Automation Simulation:
Your Gateway into Smart Manufacturing
2017 Educational Webinar Series

usa.siemens.com/digital-factory
Our customers have essential requirements – throughout the manufacturing industry

- **Speed**
- **Flexibility**
- **Quality**
- **Efficiency**

**Security**
To stay competitive, manufacturers have to improve their processes

Reduce time-to-market
- Shorter innovation cycles
- More complex products
- Larger data volumes

Increase flexibility
- Individualized mass production
- Volatile markets
- High productivity

Improve quality
- Quality processes with feedback
- Traceability and integrated genealogy

Increase efficiency
- Energy and resource efficiency as decisive competitive factors
- Integrated / Generated Diagnostics

Integration of product design & production design & process
Flexible production, Reconfigurable, Modular
Full process transparency
Optimized production
Automation Engineering needs to meet the requirements To deliver a maximum value for the PLM process

Increase your Productivity
- Open and secure communication
- Integrated Diagnostic management for less downtime, extended now with Process Diagnostics toolsets

Reduce your Time-to-market
- One for all! One tool for all Automation & Simulation
- Generating code instead of programming
- Coordinated work in team

Integrated engineering

Work open, virtual and connected
- Open system: Reduce your redundant work
- Simulation: Flexible simulation for each requirement

Digital workflow
More than an Engineering Framework
Digital Workflow, Integrated Engineering, and Transparent Operation

Open, virtual and networked operation
Digital workflow with TIA Portal

Reduce your time-to-market
Integrated engineering with TIA Portal

Increase your productivity!
Transparent operation with TIA Portal

Your gateway to automation in the digital enterprise
Simulation Basics

Key Benefits

- Validate PLC Programming code
- Validate HMI to PLC interfaces
- Validate HMI & PLC to Motion control
- Validate diagnostics
- Virtual commissioning
- Pre Factory Acceptance Test (FAT)
- Support education and training
Your Automation Engineering must include
The Simulation functionality

Simulation of the controller
... with PLCSIM

Simulation of the HMI operator device
... with HMI simulation

Simulation of the Motion Control
... with simulated technology objects

IO Check out & Network Simulation and Analysis
... with simulated PRONETA and SIEMENS Network Planner...

... reduces risk and optimizes commissioning
Live demo - TIA Portal Engineering Software
Use Case Step by Step – Extending line to multiple conveyor components...

Define a UDT

Design a Faceplate

Define an Interface of Faceplate to UDT
Apply the UDT to the Function Block and program logic to interface ...

<table>
<thead>
<tr>
<th>Name</th>
<th>Data type</th>
<th>Default value</th>
<th>Retain</th>
<th>Accessible</th>
<th>Write</th>
<th>Visible in</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Input</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ax</td>
<td>TO_SpeedAxis</td>
<td>false</td>
<td>Non-retain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>drive_enable_PB</td>
<td>Bool</td>
<td>false</td>
<td>Non-retain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>drive_reset_PB</td>
<td>Bool</td>
<td>false</td>
<td>Non-retain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Output</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>InOut</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Static</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PLCHMI_Interface</td>
<td>&quot;AxisInterfaceUDT&quot;</td>
<td>Non-retain</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Start_HMIIB</td>
<td>Bool</td>
<td>false</td>
<td>Non-retain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stop_HMIIB</td>
<td>Bool</td>
<td>false</td>
<td>Non-retain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SpeedSelection_HH</td>
<td>DInt</td>
<td>0</td>
<td>Non-retain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ActualSpeed_PLL</td>
<td>LReal</td>
<td>0.0</td>
<td>Non-retain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DriveEnabled_PLL</td>
<td>Bool</td>
<td>false</td>
<td>Non-retain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DriveOKAY_PLL</td>
<td>Bool</td>
<td>false</td>
<td>Non-retain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MCPower</td>
<td>MC_POWER</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MOVELOCITY</td>
<td>MC_MOVEVELOCITY</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MCHALT</td>
<td>MC_HALT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Optional – Configure a Drive Device as SIMATIC Motion Control Axis
Configure an Axis within PLC

Create an Axis of Motion within Technology Objects

Activate Simulation of Axis
Bring it all together within one engineering toolset

Conveyor PLC Logic plus

HMI Faceplate via the UDT

Plus Axis of Motion linked to an actual drive

Integrated with system diagnostics and scalable
Simulate the PLC via PLCSim

Select the PLC
Select the Simulate
Download to the PLCSIM application.
Select Monitor & Go Online
Monitor and Modify to Data Values

Within TIA Portal itself
Monitor and Modify Values

Using the same toolsets as being online with real hardware or equipment.

Requires no special re-configurations or setup.
The PLC Trace Function is also available within the PLCSIM

Configuration and use of the Trace Feature is also possible within the PLCSIM functionality.
HMI Simulate will automatically connect to your PLCSIM

To Setup HMISIM to connect you must configure the PG/PC Interface in your control panel for the S7 Online option to the interface hardware, or PLCSIM
Using PLCSIM to actuate data values

Set out of the TIA Portal Engineering Software, and use the PLCSIM tools to Simulate IO, and process Simulation Sequences.
In Addition… Ensuring Uptime with Integrated systems diagnostics

- Diagnosis can be run in PLC-STOP as well
- Simple configuring without programming

System diagnostics

General

- Activate system diagnostics for this device

Alarm settings

<table>
<thead>
<tr>
<th>Category</th>
<th>Alarm</th>
<th>Alarm class</th>
<th>Acknowledgement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fault</td>
<td></td>
<td>No Acknowledgement</td>
<td></td>
</tr>
<tr>
<td>Maintenance</td>
<td></td>
<td>No Acknowledgement</td>
<td></td>
</tr>
<tr>
<td>Maintenance required</td>
<td></td>
<td>No Acknowledgement</td>
<td></td>
</tr>
<tr>
<td>Info</td>
<td></td>
<td>No Acknowledgement</td>
<td></td>
</tr>
</tbody>
</table>

TIA Portal

HMI

Display

Webserver

Consistent diagnosis
SIMATIC CPU Innovations
Trace - Repeated measurements stored on memory card

Measurements stored on SMC

• Repeated measurement
• Record N measurements according trigger conditions
• Activate the trace after completing a measurement
• Option: overwrite the oldest measurement
• Up to 1000 measurements on card

Customer benefit

• Persistent storage of measurements
• Significantly more Trace Data for established Analysis

TIA Portal

Webserver

RAM*

CPU

*excl. f. Traces
Protecting the investments of automation – this isn't something new

SIMATIC Manager
Step 7 / WINCC
+Simulation

TIA Portal
Step 7
WIN CC
Start Drive
Safety Integrated
Security Integrated
+ Simulation
and so much more

Wiring  PLC  TIA  TIA Portal

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>SIMATIC G</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SIMATIC S3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SIMATIC S5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

SIMATIC S7-300/400
SIMATIC S7-1x00
But now there is MORE, you can extend your options of simulation in V14

- Simulation of the controller... with PLCSIM
- Simulation of the HMI operator device... with HMI simulation
- Simulation of the Motion Control... with simulated technology objects
- IO Check out & Network Simulation and Analysis... with simulated Proneta and SINETPlan
- Simulation of the controller including the communications interfaces (e.g. Web server, OPC-UA, PLC-PLC communication) and connection to virtual or your own developed co-simulations… with PLCSIM Advanced

... reduces risk and optimizes commissioning

NEW TIA Portal V14
Digital workflow with TIA Portal
PLCSIM Advanced – typical use cases of the virtual S7-1500 Controller

Simulation system with PLCSIM Advanced

Typical use cases

- Support the whole TIA Portal Engineering phase with simulation
- Virtual commissioning
- Pre Factory Acceptance Test (FAT)
- Support education and training for S7-1500 Automation
Digital workflow with TIA Portal
Simulation - flexible for all requirements

Use Case
- Validation of PLC program

Use Case
- Engineering support
- Pre-FAT
- Virtual commissioning
- Training

Real World
- Simulation of logic of the PLC-program
  - Real controller
  - Button/simulator LEDs

Real World
- Simulation of the whole PLC in the context of application
  - Real controller
  - Prototype/Hardware-in-the-loop

Virtual World
- PLC Program simulation
  - PLCSIM

Virtual World
- IO simulation
  - PLCSIM control panel

Virtual World
- Virtual Controller
  - PLCSIM Advanced

Virtual World
- Virtual system
  - Co-simulation/software-in-the-loop

NEW
Digital workflow with TIA Portal
PLCSIM vs. PLCSIM Advanced

### PLCSIM in TIA Portal STEP 7

PLC simulation embedded in STEP 7

**Use Case:**
Validation of PLC program

### PLCSIM Advanced Virtual S7-1500 Controller

**Use Cases:**
- Engineering & Development Support
- FAT (Final Acceptance Testing)
- Virtual Commissioning
- Service
- Maintenance
- Migration
- Training

<table>
<thead>
<tr>
<th>Feature</th>
<th>PLCSIM in TIA Portal STEP 7</th>
<th>PLCSIM Advanced Virtual S7-1500 Controller</th>
</tr>
</thead>
<tbody>
<tr>
<td>S7-1200 (F)/S7-1500 (F/T)</td>
<td>✓ / ✓</td>
<td>✗ / ✓</td>
</tr>
<tr>
<td>Runtime</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standalone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Look &amp; Feel of TIA Portal for I/O Access</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>GUI</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Management</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Webserver</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>OPC UA</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>S7-Communication</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>Support of KHP-Blocks</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>API for Co-Simulation</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>Multiple Instances</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>Distributed PLCSIM</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>Virtual Time</td>
<td>✗</td>
<td>✓</td>
</tr>
</tbody>
</table>
## Simulating the…

<table>
<thead>
<tr>
<th>Machine concept</th>
<th>Production / assembly cell</th>
<th>Plant including material flows</th>
<th>Automation</th>
</tr>
</thead>
<tbody>
<tr>
<td>With NX Mechatronics Concept Designer</td>
<td>With Process Simulate</td>
<td>With Plant Simulation</td>
<td>With PLCSIM Advanced</td>
</tr>
</tbody>
</table>

The innovative solution: Virtual commissioning
Use case Virtual Commissioning - Concept

**Engineering**
- Automation with TIA Portal
- PLC Program
- Hardware configuration (incl. signal list)
- Mechanic
  - NX CAD
- CAD Model

**Result**
- PLC SIM Advanced
  - Simulation of the whole PLC
- Preparation for virtual commissioning
  - PLC SIM Advanced
    - Simulation of the whole PLC
  - Process Simulate
    - Definition of kinematics
    - Scheduling (Sequences)
    - Movement contexts and profiles
    - Simulation of kinematics for verification
    - Definition of sensor technology and actuating elements

**Virtual Commissioning**

1. **Preparation:**
   - Creation of a model and coupling of data

2. **Implementation:**
   - Function test
   - Process of the system
   - Interaction between the various resources
   - Normal operation
   - Crashes and Faults
   - Performance
   - Optimization
Your benefits:
Quality and faster time to market, driving costs and risks down

<table>
<thead>
<tr>
<th>Quality</th>
<th>Speed</th>
<th>Cost</th>
<th>Risk</th>
<th>Flexibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optimizing the machine functionality</td>
<td>Less time for commissioning at customer plant</td>
<td>The sooner you optimize, the more you can save</td>
<td>Less real faults in real plant</td>
<td>„Laboratory“ for creating alternative control concepts</td>
</tr>
</tbody>
</table>
One for all
… to solve even more automation tasks

+ One common database

+ Consistent and unified operator concept

+ Common, central services

Totally Integrated Automation Portal

- Common data management
  - WinCC
  - STEP 7
  - SCOUT
  - Startdrive
- HMI
- IPC
- Controller
- Distributed I/O
- Motion Control
- Drives

- Security integrated
- Safety integrated
- Diagnostics
- Energy Management

PROFINET

Integrated engineering with TIA Portal
TIA Portal
All automation components - Integrated within the TIA Portal

Save projects > saving inconvenience software is also possible
Project tree > conveniently organized project structure with all objects
Diverse wizards > adding CPUs, HMI panels, drives, and technology objects quickly and in structured fashion
Devices and networks > graphic network overview of all hardware components based on PROFINET, PROFIBUS, and AS-i
Centralized data management > validation of all engineering data
Safety Administration > for central visualization, configuration and change of safety parameters
Structured program setup > conveniently organized program structure
Search for symbols > immediately available in all editors once defined
PLC Data Types > programs with symbolic names within the whole project as object
Drives integration > consistently configurable
Drag & Drop > easy data handling from one editor to another
Simulation > integrated as a standard feature
Online/offline comparison > quickly visualize differences
IntelliSense > easy object selection
Intuitive tab pages > follows the selected editor
Global Library concept > reusing of project parts
Property window > displays all relevant parameters of the selected object
Information window > displays detailed information of the selected object in the tab accordingly
Cross-references > project-wide overview using tags and objects
Window switcher > to switch between opened editors

Thank you

John DeTellem
TIA Portal
US DF FA MK PLC

5300 Triangle Parkway
Norcross 30092

Contact: +1 (765) 318-5122
E-Mail: john.detellem@siemens.com

usa.siemens.com/tia-portal