SIMATIC S7-1500R/H
Technical Slides
- Motivation and Product Strategy
- System Overview
- Synchronization Principle
- System Redundancy and Network Configuration
- Failure Scenarios
- Communication
- S7-1500R/H and Safety
- HMI Connection
- Restrictions 1st Release Step
- Ordering Information
Redundant systems
Motivation

Preventing plant downtime
High availability during operation,
Avoidance of loss of production

Prevention of damages
Avoidance of unplanned production
stops where the product to be processed would be permanently
damaged

Save on maintenance
Application solutions are mostly
complicated and difficult to maintain

Prevention of data losses
The data remain intact and long restart
times after a failure are eliminated.

Operation without persons locally
Maintenance trips can be better
planned

Redundant systems reduce costs
SIMATIC High Available Systems
Product Strategy S7-1500R/H

Based on Standard S7-1500 CPUs and PROFINET

- Basis Hardware Standard-CPUs/Fail-safe CPUs

Transparent Programming

- Standard Engineering Tool TIA Portal V15.1
- Redundancy functions fully integrated in TIA Portal
- General handling like standard
- No deep Redundancy Know-How needed

Extensive Scalability

- Scalability of switch-over time
- Scalability of the Redundancy Architecture
- Scalability of the CPU Performance (1513 → 1517)

Step by Step Product Launch Strategy

- First release with basic redundancy functions
- First release will not include all standard and redundancy functions
- Step by Step increasing of feature set in future versions

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SIMATIC S7-1500 Redundant systems
System overview (1st Release step)

Consistent concept – Identical synchronization process

Scaling of the switching performance over the available bandwidth of the sync connection

<table>
<thead>
<tr>
<th>CPU type</th>
<th>Synchronization</th>
<th>Switchover time</th>
<th>I/O systems</th>
<th>Type of connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPU 1513R/CPU 1515R</td>
<td>via PROFINET Ring (MRP)</td>
<td>200 – 500ms</td>
<td>ET 200SP and ET 200MP</td>
<td>Single connection (PN redundancy S2)</td>
</tr>
<tr>
<td>CPU 1517H</td>
<td>via Sync-Module</td>
<td>&lt;100ms</td>
<td>ET 200SP and ET 200MP</td>
<td>Single connection (PN redundancy S2)</td>
</tr>
</tbody>
</table>

Redundant – S7-1500R

High available – S7-1500H

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**SIMATIC S7-1500R/H**

PLC Hardware in 1\textsuperscript{st} Release step

<table>
<thead>
<tr>
<th></th>
<th>S7-1513R-1PN 6ES7513-1RL00-0AB0</th>
<th>S7-1515R-2PN 6ES7515-2RM00-0AB0</th>
<th>S7-1517H-3PN 6ES7517-3HP00-0AB0</th>
<th>Short Distance &lt;= 10m</th>
<th>Long Distance &lt;= 10km</th>
</tr>
</thead>
<tbody>
<tr>
<td>Program / memory</td>
<td>350 kB code 1,5 MB data</td>
<td>500 kB code 3 MB data</td>
<td>2 MB code 8 MB data</td>
<td>Fiber Optic Cable</td>
<td>Plastic Glass fiber</td>
</tr>
<tr>
<td>Interfaces</td>
<td><img src="image1" alt="X1" /></td>
<td><img src="image2" alt="X2 X1" /></td>
<td><img src="image3" alt="X2 X1 X3 X4" /></td>
<td>Sync module SFP</td>
<td>6ES7960-1CB00-0AA5</td>
</tr>
<tr>
<td>Firmware</td>
<td>V2.6</td>
<td>V2.6</td>
<td>V2.6</td>
<td>6ES7960-1FB00-0AA5</td>
<td></td>
</tr>
</tbody>
</table>

X1: PROFINET IO Controller, Supports RT, MRP, Transport Protocol TCP/IP, Open User Communication  
X2: PROFINET Basic Services, Transport Protocol TCP/IP, Open User Communication
**SIMATIC S7-1500R/H**
Periphery in 1st Release step

<table>
<thead>
<tr>
<th>Periphery</th>
<th>IM 155-6PN HF ET 200SP</th>
<th>IM 155-5PN HF ET 200MP</th>
<th>PN/PN coupler</th>
<th>SINAMICS S120</th>
</tr>
</thead>
<tbody>
<tr>
<td>IM 155-6PN HF ET 200SP</td>
<td>6ES7-155-6AU00-0CN0</td>
<td>6ES7-155-5AA00-0AC0</td>
<td>6ES7-158-3AD10-0XA0</td>
<td></td>
</tr>
<tr>
<td>IM 155-5PN HF ET 200MP</td>
<td>6ES7-155-5AA00-0AC0</td>
<td></td>
<td>6ES7-158-3AD10-0XA0</td>
<td></td>
</tr>
<tr>
<td>PN/PN coupler</td>
<td></td>
<td></td>
<td>6ES7-158-3AD10-0XA0</td>
<td></td>
</tr>
<tr>
<td>SINAMICS S120</td>
<td></td>
<td></td>
<td>6ES7-158-3AD10-0XA0</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Firmware</strong></th>
<th>&gt;=V4.2</th>
<th>&gt;=V4.2</th>
<th>&gt;=V4.2</th>
<th>&gt;=V5.1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Address range (S2)</strong></td>
<td>1000Byte IN / OUT</td>
<td>512Byte IN / 512 Byte OUT</td>
<td>1000Byte IN / 1000Byte OUT</td>
<td>---</td>
</tr>
</tbody>
</table>

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SFP = Small Form-factor Pluggable
Motivation and Product Strategy
System Overview

**Synchronization Principle**

- System Redundancy and Network Configuration
- Failure Scenarios
- Communication
- S7-1500R/H and Safety
- HMI Connection
- Restrictions 1st Release Step
- Ordering Information
Synchronization Principle – Event Synchronization
Comparison S7-400H ↔ S7-1500H

Synchronization events:
- Cycle control point (R/W process images)
- Periphery direct access
- Interrupts/Alarms
- Timer modules
- Communication

S7-400H – Synchronous Principle

S7-1500H – Asynchronous Principle
S7-400H – Synchronous adjustment (interrupted)

Master

Working...

Sync

Sync

Sync

StandBy

Working...

END
S7-1500H – Asynchronous adjustment (continuous)

Primary
- 0
- 1
- 2
- 3
- 4

Working...

Jump over 3
Jump over 4

Primary fast
- 0
- 1
- 2
- 3

Queue
- Jump over 2
- Jump over 1

Backup
- 0
- 1
- 2
- 3

Working....

Backup fast
- 0
- 1
- 2
- 3

Queue

Primary
- 0
- 1
- 2
- 3
- 4

Working...

Jump over 2
Jump over 3

Backup
- 0
- 1
- 2
- 3

Waiting at 2
Waiting at 3

Sync event

(user) program

END
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PNO PROFINET System redundancy

PROFINET SR
• A System with redundant PN controllers and single or redundant PN devices.
• 3 Level:
  • PN Controller,
  • PROFINET Bus
  • PN-device.
• Redundancy at one level is independent of redundancy at each other level.
PNO PROFINET System redundancy

S1 Mode

- **S1 Device**
  - **S → Single interface**
  - **1 → one connection to one PLC**

S2 Mode

- **S2 Device**
  - **S → Single interface**
  - **2 → can switch between two connections**

R1 Mode

- **R1 Device**
  - **R → Redundant interface**
  - **1 → each interface has one connection to one PLC**

**Standard PLC**

For **R/H Release 1**

Future **1500H release**
Requirements for the PROFINET network configuration

• MRP Ring (default setting in the configuration)
• PN IO only at X1 interface
• PLC’s need to be part of the ring
• 1500R → no devices in the connection between the two PLC’s
• PN Devices need to support PN System redundancy NAP S2 (V1.11)

Redundant 1500R

High Available 1500H

Max. 16 devices in ring*)

Max. 50 devices in ring*)

*) Recommendation
SIMATIC S7-1500R/H - PROFINET Network configuration
1513R/1515R Length of the synchronization connection

- Direct link up to 100 m
- Fiber optic link (media converter) up to 3 km
SIMATIC S7-1500R (1st Release step)  
Basic System Configuration

Structure

1. MRP-Ring must be connected to the X1 - Port
2. Synchronization over PN-Ring – no device in this segment
3. All PN-IO Devices must support PN S2-Redundancy
Configuration example (1st Release step)
CPU1515R
SIMATIC S7-1500R/H - PROFINET Network configuration
1517H Length of the synchronization connection

The sync cables are redundant. The loss of one fiber optic cable has no impact on the runtime behavior.
SIMATIC S7-1500H (1st Release step)
Basic System Configuration

Structure

1. MRP-Ring must be connected to X1 - Port
2. Synchronization over Sync-Modules – Device connection possible
3. All PN-IO Devices must support PN S2-Redundancy
Configuration example SIMATIC S7-1500H (1st Release step)
CPU1517H
SIMATIC S7-1500R/H - PROFINET Network configuration

PROFINET Devices – System redundancy S2

Only S2 devices are supported in the ring

PN-Devices NAP S2
- ET 200MP HF
- ET 200SP HF

Standard PN-Device
- ET 200M/MP
- ET 200S/SP

PN-Controller
- S7-1200
- S7-1500
- S7-300
- S7-400

DP-Slaves
- ET 200M/MP
- ET 200S/SP

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SIMATIC S7-1500R/H - PROFINET Network configuration

PROFINET Devices – PN Controller

PN-Devices NAP S2

Standard PN-Device

ET 200M/MP

ET 200S/SP

PN-Controller

S7-1200
S7-300
S7-1500
S7-400

DP-Slaves

ET 200M/MP

DP Slave

ET 200S/SP

PN/PN coupler for network separation

Primary

Backup

H-Sync

Standard PN-Device

ET 200M/MP

ET 200S/SP

PN-Device
SIMATIC S7-1500R/H - PROFINET Network configuration

PROFINET Devices – Standard Devices

NAP S1 Devices in subordinated PN Network

PN-Devices NAP S2

Standard PN-Device

ET 200M/MP

ET 200S/SP

PN-Device

PN-Controller

DP-Slaves

ET 200M/MP

ET 200S/SP

DP Slave

DP/DP

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SIMATIC S7-1500R/H - PROFINET Network configuration

PROFINET Devices – DP Slaves

DP Slaves via DP Master of Sub-Controller

PN-Devices NAP S2
Standard PN-Device
PN-Controller
DP-Slaves
 ET 200M/MP
 DP Slave
 DP/DP
 ET 200S/SP

Primary
Backup
H-Sync

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SIMATIC S7-1500R/H - PROFINET Network configuration

Network connections

As a stitch over a switch into the ring

As part of the ring
Motivation and Product Strategy
System Overview
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System Redundancy and Network Configuration

Failure Scenarios
Communication
S7-1500R/H and Safety
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Failure scenarios for S7-1500R/H

Primary or Backup CPU failure

Failure of an IO device in the PROFINET ring

Failure of the PROFINET cable in the PROFINET ring

Primary or Backup CPU failure

Failure of an IO device in the PROFINET ring

Failure of the PROFINET cable in the PROFINET ring
Failure scenarios for S7-1500R/H

Failure of a switch in the PROFINET ring (with line topology)

Failure of an IO device in the PROFINET ring AND of the Primary CPU
Specific failure scenarios for S7-1500R

Failure of the direct redundancy connection

Failure of the two direct redundancy connections and PROFINET cable in the PROFINET ring

Time interval 2nd failure

- Sync

Time interval 2nd failure

- > 1500ms

Time interval 2nd failure

- < 100ms

Undefined condition
Specific failure scenarios for S7-1500H

Failure of a direct redundancy connection

Failure of the two direct redundancy connections

Primary | BACKUP
---|---
RUN-redundant | RUN-redundant

Time interval 2nd failure

- > 1500ms
- < 100ms

Undefined condition
Specific failure scenarios for S7-1500H

Failure of the direct redundancy connection and of the Primary CPU

Failure of the two direct redundancy connections and PROFINET cable in the PROFINET ring

Time interval 2nd failure
> 1500ms
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Communication with a redundant PLC System without special drivers
Accessing the R/H system by using "System IP-Address"
Using System IP instead of PLC interface IP

- Transparent communication between standard PLC and R/H-System
- The standard communication partner is automatically connected to the primary PLC
Using System IP instead of PLC interface IP

- Transparent communication between standard PLC and R/H-System
- The standard communication partner is automatically connected to the primary PLC
Using System IP instead of PLC interface IP

- Transparent communication between standard PLC and R/H-System
- The standard communication partner is automatically connected to the primary PLC
Include Standard Controllers in the MRP Ring

- The S7-1500R/H does not support Single PN Devices (S1) or iDevices.
- Nevertheless, it is possible to physically include a S7-1500/1200 per Switch or directly into the MRP Ring, to communicate to the H-System via OUC.
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R/H PROFINET Network configuration
PROFINET Devices – NAP S2

Only NAP S2 devices are supported in the ring

PN-Devices NAP S2
- ET 200MP HF
- PN/PN ET 200SP HF

PN-F-Controller
- S7-1500F
- ET200S/SP F
- SINAMICS F
- ET200M/MP F

Primary
Backup
H-Sync
R/H PROFINET Network configuration
PROFINET Devices – PN F-Controller

PN/ PN coupler for network separation

- PN-Devices NAP S2
- PN-F-Controller
  - S7-1500F
  - ET200S/SP F
  - SINAMICS F
- PN-F-Device
  - ET200M/MP F

Primary
Backup

H-Sync
R/H PROFINET Network configuration
PROFINET Devices – Safety Devices

Devices in subordinated PN network

Primary
Backup

H-Sync

PN-Devices NAP S2

PN-F-Controller

PN-F-Device

ET200S/SP F
SINAMICS F
ET200M/MP F

MRP Ring

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R/H PROFINET Network configuration
PROFINET Devices – Safety Devices

Devices in subordinated PN network

PN-Devices NAP S2
PN-F-Controller
PN-F-Device
MRP Ring
Primary
Backup
H-Sync
Reduce SPoF

SPoF: Single Point of Failure
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HMI Connection via 1 Network (Ring or Line)

<table>
<thead>
<tr>
<th>Communication between S7-1500R/H and...</th>
<th>Via System-IP (One HMI-Connection)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WinCC Comfort V15.1 (Comfort Panels)</td>
<td>OK</td>
</tr>
<tr>
<td>WinCC Advanced V15.1 (RT Advanced)</td>
<td>OK</td>
</tr>
<tr>
<td>WinCC Basic V15.1 (Basic Panels)</td>
<td>OK</td>
</tr>
<tr>
<td>WinCC Professional V15.1</td>
<td>OK</td>
</tr>
<tr>
<td>WinCC V7.5</td>
<td>OK</td>
</tr>
<tr>
<td>WinCC V15.1</td>
<td>OK</td>
</tr>
<tr>
<td>WinCC OA V3.16</td>
<td>OK</td>
</tr>
</tbody>
</table>

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HMI Connection via 1 Network (Ring or Line)

<table>
<thead>
<tr>
<th>Communication between S7-1500R/H and...</th>
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</thead>
<tbody>
<tr>
<td>WinCC Professional V15.1</td>
<td>OK</td>
</tr>
<tr>
<td>WinCC V7.5</td>
<td>OK</td>
</tr>
<tr>
<td>WinCC V15.1</td>
<td>OK</td>
</tr>
</tbody>
</table>
HMI Connection
via redundant Network (Line or Ring)

Industrial Ethernet

<table>
<thead>
<tr>
<th>Communication between S7-1500R/H and…</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>WinCC Comfort V15.1 (Comfort Panels)</td>
<td>NOK</td>
</tr>
<tr>
<td>WinCC Advanced V15.1 (RT Advanced)</td>
<td>NOK</td>
</tr>
<tr>
<td>WinCC Basic V15.1 (Basic Panels)</td>
<td>NOK</td>
</tr>
<tr>
<td>WinCC Professional V15.1</td>
<td>NOK</td>
</tr>
<tr>
<td>WinCC V7.5</td>
<td>NOK</td>
</tr>
<tr>
<td>WinCC OA V3.16</td>
<td>OK</td>
</tr>
</tbody>
</table>
Single sided HMI Connection via redundant Network (Line or Ring)

<table>
<thead>
<tr>
<th>Communication between S7-1500R/H and…</th>
<th>Single sided connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>WinCC Comfort V15.1 (Comfort Panels)</td>
<td>OK</td>
</tr>
<tr>
<td>WinCC Advanced V15.1 (RT Advanced)</td>
<td>OK</td>
</tr>
<tr>
<td>WinCC Basic V15.1 (Basic Panels)</td>
<td>OK</td>
</tr>
</tbody>
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## Restrictions for S7-1500R/H

### 1st Release step

Restrictions of the configuration for S7-1500R/H

<table>
<thead>
<tr>
<th>Feature</th>
<th>S7-1500R/H</th>
<th>S7-1500</th>
<th>S7-400H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single PLC projectable (H/R CPUs as redundant System only)</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Central periphery or central CPs / CMs projectable</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Configure System-PS</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Only MRP-Ring PN-Networks are supported (no „open Ring“ like in 400H)</td>
<td>yes</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Only PN System redundancy S2 Devices are supported (V1.11)</td>
<td>yes</td>
<td>no</td>
<td>S1 + S2</td>
</tr>
<tr>
<td>Shared Device</td>
<td>no</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>I-Device</td>
<td>no</td>
<td>yes</td>
<td>no</td>
</tr>
</tbody>
</table>
## Functional restrictions for S7-1500R/H

<table>
<thead>
<tr>
<th>Feature</th>
<th>S7-1500R/H</th>
<th>S7-1500</th>
<th>S7-400H</th>
</tr>
</thead>
<tbody>
<tr>
<td>S7-Com, E-Mail, FDL, ISO, <em>(OUC with dynamic connections is supported)</em></td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>OPC UA</td>
<td>no</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>system-supported H-communication <em>(but the System IP-Address)</em></td>
<td>no</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>webserver</td>
<td>no</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>system-supported redundant I/Os</td>
<td>no</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>PROFIsecure</td>
<td>no</td>
<td>F-CPU</td>
<td>yes</td>
</tr>
<tr>
<td>technology objects</td>
<td>no</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>support for MRPD, clock synchrony and IRT</td>
<td>no</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>CiR and firmware update in run is supported</td>
<td>no</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>direct migration through hardware replacement <em>(Import of user programs via Copy/Paste)</em></td>
<td>no</td>
<td>n.a.</td>
<td>no</td>
</tr>
<tr>
<td>PLCsim and PLCsim advanced are supported</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
</tbody>
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### Ordering Information

#### CPU S7-1500R
- CPU 1513R-1 PN: 6ES7 513-1RL00-0AB0
- CPU 1515R-2 PN: 6ES7 515-2RM00-0AB0

#### CPU S7-1500H
- CPU 1517H-3 PN: 6ES7 517-3HP00-0AB0

#### Distance up to 10m between the S7-1500H PLCs
**Use of the Synchronization Modules for FO cables up to 10 m**
- MLFB Module: 6ES7960-1CB00-0AA5
- MLFB LWL-Cable 1m: 6ES7960-1BB00-5AA5
- MLFB LWL-Cable 2m: 6ES7960-1BC00-5AA5
- MLFB LWL-Cable 10m: 6ES7960-1CB00-5AA5

#### Distance up to 10km between the PLCs
- MLFB Module: 6ES7960-1FB00-0AA5
- Monomode LWL-Cable LC/LC Duplex Crossed 9/125µ

#### S7-1500H Bundle (Consisting of 2 CPU 1517-3 PN, 4 Sync-Modules 10m and 2 Sync-Cables 1m)
- 6ES7500-0HP00-0AB0
Thank you!

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