without prior announcement.
No claims for the modification of products that have already been supplied may be made on the basis of the data, diagrams and descriptions in this documentation.

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1.2 Safety instructions

Safety regulations

Please note the following safety instructions and explanations!
Product-specific safety instructions can be found on following pages or in the areas mounting, wiring, commissioning etc.

Exclusion of liability

All the components are supplied in particular hardware and software configurations appropriate for the application. Modifications to hardware or software configurations other than those described in the documentation are not permitted, and nullify the liability of Beckhoff Automation GmbH & Co. KG.

Personnel qualification

This description is only intended for trained specialists in control, automation and drive engineering who are familiar with the applicable national standards.

Description of symbols

In this documentation the following symbols are used with an accompanying safety instruction or note. The safety instructions must be read carefully and followed without fail!

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>⚠️</td>
<td>DANGER</td>
<td>Serious risk of injury! Failure to follow the safety instructions associated with this symbol directly endangers the life and health of persons.</td>
</tr>
<tr>
<td>⚠️</td>
<td>WARNING</td>
<td>Risk of injury! Failure to follow the safety instructions associated with this symbol endangers the life and health of persons.</td>
</tr>
<tr>
<td>⚠️</td>
<td>CAUTION</td>
<td>Personal injuries! Failure to follow the safety instructions associated with this symbol can lead to injuries to persons.</td>
</tr>
<tr>
<td></td>
<td>NOTE</td>
<td>Damage to the environment or devices Failure to follow the instructions associated with this symbol can lead to damage to the environment or equipment.</td>
</tr>
</tbody>
</table>

Tip or pointer

This symbol indicates information that contributes to better understanding.
2 Concept

More and more machine and system functions are implemented in software. To allow for this, nowadays teams of several programmers are involved in creating the control code and subsequently the commissioning of these machines and systems. This poses several challenges, especially during commissioning:

- In many cases, access to source control systems is not guaranteed
- The latest (active) software version on the machine may differ from the local version
- If changes that are "downloaded" to the target system turn out to be incorrect, it is not possible to undo the "download".

TwinCAT Multiuser was developed to meet these challenges. This is a "local" Source Control System on the target system, the handling of which has been fully integrated into the existing workflow. This means that no in-depth knowledge of the exact functionality of Source Control Systems is required to use TwinCAT Multiuser.

TwinCAT Multiuser is available from version TC3.1.4024. In this version, TwinCAT Multiuser mainly facilitates collaboration of several programmers, with each programmer working on one PLC project. If several PLC projects are integrated in a TwinCAT project, the multiuser functionality can be enabled separately for each project. In this case, separate repositories are automatically created for each of these projects, both locally and on the target system. The following diagram illustrates the concept.

![Diagram of TwinCAT Multiuser](image)

The target system is selected as the Source Control Server during commissioning, since a connection to the target system is required in any case in order to load a control program onto the target system. This avoids the need for additional infrastructure.

Another objective of multiuser integration is to avoid the need for specific Source Control knowledge. The Source Control functionality is integrated in the standard workflow. For example, the current project status is automatically transferred to the target system during a download or online change of a project, without the need to trigger the transfer separately. The history is also created automatically. All changes (including user name, time stamp and change) are recorded. If required, a query for a comment can be set for each change transfer.
To ensure that the history created in this way continues to be available after commissioning, a Source Control System was integrated, which permits several repositories and also transfers the full history into all repositories. After successful commissioning, it is thus possible to transfer the active project status of the machine/system to a "development repository", including traceability of all steps performed during commissioning. The latter is done with the on-board resources of the Source Control System.

The Source Control System on which the multiuser functionality is based is Git.

**Differentiation from the Source Control Integration of TwinCAT:**

The general interfacing of TwinCAT with Source Control Systems remains unaffected by the multiuser functionality and can take place independently of it. By using the standard interface of the Microsoft Visual Studio Shell integrated in TwinCAT, a large number of Source Control Systems are available for this purpose. In addition, all aspects of a TwinCAT project can be handled by this integration.

The TwinCAT multiuser functionality is based on the Git standard. As already described, the aim of this functionality is to enable a team of several programmers to collaborate on a control program during the commissioning phase, without the need for a special infrastructure or special knowledge of Source Control Systems on the part of the programmers.

Although it is therefore possible to use different Source Control Systems for both functionalities, the full capabilities can only be achieved if both functionalities are based on Git. This refers to the transfer of the history during commissioning to the "main" Source Control System.
3 Workflow

3.1 Creating a new project

To activate this function for a project that is not yet managed through the multiuser functionality, carry out the following steps.

1. Activate the Use Multiuser option in the project settings of the PLC project that is to be managed through the multiuser functionality (see Reference, project settings [p. 21]).
2. Open the Multiuser Explorer window under View -> More Windows -> Multiuser Explorer.
3. Select a PLC project in the combo box of the Multiuser Explorer.
   ▶ Several tabs should now appear in the Multiuser Explorer.
4. Select the Settings tab.
5. In the ADS Route field, select a target system for the multiuser repository.
6. In the Multiuser Repository field, select a name for the multiuser repository.
7. If required, select the option Ask for update message on each usage (see also Settings tab [p. 14]).
8. Click the Init local and remote button.
   ▶ The multiuser repositories in the project and on the target system are initialized.

3.2 Using an existing project

If an existing project is to be connected to the multiuser server for which a repository has already been set up on the target system, proceed in the same way as for setting up the functionality. The only difference is that in the combo box for the name of the target system you do not create a new repository but select an existing one.

The steps in detail:

1. Open the project.
2. In the project settings of the PLC project that is to be managed through the multiuser functionality, check whether the option Use Multiuser (see Reference, project settings [p. 21]) is enabled. If not, enable it.
4. Select the PLC project in the combo box of the Multiuser Explorer.
   ▶ Several tabs should now appear in the Multiuser Explorer.
5. Select the Settings tab.
6. In the ADS Route field, select the target system that contains the multiuser repository.
7. In the Multiuser Repository combo box, select the name of the multiuser repository to which the project is to be linked.
8. If required, select the option Ask for update message on each usage (see also Settings tab [p. 14]).
9. Click the Init local and remote button.
   ▶ The multiuser repository in the project is now initialized.

---

If you do not have an existing project, you can create a TwinCAT project. Then add an empty PLC project and link it to the multiuser repository on the target system as described above.

The Git Source Control System uses absolute paths in the repositories. This means that copying a project in which multiuser functionality is already installed (including the .TcGit folder) will result in the multiuser functionality not working correctly!
3.3 Working with set functionality

If the multiuser functionality was set up as described under Creating a new project or Using an existing project and linked to the PLC project, this functionality is automatically integrated into the existing workflow.

Transferring the data to the target repository

The changes generated while working on the PLC project are automatically transferred to the target repository (if multiuser functionality is activated) during a download or online change.

Checks are carried out to ascertain whether there is a conflict with the data in the target repository. This is the case if other programmers working on the project have already made changes to the same project parts (e.g. POUs, settings etc.) and transferred them to the target repository. If there is a conflict, it is displayed in the following dialog.

In this selection dialog you then have the option to

- resolve the conflicts using the TwinCAT Project Compare Tool,
- force an update of the target system including the target repository, or
- cancel the login.

Force Update can be used if the target system is required to run with the current project without taking into account the changes made by the other programmers involved in the project.

The normal workflow for collaborating on a project involves resolving conflicts. In this step, you can merge the changes you have made to the project with those of the other programmers working on the project.

1. To do this, click Solve Conflict.
   - In the dialog that follows you will be informed that resolving conflicts may cause changes to the files, in which case the project has to be recompiled after a merge operation.
2. Confirm this message with OK.

The Conflict tab now opens. This allows you to discard all your local changes and apply the version from the target repository, or to merge the two versions.
3. To merge, click **Merge Local and Remote**.

![Multiuser Explorer](image)

An overview appears that shows all POUs (Programming Organization Units) where changes have led to conflicts with the target repository.

4. For each conflict displayed, click **Start Merge**.

   ![Multiuser Explorer](image)

   The TwinCAT Project Compare Tool opens, in which you can merge the changes.

5. Accept the result with **Accept**.
Once all changes have been merged, you are notified that there are no further conflicts.

6. Now log in again.

The current and merged version of the project is transferred to the target system and stored in the target repository.
Only one at a time

Although several programmers can be logged into the target at the same time to view the project status, only one programmer can make changes at any one time. All other programmers have to log out briefly. The logged-in programmers are shown in the following dialog.

Once the changes have been made, the other programmers can log in again and the workflow shown above is triggered to merge the changes with those of the other programmers. If the other programmers have not yet made any further changes to the project, they are notified that a newer version is available on the remote system.
4 Reference, user interface

The Multiuser Explorer is the central administration tool for the multiuser functionality. This window remains empty as long as no project has been associated with multiuser functionality.

As soon as a project has been selected, the tabs listed below become visible.

4.1 Settings tab

Once a PLC project has been selected, the Settings tab appears as follows.
<table>
<thead>
<tr>
<th>Reference, user interface</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>ADS route</th>
<th>Combo box for selecting an existing ADS route</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiuser repository</td>
<td>Combo box for selecting an existing MU repository or creating a new one</td>
</tr>
<tr>
<td>Remote Multiuser URL</td>
<td>URL for repository</td>
</tr>
<tr>
<td>User name</td>
<td>User name to be used for the entries in the history. The default setting is the placeholder &quot;%LoggedInUser%&quot;. This is automatically replaced by the locally logged in user as user name in the comment.</td>
</tr>
<tr>
<td>Ask for update message on each usage</td>
<td>Option to query change messages</td>
</tr>
<tr>
<td>Update message</td>
<td>Structure of the update message. The placeholders &quot;%Action %, %FilesChanged%&quot; and &quot;%UserMessage%&quot; are automatically replaced by the corresponding information during an online change or download. If a placeholder is removed, the corresponding information is removed from the automatically generated comment. Placeholder: &quot;%Action%&quot;: indicates whether an online change or download was performed &quot;%FilesChanges%&quot;: indicates the number and reason for the changed files (e.g. 2 added) &quot;%UserMessage%&quot;: is replaced by the user-specific comment if the option <strong>Ask for update message on each usage</strong> is enabled.</td>
</tr>
<tr>
<td>Init local and remote</td>
<td>Initializes the local and target repositories</td>
</tr>
</tbody>
</table>

### 4.2 History tab

The **History** tab has a **Show History** button. This opens a tool window which shows the history of the current project.

![History tab](image)

Example: History of the documentation example. In this example, changes were made both on the target system and on the local system.
4.3 Diff tab

The **Diff** tab shows all files where changes have been made that have not yet been transferred to the target repository.

As an example, the following image shows changes made to the PLC project file of the project Untiteld1.
**Updating of the target system only in case of changes in the code.**

Not every change displayed is a code change. The changes are only transferred to the target system if there is a change in the code that requires a new download of the project or project parts.

Example: A change in a comment within a POU is a change within a file that does not require re-compiling. For this reason, it is possible to log in without online change and thus without downloading the changes.

### 4.4 Status tab

Displays the status of the multiuser functionality and provides the option to disable this setting. This will delete the local repository.

<table>
<thead>
<tr>
<th>Environment</th>
<th>Displays the state of the multiuser server:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>OK</strong>: local and target repository found</td>
</tr>
<tr>
<td></td>
<td><strong>LocalNotExists</strong>: no local repository was found</td>
</tr>
<tr>
<td></td>
<td><strong>RemoteNotExists</strong>: no target repository was found</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Files</th>
<th>Shows the status of the files.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>OK</strong>: local and target repository found, no newer project status on target repository</td>
</tr>
<tr>
<td></td>
<td><strong>LocalNotExists</strong>: no local repository was found</td>
</tr>
<tr>
<td></td>
<td><strong>RemoteNotExists</strong>: no target repository was found</td>
</tr>
<tr>
<td></td>
<td><strong>LokalsbehindRemote</strong>: A newer version exists on the target repository</td>
</tr>
</tbody>
</table>

Delete Multiuser files / Deactivate Multiuser

Deletes the local repository and disables multiuser functionality

The Files status entry also displays OK if the local files status is newer than that in the repository. You can see which files have been changed in the [Diff tab](#).
4.5 Conflict tab

The Conflict tab shows whether there are any conflicts between the local status and the status in the target repository, or if a merge has been triggered. The following cases are possible:

Local and target repositories have the same status:

![Image of Conflict tab with message: Local and Remote are in Sync. No conflicts.]

The local system contains changes that have not yet been transferred:

![Image of Conflict tab with message: Local has changes. No conflicts. Discard local changes.]

Changes were made on both the local and the remote system:
Click the **Merge Local and Remote** button to show a list of the changes. In the following view you will see all objects in which changes have been made on both sides (for example the POU Main in the following figure).

To merge the changes, click the **Start Merge** button. The TwinCAT Project Compare Tool opens, in which you can merge the objects. After a successful merge, please confirm the changes with **Accept**, both in the TwinCAT Project Compare tool and in the Multiuser Explorer.

The target repository contains changes that have not yet been implemented locally:
Click the **Get Latest** button to fetch the current status of the target repository. TwinCAT now informs you that files have changed in the background and asks whether you want to reload them. Confirm this question with **OK**.

### 4.6 Manual tab

The **Manual** tab is used to write the current project status to the target system or to fetch it from there.

<table>
<thead>
<tr>
<th>Operation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pull (override local)</td>
<td>Fetches the current project status from the target system and overwrites the local project. No merging of the project statuses takes place.</td>
</tr>
<tr>
<td>Push (override remote)</td>
<td>Overwrites the status on the target system. No merging of the project statuses takes place.</td>
</tr>
</tbody>
</table>
5 Reference, project settings

To use Multiuser in a project, this function has to be enabled.

| Use Multiuser | Enables the multiuser functionality of the PLC project |
6 Reference, server settings

The TwinCAT Multiuser functionality is based on the Git Source Control System. This is automatically installed with the "Minimal Git for Windows" version.

Changing the storage location of the Git repositories

If necessary, you can change the default storage location of the Git repositories on the target system. The default location is "C:\MultiuserRepository".

To adjust the path, change the entry in the file "<TwinCAT Folder>/Functions/Multiuser/directorypath.config" so that it points to the desired path.


7 FAQ

The Multiuser functionality is behaving in a way that is not described. What can I do?

The status of the Multiuser functionality can be viewed in the MultiuserExplorer on the Status tab. This is the first place to look if there is any unexpected behavior when using the Multiuser functionality (see Status tab [p. 17]).

Also check whether the TwinCAT3 AdsGitServer Windows service has started on the target system and restart it if necessary.

How can I restart with the Multiuser functionality?

Local Git repositories can be deleted on the Status tab in the MultiuserExplorer with the DeleteMultiuser files/Deactive Multiuser button in order to restart with the Multiuser functionality (see Status tab [p. 17]).

I get the message: "RepositoryExistsException". How can I resolve this situation?

On account of an invalid operation in the past, a Git repository has already been created for the current project.

Delete this invalid repository on the Status tab in the MultiuserExplorer using the DeleteMultiuser files/Deactive Multiuser button.

I get the message “ADS error 0x745: Timeout elapsed”. How can I resolve this situation?

Open the Status tab in the MultiuserExplorer. The message "RemoteNotExists" indicates that the remote repository has not been created or has been deleted.

Alternatively, look on the target system in the Windows Explorer as well under C:\ProgramData\Beckhoff\MultiuserRepository.

If you get this message several times, restart the TwinCAT3 AdsGitServer Windows service on the target system.

I get the message "ADS error 0x1: an internal error has occurred". How can I resolve this situation?

Please check whether the Multiuser functionality has been properly installed. Among other things, the files LibGit2Sharp.dll, TcAdsGitPackage.dll and TcAdsGitServer.exe as well as the folders cmd and mingw32 must be present in the C:\TwinCAT\Functions\Multiuser folder.
8 3rd Party Licenses

The TwinCAT Multiuser functionality uses Git as source control system, which is released under GNU General Public License version 2.0.

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