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Application Notes

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Data Storage on PC's and PLC's

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This document covers the storage of data on Beckhoff controllers for methods such as recipe handling, configuration files, and cycle to cycle data storage for recovery after a power loss.

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Overview

Key Terms

Configuration Data: Data that is necessary for the setup and configuration of the machine.

Recipe Data: Data that is associated with varying the operation of the machine to perform a different function or produce a different part.

Persistent Data: Data within the PLC program that is changed by the PLC Program through the operation of the machine and that will survive a shutdown of the controller and changes to the PLC Program.

Retain Data: This is similar to Persistent Data. The data is stored through a shutdown and a restart, but will not be saved if changes are made to the PLC Program.

Available Methods

There are several different methods for storing data within the TwinCAT environment. The method used depends on the type of data being saved, the frequency of changes to the data, the amount of data, and the hardware being used. Each method also has it's associated vulnerabilities.

The following sections describe the hardware dependant methods for storing data.

Constant Variables

Constant variables are defined in the PLC Program and have fixed values. These values are typically used/created in 1 POU.

Advantages

- It is extremely simple to use.
- Values are contained in the PRO file and easily edited and distributed.

Disadvantages

- Values are constant and can only be changed by changing the PLC code.

Best Suited For

- Critical values that will not change after the machine is built such as soft position limits of axis with fixed travel lengths.
- Parameters that do not change and are necessary for basic machine functions.

Var Retain and Var Persistent Data on PC's

Persistent or retain variable declaration in the PLC program is available on PC's with hard drives (not flash) that have a Uninterruptible Power Supply (UPS). All variables declared as persistent data and retain Data will be stored to the hard drive when the PC is shut down properly.

Advantages

- The amount of data stored is only limited by the hard drive space available for files
- Implementation is very simple.

Disadvantages

- The data is only stored when the PC is properly shut down.

- The data file stored is binary and readable only by the PLC program.
- The data is stored on the hard drive.
- Error handling must be planned ahead of time.

Best Suited For

- Values that are not critical to machine startup
- Values that will be changed as the machine runs such as number of hours of operation. Number of parts produced

NOV Ram

Some Components have Non-Volatile RAM (NOV Ram). NOV Ram technology is typically limited in size. The Beckhoff hardware components that contain NOV Ram are the following:

BCxxxx Bus Controllers. Depending on which particular BC is used the NOV Ram ranges from 2KB (2,000 bytes) to 512Bytes. See the particular BC's documentation for more information.

BXxxxx Controllers have 2KB of NOV Ram.

CX1100-000x power supply modules have 8KB of NOV Ram.

CP67xx CP77xx Ethernet Control Panels have 32KB of NOV Ram.

Ethernet Control Panels have 32KB of NOV Ram.

PCI cards have 32KB of NOV Ram

CX9000 has 128KB of NOV Ram**.**

Advantages

- It is fairly quick and easy to use
- Data is updated every PLC cycle.

Disadvantages

- It has limited data size.
- If an error occurs there is no recovery process.
- Data is not transferable.

Best Suited For

- Values necessary to resume operation without completely restarting the process (e.g., resuming operation with partially completed parts in the machine)
- Data storage on BC Bus Controller devices

File Access

Beckhoff Devices with an operating system (CX devices and PC's) have the ability to read and write files.

Advantages

- Complete control of the data written and read
- Data stored can be stored in a readable format. For example, if the file is stored as a text file with commas separating the variables (csv), the file is readable by any program that can read a CSV file (such as Microsoft Excel).
- Data can be stored locally or to a network drive.
- Files are readily available to be copied from machine to machine.

Disadvantages

- The PLC Program must be written to create the file and to read the file.
- The file is only read or written when commanded by the PLC program.
- Special care must be used when writing to a flash device. Each time a flash device is written to it is degraded. Eventually writing enough data to the flash card will destroy it. A good estimate is that after 600,000 writes to a flash, the device will soon fail.

Best Suited For

- Anything that is best edited in "plain language" such as error codes. One file can be English another French, etc.
- Recipe data that may need to come from a central server
- Initial machine startup parameters
- Parameters that are read at startup and then rarely changed.

HMI Access

On many systems there is a Human Machine Interface (HMI) or Graphical User Interface (GUI). Sometimes this is a software package from companies such as Indusoft, Iconics, Invensys, Wonderware, etc. Other times this is a custom written application. These programs may already have tools for recipe management and machine configuration. These tools often add the ability to interface to a Database such as Dbase 3, Microsoft Access, Oracle, or many of the hundreds of other database systems.

Advantages

- Very powerful data storage tools (trending)
- May allow database connectivity
- Can contain tools for recipe editing and management
- Might already be part of the machine

Disadvantages

- Might be another piece of software that must be programmed, maintained and possibly purchased purchased

Planning

Care must be taken when planning a system. Determining what type of data storage methods should be used for what kind of data can save a significant amount of time later. For example, if persistent data is used for everything including machine configuration and recipes, and the data file is corrupted because the UPS or hard drive fails, then there is no recovery plan. All the data is lost. Even if the file is recovered from a failed hard drive it is not a readable format. Conversely if NOV Ram is used to save all the data, including recipe data, there are two problems: Data cannot be edited outside the PLC program and is typically small (for technical reasons).

Configuration Data

Each machine typically has a significant amount of configuration data. These are usually the parameters which define how the machine can move: Soft position limits, acceleration rates, default settings for PID loop gains etc. There should be a simple way to implement backup of this data so that after a failure a machine or system can easily be restarted. For a machine builder that builds many machines that are similar but with some values that vary, it is a good idea to create a configuration data file that is associated with each individual machine. Then on startup the PLC program reads this plain language file and configures itself. This way any machine can load any configuration file. For a machine builder who either builds very few machines (or many identical machines), storing this configuration data as constants within the PLC program may be enough.

Recipe Data

Machines that have user adjustable processes often have associated recipes. For example, to make chocolate chip cookies, X lbs of chocolate chips are necessary for N number of cookies. For super chocolate chip cookies Y lbs of chocolate chips are necessary for N number of cookies. This data can be edited, though not often (perhaps once per day). These edits are best made in plain language. Recipes are often transferred from machine to machine. File access (or having an another program handle file or database access) is by far the best method for recipe handling.

Resume Operation Data

This is the data necessary for the machine to continue where it left off (particularly after an unexpected shut down). This data should contain things like the current state of the machine, how many parts are in the machine, and at what locations or which stage of the process the machine is currently in. This data is best stored in NOV Ram. There is a relatively small amount of data necessary for this. The data does not need to be in plain language, however, this data does need to be updated very often. The distinction should be made between Resume Operation Data and Machine Configuration Data. The worst case scenario for the loss of Resume Operation Data is that the machine must be emptied out and started fresh. The loss of Resume Operation Data should not cause the machine to become unusable.

Occasional Data Storage

In some cases it makes sense to occasionally store a form of Resume Operation Data or make a second copy of the Resume Operation Data, for example, in long or expensive processes where starting from scratch is not a valid option. In these cases there are a few things that should be done. First, have an uninterruptible power supply connected to the controller. Then, occasionally save data to a file. Persistent data is often handled It is possible to trigger an update of the Persistent data from the PLC code. The PLC code could trigger a Persistent data write to happen either when the machine changes state or at timed intervals.

General Considerations

1. Determine what data changes and what data needs to be saved.
2. Then, isolate what data will be changed by the user (this data should be recipe data) and what data is changed through the operation of the machine (resume operation data)
3. Determine what methods are available for the specific hardware platform and what methods make sense for the particular machine.
4. Beckhoff Application engineers can provide insight into which methods should be used and how to implement them in an applicaiton.