

Application Note



2500 Series® Programmable Automation Control System

Online Change with Janus Processors

Overview

The CTI Online Change facility allows you to change your application program "on the fly" while it is running in the target system. The facility allows a full download of a modified version of a project while the old version is still running. When download and project validation is complete, the old project is replaced with the downloaded project.

While the old project is being replaced, the old project is stopped and fieldbus connections are closed, except for I/O subsystems (Local I/O, Remote I/O, Profibus I/O Ethernet/IP Scanner and Adapter), which remain operational, maintaining the last state of all outputs. See Fieldbus Protocol Operation section below for restrictions.

Once the new project has been downloaded and validated, the current value of all variables existing in both the old and new projects are copied from the old project database to new project database. See Rules for Copying Variable Values section below. If the new project contains SFC program(s), SFC state information is copied to the new project database if the SFC charts match (indicating no changes) between old and new projects. See Rules for SFC Charts section below. All fieldbus drivers are restarted and logic processing for the new project begins.



The time to complete the CTI Online Change is dependent on project configuration – including code size, variables, function block instances, and fieldbus protocols. The main advantage is that it will execute with basically unlimited project changes while maintaining all database values at their last state throughout the process (bumpless transfer).

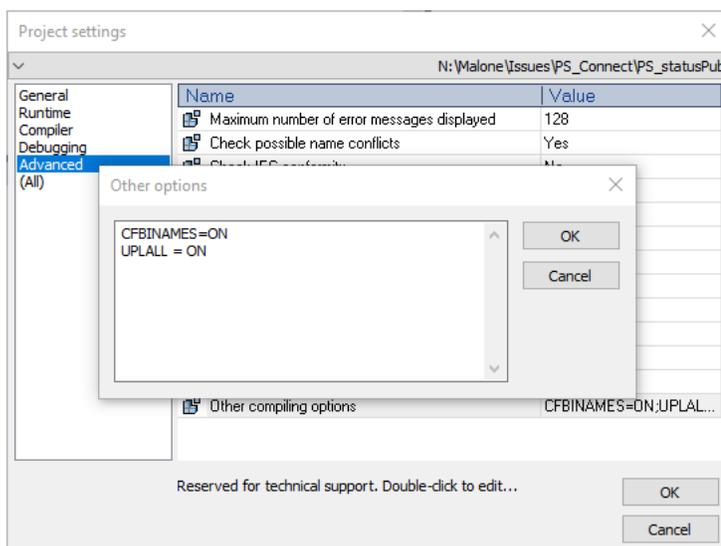
Features

The CTI Online Change operation included in all Janus controllers provides the following industry-leading features:

- Performance - application is paused for less than 500 msec in almost all cases
- Maintains state of all unaltered variables and function block instances
- Maintains normal operation of all I/O networks (including Local I/O, Remote I/O, Profibus, and Ethernet/IP Scanner/Adapter) throughout the process, except when restart is required due to I/O configuration changes as noted below
- Detailed reporting of how each application variable will be affected (Added, Deleted, or Copied)
- Reports all changes to User Defined Type (UDT) structures and function blocks
- Reports application version numbers of current and modified applications
- Detailed reporting of interruptions in execution of SFC programs that will result from the changes made to the SFC programs and/or SFC child programs
- Reports interruption in Profibus network operation that will result from changes made to the Profibus Master configuration
- Reports interruption in Ethernet/IP I/O Scanner and/or Ethernet/IP Adapter operation that will result from changes to either configuration
- Provides user option to cancel Online Change (after results of modifications are reported without affecting the application running on the controller)
- Comprehensive error detection - all processes are validated before execution and any error conditions result in termination of Online Change operation without affecting the application executing on the controller
- Ability to quickly restore development/monitoring environment to match application executing on the controller following user cancellation or error
- History of all Online Change operations recorded in 'Runtime' history Log and Event Log

Required Project Settings

The following compile options must be set in 'Project Settings':



- CFBINAMES=ON
- Includes information for all Function Block Instances.
- UPLALL=ON
- Includes all files in project folder in “source to download target”

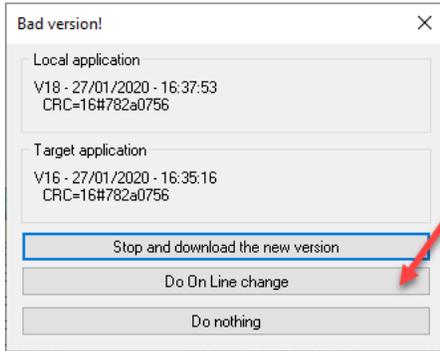


Online Change Procedure

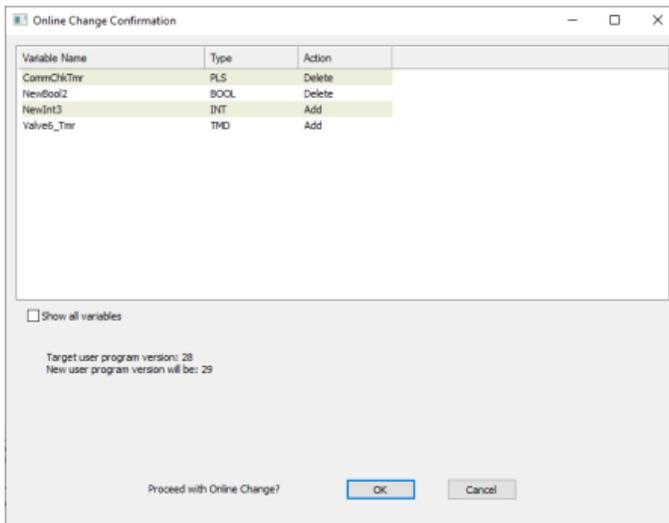
An Online Change can be initiated after successfully compiling and creating a new project version while offline (not connected) to the target. You can trigger an Online Change by connecting to the target via 'On Line' button in main toolbar (shown below):



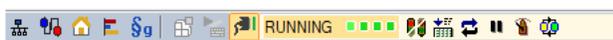
Then, select the "Do On Line Change" option in the pop-up window shown below.



After initiating the download procedure, a confirmation window will be displayed that provides information regarding the effect of the online change operation. Based on this information, you can decide whether to proceed with online change or cancel the operation.



Selecting OK will download the new project executable and related files to the controller. The controller will then execute the **Online Change** operation. The results of *Online Change* are recorded in the 'Runtime' history log, which can be viewed in the Output pane by selecting the Runtime tab in the status bar at the bottom of the Workbench window. Successful operation is indicated by the 'RUNNING' status on the main toolbar as shown below.



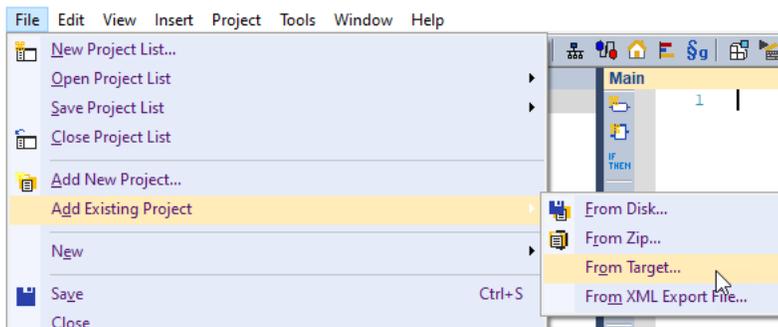
Recovery from Version Mismatch

User cancellation of Online Change or errors that may occur during the online change process will terminate the process while the old application continues in RUN state. When this occurs, the online status will be reported as 'Version Mismatch' since the application in Workbench does not match the one running in the controller (see below). This section describes how to recover from this condition.

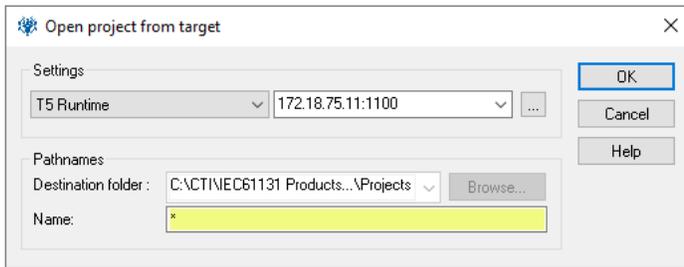


Errors detected by Workbench are reported in a pop-up dialog window. Errors detected by the controller firmware are reported in the 'Runtime' history log (viewed by selecting the 'Runtime' tab in the Status bar on bottom of Workbench). If any of these errors are detected, you must cancel Online Change by clicking on [Cancel] in the Online Change Confirmation dialog or acknowledging errors reported in pop-up windows. Janus Workbench can be restored to match the executing application through the following steps:

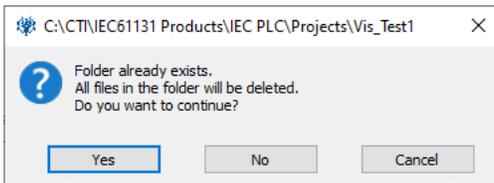
- Halt communications between CTI Workbench and the target by clicking on the 'Online' button in the main toolbar. This will transition Workbench to 'Offline' (or 'development') mode.
- Save the modified project by one of the methods below. NOTE: Saving the modified project allows you to subsequently import it into the Workspace pane. Once imported, you can compare differences in the project versions and copy/paste changes between them. If you want to discard all changes, you can skip this step.
 - Right-click on the project name in Workspace pane and choose 'Save Project / To Zip' options from the pop-up menu. A dialog box for entering the name of the zip file will be displayed. The default name contains the project name and version number.
 - Right click on the project name and choose the 'Duplicate Project' option from the pop-up menu. A dialog box for entering a new project name will be displayed. Choosing this option will create a new project in the same workspace.
- Remove the modified project from the Workspace pane by right-clicking on the project name and selecting the 'Remove Project' option in the pop-up menu. NOTE: This action does not delete the project folder or any internal files. It only removes the project from the Workspace pane.
- Upload the source files for the original project. Note: this action will overwrite the existing (modified) files in the project folder with the original project files. This is the reason the modified project was saved.
 - Select 'File / Add Existing Project/ From Target' from the main toolbar.



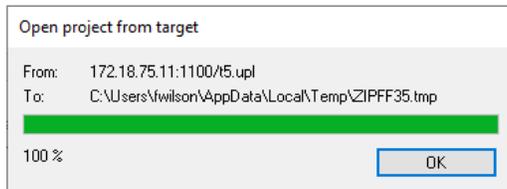
A dialog box that allows you to enter a project name is displayed as shown below. The project name you enter must exactly match the original project name.



A dialog box that allows you to enter a project name will be displayed as shown below. The project name you enter must exactly match the original project name. If the match is exact, selecting OK will open the following dialog box. Confirm overwrite by clicking on the Yes button.



A progress dialog box will be displayed. After the Open process is complete, click on the OK button to close it.



The original project (uploaded from the Janus controller) is now loaded onto the Workspace pane and selected as the startup (active) project. Go online to the target by clicking on the button in the main toolbar. The toolbar should indicate normal operation ("RUNNING").



Rules for Copying Variable Values

The following sections describe the conditions for copying variable values between the old project and the new project.

Rules for Basic Data Type Variables

A variable is uniquely identified by 'name' and 'data type'. A variable with a basic data type (BOOL, BYTE, SINT, USINT, WORD, INT, UINT, DWORD, DINT, UDINT, LINT, ULINT, REAL, LREAL, TIME, or STRING) is considered a basic variable.

A variable value is copied only if the 'name' exists in both projects and corresponding 'data type' is unchanged. A variable 'name' includes the variable scope, and therefore the scope must be the same in both projects. *This means a Global variable with name 'VarName1' is not the same as private UDFB variable named 'VarName1 or a local variable named 'VarName1'.*

NOTE: Changing a variable from Global to RETAIN or RETAIN to Global does not change the scope.



STRING variables have two properties: maximum size and current size. Following are the rules for STRING variables.

- If the maximum size of a STRING variable is reduced in the new project:
 - If new 'maximum size' is less than 'current size' of the STRING in the old project, only number of characters that fit in the new maximum size are copied (starting with the first character of the STRING). The 'current size' of the STRING in the new project is reduced to new maximum.
 - If new 'maximum size' is greater than or equal to the 'current size' of the STRING in the old project, all characters in the STRING are copied and 'current size' of the STRING in the new project is unchanged..
- If the maximum size of a STRING variable is increased in the new project, all characters in the STRING are copied and 'current size' of the STRING in the new project is unchanged.

A single-element basic variable that is changed to an array by setting the dimension size greater than '1' is not copied across projects. This rule also applies when a basic data type array is changed to a single variable by setting the dimension size to '1'. None of the array elements are copied across projects.

ATTENTION: Single variables converted to arrays are not copied because the values are stored in different memory areas when 'Complex variables in a separate segment' option is selected in Project Settings. This option is automatically selected when the CTI Product Type is set to any Janus series product

Rules for Complex Variables

Complex variables include the following items:

- Variable arrays of basic data types,
- Standard Function Block instances,
- Variables of User Structure types,
- Instances of User Defined Function Blocks (UDFB).

A complex variable is uniquely identified by 'name' and 'data type'. A complex variable value is copied only if the variable 'name' exists in both projects and corresponding 'data type' is unchanged. This means that the variable (or instance) data for a user-defined type (structure or UDFB) is copied only if the 'name' exists in both projects and user-defined type (UDT) is unchanged. A UDT is considered 'changed' if any of the following is detected:

- UDT 'data type name' is changed
- UDT Member is added or deleted
- A data property (data type, string length, or dimension) associated with a UDT Member is changed. A change to the member "name" does not prevent variable data from being copied across projects as long as all data properties are unchanged.
- Array dimension of any UDT Member is changed
- UDT Member array changed from 'Local Variable' to 'Input Parameter' or from 'Input Parameter' to 'Local Variable'.

Rules for Sequential Function Charts (SFC)

The following rules apply to Special Function Charts.



- The SFC POU 'Name' must exist in both old and new projects.
- The code within a step action block can be modified as desired.
- If the structure of the SFC chart (set of Steps and Transitions) for a Main SFC program is identical for both projects, the SFC program in the new project will resume operation at the point it left off in the old project.
- If the structure of the SFC chart is changed, then the SFC state for that SFC POU is reset to its initial state when the new project

Note

After the Online Change procedure is triggered, a Confirmation window will be presented that includes information regarding how each SFC program will be affected by the Online Change operation. This allows you to decide whether or not to proceed.

is started. All 'Child SFC' POUs of this parent will also be reset to their initialization step.

Rules for WAIT and WAIT_TIME Statements

Main Programs and Sub-Programs written in ST language may contain statements 'WAIT' and/or 'WAIT_TIME', which suspend execution of that POU until the specified event becomes TRUE. These statements are extensions to the IEC standard and are not IEC 61131-3 compliant. The operational data associated with these instructions is program-specific and applicable only to a particular instance (version) of the program.

The CTI Online Change procedure will execute normally even if a "WAIT" or "WAIT_TIME" instruction is active. However, in this

Note

The Straton GETSYSINFO function (with _SYSINFO_CHANGE_CYCLE parameter) can be used to provide indication of the PLC cycle immediately following an Online Change. This can be used to trigger any special processing required after an OLC operation. This function can be called from a POU written in LD, ST, FBD, or IL language. See example below.

```
IF GETSYSINFO (_SYSINFO_CHANGE_CYCLE) <> 0 THEN
//OLC detected - special code goes here
END_IF
```

case, the expression associated with each instruction is set to FALSE when the new project is started. Therefore, all POUs will run from the first instruction.

Fieldbus Protocol Operation

All I/O Subsystems (Local I/O, Remote I/O, and Profibus) remain operational during the online change procedure. This provides network communications to keep all I/O devices operational and maintains the last state of all outputs.

The design of Local I/O and Remote I/O subsystems allow configuration changes, such as adding a module to Local I/O or adding a Remote Base to Remote I/O, to be made without "bumping" the existing I/O. This is not possible with Profibus due to the constraint that the network configuration can be modified only while network operation is stopped. Therefore, Profibus outputs remain "bumpless" through the Online Change process only when the Profibus configuration is unchanged.

Local I/O

Any changes to the Local I/O configuration take effect when the new project is started. Changes are allowed to the Local I/O fieldbus configuration without causing a state change (i.e. 'bump') to any existing I/O point. Communication to all existing modules



and bases will remain active and maintain 'last state' through the entire online change operation.

All Input and Output points configured in the old project maintain their 'last state' values throughout the Online Change process. Newly created variables mapped to Local I/O points are set to their initialization values.

All mapped variables retain these values until changed by user logic or forced by operator (outputs) or updated by the I/O driver with data read from specified module (inputs).

Remote I/O

Any changes to the Remote I/O configuration take effect when the new project is started. Changes are allowed to the Remote I/O fieldbus configuration without causing a state change (i.e. 'bump') to any existing I/O point. Communication to all existing modules and bases will remain active and maintain 'last state' through the entire online change operation.

All Input and Output points configured in the old project maintain their 'last state' values throughout the Online Change process. Newly created variables mapped to Remote I/O points are set to their initialization values.

All mapped variables retain these values until changed by user logic or forced by operator (outputs) or updated by the I/O driver with data read from specified module (inputs).

Major changes, such as adding a new remote base or adding/changing modules within a remote base, require more time, since the

Attention

If the Profibus configuration is changed, the Profibus Master must stop all communications with slave devices while the revised Profibus network configuration is loaded. This will result in "bumping" the I/O unless fail-safe procedures for all slaves is implemented.

remote base controller be reconfigured. Consequently, several I/O cycles will elapse before data can be written or read from that

Note

It is possible to set the CTI and/or Siemens Profibus RBC "Freeze" jumper and use the "Fail-safe" option to allow Profibus network reconfiguration without bumping outputs on existing slaves. Other Profibus slave devices may allow I/O points to be configured to hold last state when I/O communication is lost.

device. All variables retain their values during the reconfiguration process.

Profibus DP I/O

If the Profibus DP network configuration is not changed, the Profibus Master continues normal network communications with all slave devices through the Online Change process, and all variables mapped to I/O points maintain their 'last state'.

If the Profibus DP network configuration is changed (add or delete Slave device or change module configuration of a device), the Profibus Master must be reconfigured. This operation forces all network communications to be stopped (which results in all slave devices setting their outputs to 'default' state).

Ethernet IP Scanner/Adapter

Because the Ethernet/IP stack uses common code for the initialization of the EIP I/O Scanner and EIP Adapter, these fieldbus types are combined in regard to their operation during the Online Change process.

For all cases, the variables associated with the EIP I/O Scanner fieldbus and/or EIP adapter are unchanged throughout the Online Change process.

If either the EIP I/O Scanner or EIP I/O adapter configuration is changed, the drivers for both of these fieldbuses (if both exist) are stopped and restarted when the new project is started.

If neither configuration is changed, the fieldbus drivers remain open through the Online Change process and the existing connection(s) are used by the new project. All existing TCP connections are maintained, and the I/O messages are temporarily suspended while the database is copied between projects. The I/O messages are restarted as soon as the new project is running. Under most circumstances, the Online Change operation should not cause I/O connection timeouts between EIP I/O Scanner and Adapter when the RPI is set to 100ms and above.

Ethernet/IP I/O Scanner will terminate and cause all specified "active" EIP Adapters to timeout and close the I/O connection when a change is made to either the EIP I/O Scanner or EIP Adapter configuration (Levels 1-3) in the Janus controller. Otherwise, existing EIP I/O connections will remain open through the entire online change operation.

Ethernet/IP Adapter will terminate and cause all attached EIP I/O Scanners to timeout and close the I/O connection when a change is made to either the EIP I/O Scanner or EIP Adapter configuration (Levels 1-3). Otherwise, existing EIP I/O connections will remain open through the entire online change operation.

Other Fieldbus Protocols

This applies to all other fieldbus client and server applications. During the online change operation, all connections are closed, the fieldbus drivers stopped, rebuilt, and restarted with the new project. All variables mapped to data blocks associated with these client protocols maintain 'last state' throughout this process.

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