TROUBLESHOOTING PROFISAFE MODULES

References PROFIsafe at TIA

SUMMARY

1. Fundamentals PROFIsafe
2. References “TIA – Application”
3. References “TIA – PROFINET – PLC”
4. References “TIA – PROFINET – IO-Device”
5. References “TIA – Safety-Administration”
6. References “PROFINET fundamentals”
7. References “PROFINET conformance classes”
8. References “PROFINET communication”

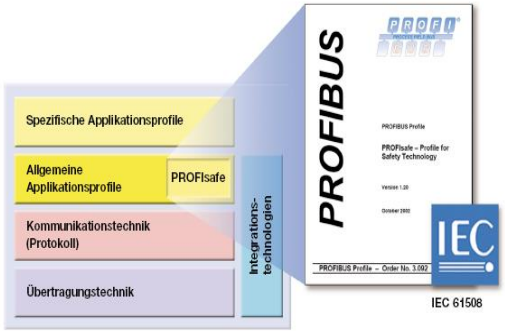
SUMMARY

TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

Fundamentals PROFIsafe – PROFIsafe (1)

- Abstract
  - Organization “**PROFIBUS und PROFINET International“** -> shortcut **PI**
  - **Specification** “funktionale sichere Kommunikation“ now **PROFIsafe**
  - ***PROFIsafe*** international standard ***IEC 61784-3-3***

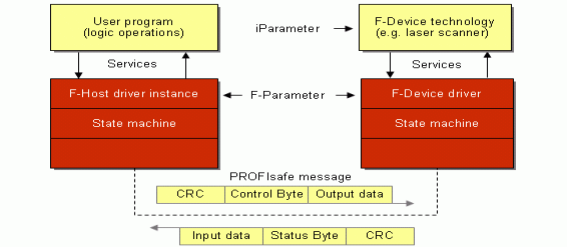
- Fundamentals
  - PROFIsafe open solution in combination with PROFIBUS-DP and PROFINET
  - Coexistence between safety messages and standard communication possible
  - Retrofit with PROFIsafe at applications possible
  - „Black Channel“ principle
    - Safety hardware and firmware considered as one unit (+ PROFIsafe communication)
    - Bus components and bus cable assigned to the “Black Channel”
    - PROFIsafe detects all errors at the “Black Channel”
      - No safety inspection of “Black Channel” necessary



TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

Fundamentals PROFIsafe – PROFIsafe (2)

- PROFIsafe parameter
  - ➢ PROFIsafe communication parameter defined as F-Parameter (GSD file)
  - ➢ Application or individual parameter safety device defined as iParameter
    - Settings, verification, documentation with manufacturer tooling
    - iParameter stored at safety device
    - Central backup with iPar-Server technology possible
    - PROFINET Offline configuration “iPar by GSD” possible
  - ➢ PROFIsafe device still **consists of F-Parameter**, sometimes with **additional iParameter**



source: TCI Workshop PI in Stuttgart, 25.10.2007

- Safety applications
  - ➢ IEC 61508 up to SIL 3
  - ➢ IEC 62061 up to SIL 3
  - ➢ ISO 13849-1 up to performance level e

TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

Fundamentals PROFIsafe – PROFIsafe (3)

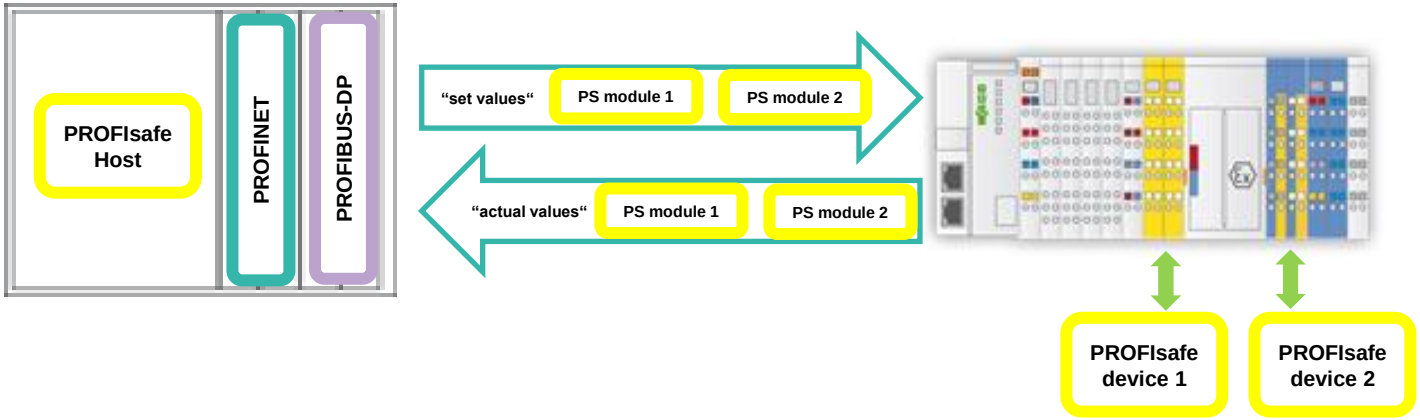
- F-Parameter
  - ➢ Part of GSD-File
    - PROFIsafe Host address
    - PROFIsafe Device address
    - Checksum PROFIsafe Device F_iPar_CRC
    - Timeout PROFIsafe communication
  - ➢ F-Parameter stored at project (system configuration)
  - ➢ Standard parameter F-Device

- iParameter
  - ➢ Individual device / application parameter
  - ➢ Tooling for each device necessary (manufacturer)
    - Adjustment and verification
    - Calculation F_iPar_CRC
    - Documentation of settings
    - Addition functions, such as comparison, factory reset
  - ➢ iParameter stored at application
    - Technology iPar-Server
    - Safety plc offers iPar-Server (mandatory)
    - Offline configuration PROFINET “iPar by GSD”
  - ➢ Optional parameter F-Device

TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

Fundamentals PROFIsafe – Technology (1)

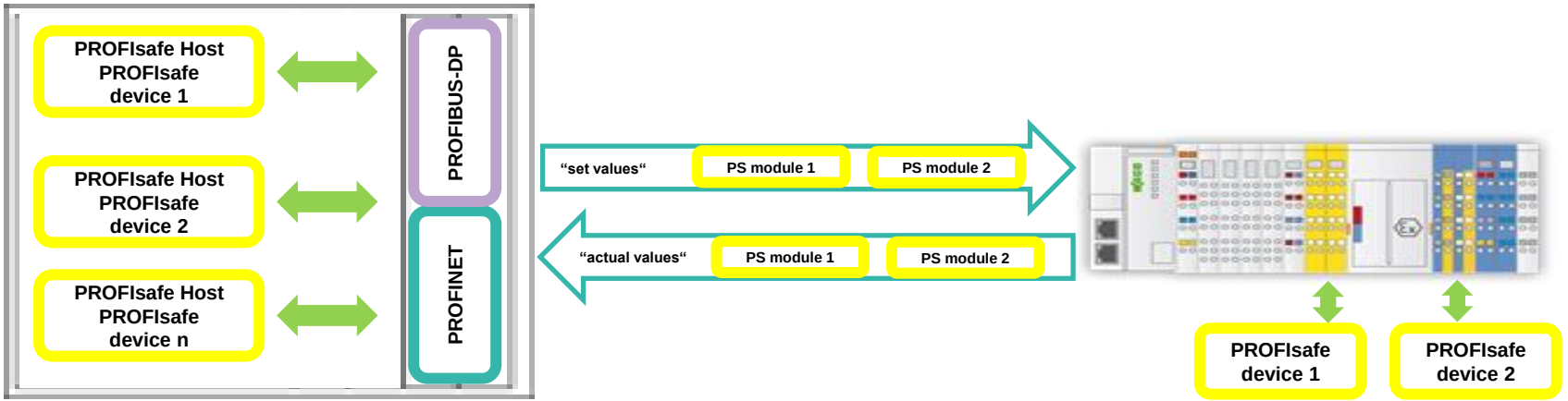
- PROFIsafe telegram
  - Part of cyclic telegram at PROFIBUS-DP and PROFINET
  - Self-contained and verified with checksum
  - PROFIsafe Host “encodes” set values and “decodes” actual values
  - PROFIsafe Device “decodes” set values and “encodes” actual values



TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

Fundamentals PROFIsafe – Technology (2)

- Point of view PROFIsafe host
  - ➢ PROFIsafe host necessary for each PROFIsafe device
  - ➢ “Self-contained” PROFIsafe telegram available for bus controller
  - ➢ “Integration” of PROFIsafe telegram at normal telegram by bus controller



TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

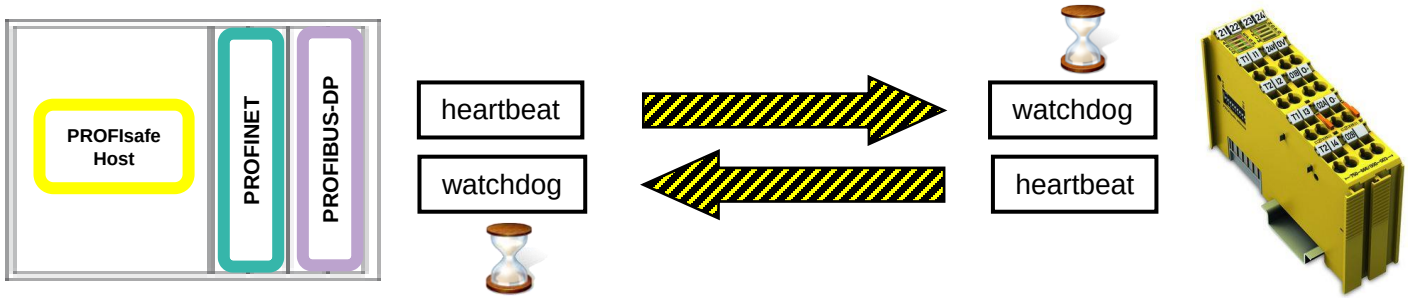
Fundamentals PROFIsafe – Technology (3)

- PROFIsafe communication parameter
  - PROFIsafe host address
    - Unique PROFIsafe address of PROFIsafe host for application
  - PROFIsafe device address
    - Unique PROFIsafe address per PROFIsafe device
    - Unique address at PROFIBUS-DP or PROFINET network
  - Checksum iParameter (F_iPar_CRC)
    - Checksum of application parameter – iParameter of PROFIsafe device
    - Calculation after validation with manufacturer tooling
  - PROFIsafe communication monitoring
    - Set value for each PROFIsafe device available

TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

Fundamentals PROFIsafe – Safety mechanism (1)

- PROFIsafe Host
  - Trigger “heartbeat” for each PROFIsafe Device
  - Telegram failure initiates “safe state” at PROFIsafe Device
- PROFIsafe Device
  - Trigger “heartbeat” for each PROFIsafe Host
  - Telegram failure at PROFIsafe Host initiates “safe state” for PROFIsafe Device

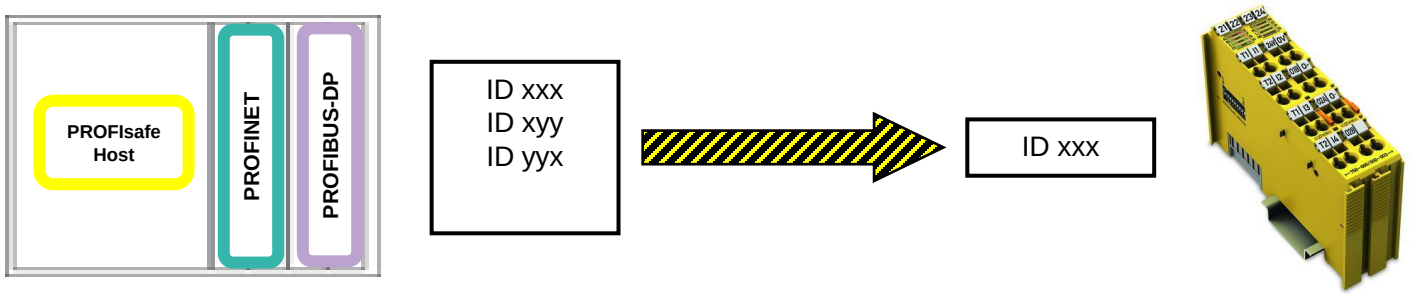


TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

Fundamentals PROFIsafe – Safety mechanism (2)

- PROFIsafe Host
  - ➢ “Numeration” inserted at each PROFIsafe telegram to PROFIsafe Device

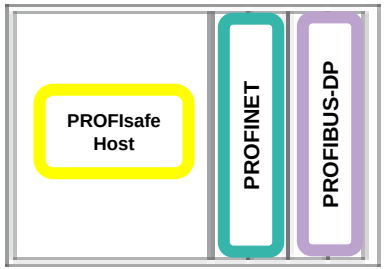
- PROFIsafe Device
  - ➢ Received PROFIsafe telegrams checked by “numeration” of PROFIsafe Host
  - ➢ Telegram failure initiates “safe state” at PROFIsafe Device

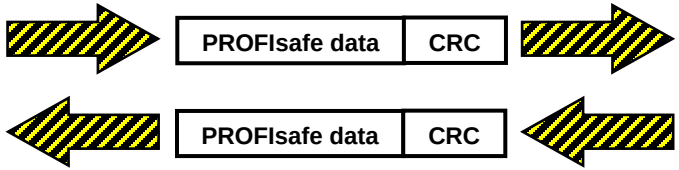


TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

Fundamentals PROFIsafe – Safety mechanism (3)

- PROFIsafe Host
  - Internal “numeration” for PROFIsafe telegrams
  - Number transferred with CRC and toggle bit
- PROFIsafe Device
  - Internal “numeration” for PROFIsafe telegrams
  - Number transferred with CRC and toggle bit
  - Telegram failure initiates “safe state” at PROFIsafe Device





TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

Fundamentals PROFIsafe – Safety mechanism (4)

- Possible transmission errors
  - Unintended repetition or loss
  - Insertion
  - Incorrect sequence
  - Corruption
  - Unacceptable delay

- Measures against transmission errors
  - Consecutive number (with sign of life)
  - Time-out with receipt
  - Codename (for sender and receiver)
  - Data integrity (CRC)

SUMMARY

TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

References “TIA – Application” – Fundamentals

- Pay attention to technical manuals
  - ➢ SIMATIC Safety – Configuration and Programming
  - ➢ Safety PLC
  - ➢ PROFIsafe devices
  - ➢ PROFINET requirements
    - Set topology
    - IO-Device from Conformance Class B (CC-B)
    - Communication settings application

TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

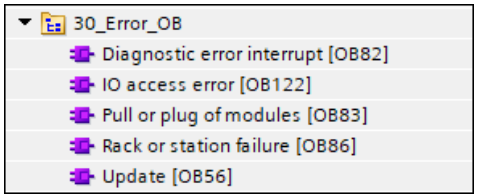
References “TIA – Application” – Organization blocks for error handling

- Organization block called at Siemens PLC by
  - Error and hardware interrupts or system events

- System behavior if interrupt or event activated
  - Organization block called
  - If organization not available PLC changes to STOP

- Required organization block for WAGO PROFIsafe modules – “Online configuration WAGO Safety Editor”
  - Pull or plug of modules [OB83]

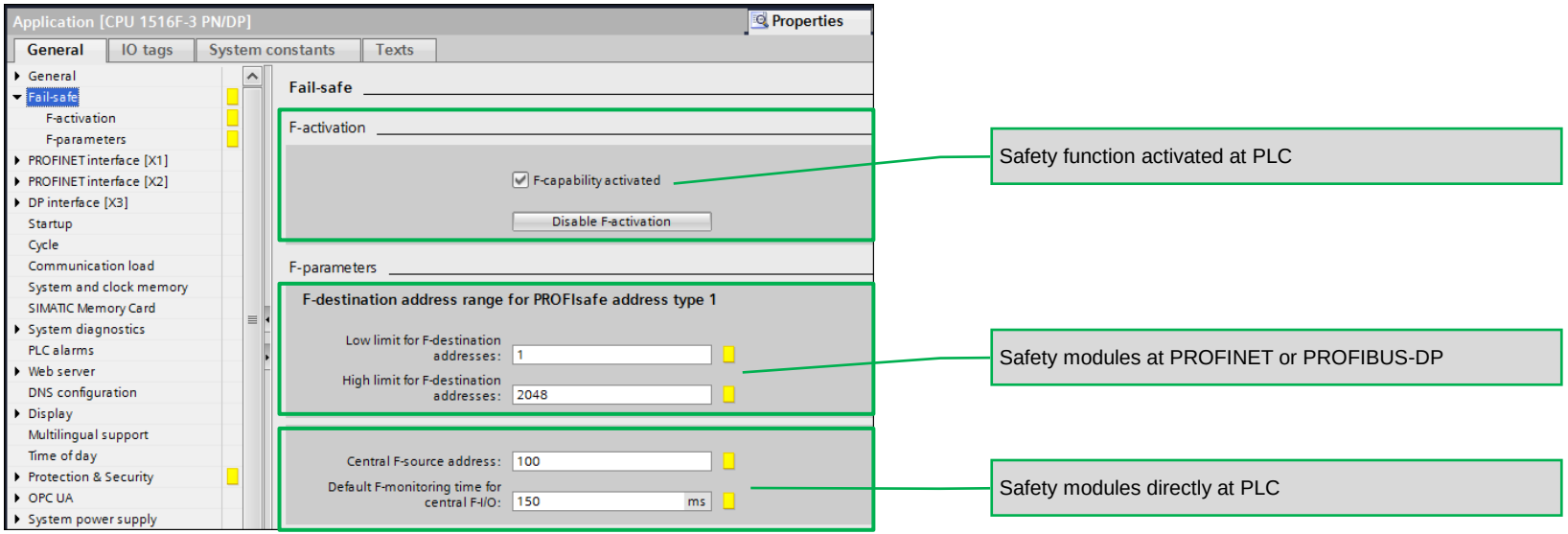
- Recommended organization blocks for applications
  - Diagnostic error interrupt [OB82]
  - IO access error [OB122]
  - Rack or station failure [OB 86]



TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

References “TIA – Application” – Settings area “Fail-safe”

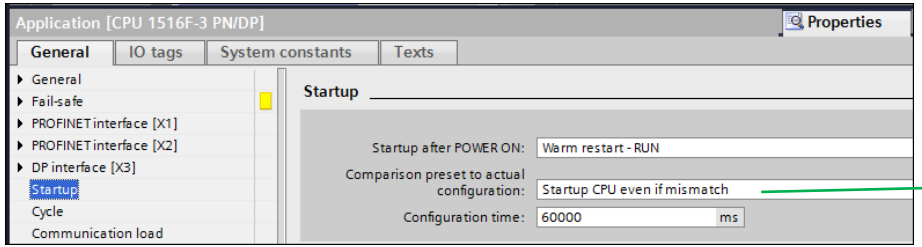
- Modify settings – Area “Fail-safe”



TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

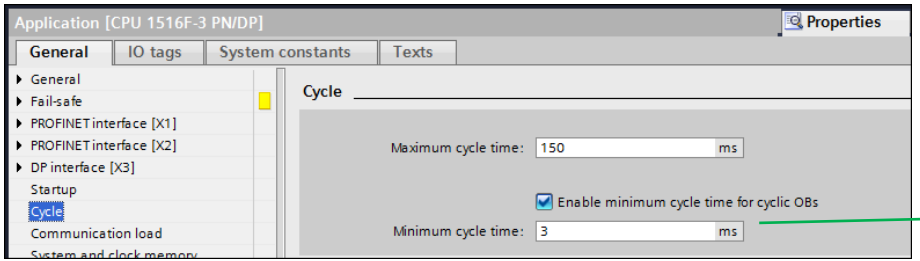
References “TIA – Application” – Settings area “Startup”, “Cycle”

- Modify settings – Area “Startup”



Change setting – Startup PLC and receive configuration errors as diagnosis messages

- Modify settings – Area “Cycle”

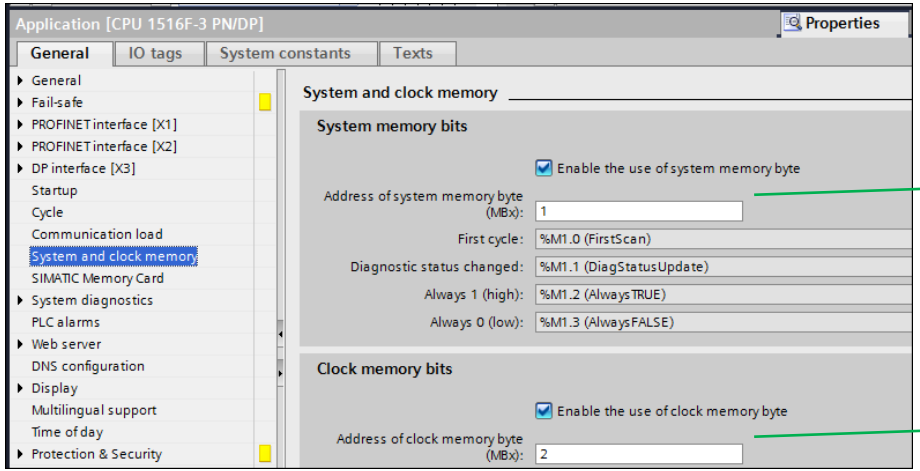


Activate minimum cycle time of application

TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

References “TIA – Application” – Settings area “System and clock memory”

- Modify settings – Area “System and clock memory”



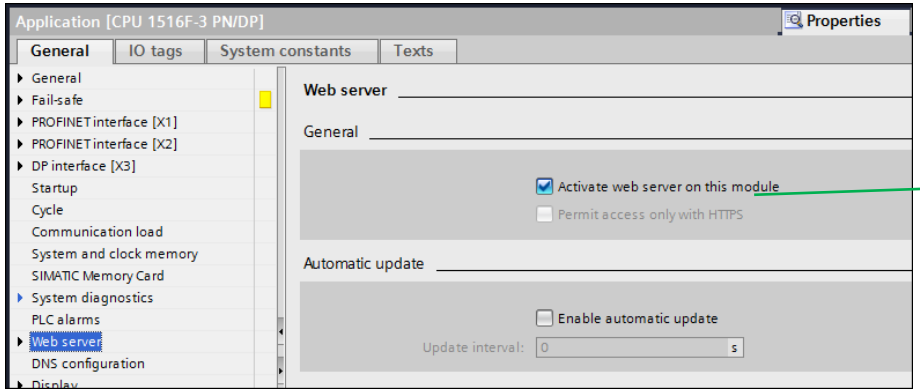
Activate system memory bits at MB1

Activate clock memory byte at MB2

TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

References “TIA – Application” – Settings area “Web server”

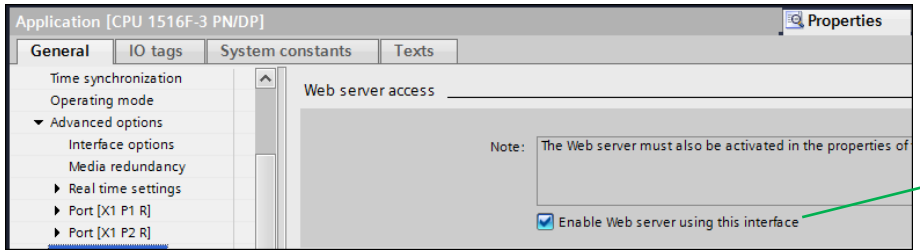
- Modify settings – Area “Web server”



Activate web server

User: admin
Password: wago

- Activate Web server access at interface X1 and X2



Web server access possible if access activated at PROFINET interface and web server general

SUMMARY

1. Fundamentals PROFIsafe
2. References “TIA – Application”
3. References “TIA – PROFINET – PLC”
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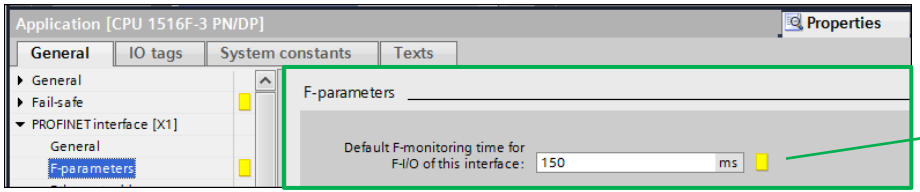
5. References “TIA – Safety-Administration”
6. References “PROFINET fundamentals”
7. References “PROFINET conformance classes”
8. References “PROFINET communication”
9.

TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

References “TIA – PROFINET – PLC” – Settings area “PROFINET interface [X1]” (1)

- Modify settings – Area “PROFINET interface [X1] – F-parameters”

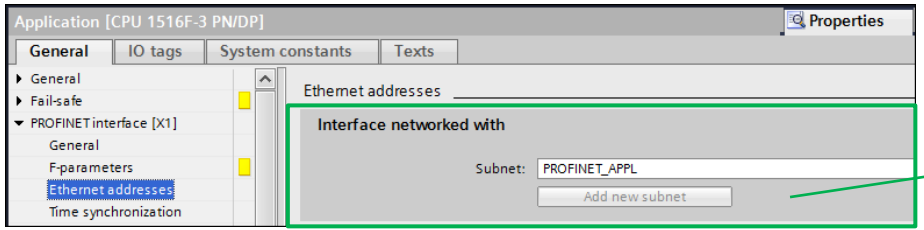


Default monitoring time PROFIsafe communication to PROFIsafe devices at PROFINET interface X1.

Watchdog PROFIsafe communication

  - **Pay attention to dependence setting “cycle time F-Runtime group” and value “F-monitoring time”**
  - ***Information available at topic “TIA – Safety Administration”***

- Modify settings – Area “PROFINET interface [X1] – Ethernet addresses”

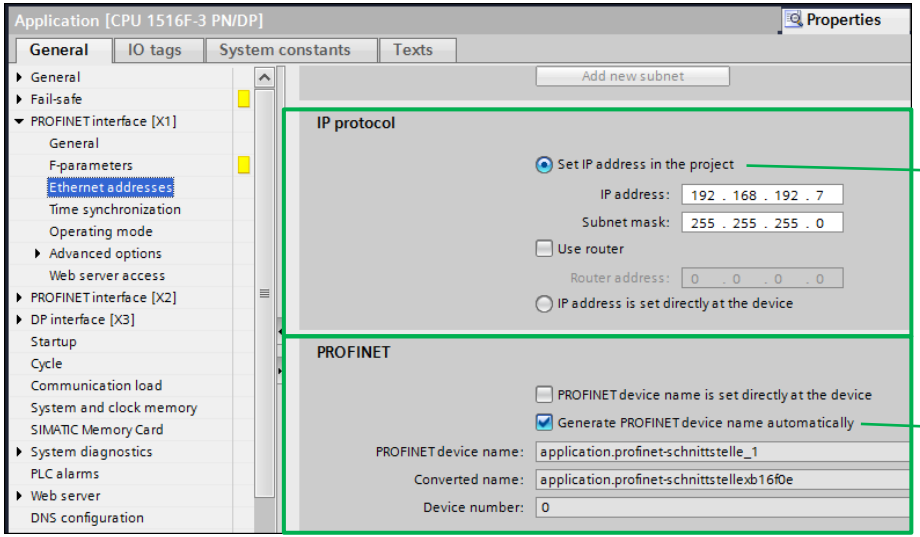


Insert new PROFINET subnet and change name to “PROFINET_APPL” – PROFINET application

TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

References “TIA – PROFINET – PLC” – Settings area “PROFINET interface [X1]” (2)

- Modify settings – Area “PROFINET interface [X1] – Ethernet addresses”



IP address of PLC PROFINET interface [X1]

Pay attention to technical manual about topics interface [X1] and [X2] of PLC

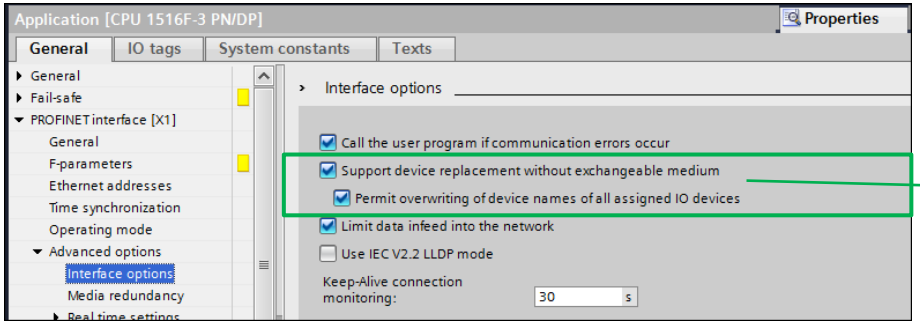
Set options topic “PROFINET device name” of PLC

Example based on practical experience

TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

References “TIA – PROFINET – PLC” – Settings area “PROFINET interface [X1]” (3)

- Modify settings – Area “PROFINET interface [X1] – Ethernet addresses – Advanced options”



Important settings topic “assign device name” and IO-Device replacement without tooling

Option enabled: overwriting the device name by the IO controller is permitted

The IO controller (PROFINET interface of the CPU) can overwrite the PROFINET device names of IO devices when this option is selected. This reduces the effort during automatic commissioning, for example, when replacing a device.

To rule out any danger, check whether the suitable device is connected and wired correctly and whether the port interconnection matches the configured preset topology. You should also observe the information in the online help.

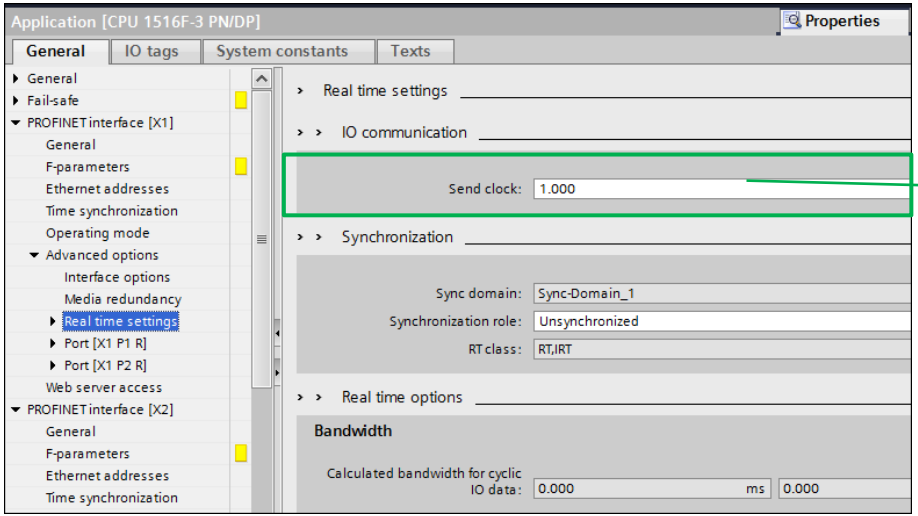
If the option is not selected, the IO controller cannot overwrite the device names of the IO devices. In this case, you must manually assign the PROFINET device name on the IO device if the PROFINET device name changes in the configuration or when a device is replaced, or delete the device names of the IO devices prior to an automatic commissioning.

- ➢ Advice settings device replacement
  - Activate options for device replacement without tooling
  - Device names assigned automatically at start up or replacement
  - Set topology at project necessary
  - **Fundamental settings for device replacement without tooling**

TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

References “TIA – PROFINET – PLC” – Settings area “PROFINET interface [X1]” (4)

- Modify settings – Area “PROFINET interface [X1] – Ethernet addresses – Advanced options”

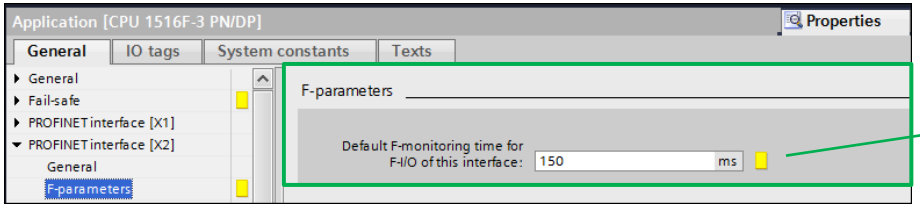


“Fundamental” send clock of PROFINET interface X1

TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

References “TIA – PROFINET – PLC” – Settings area “PROFINET interface [X2]” (1)

- Modify settings – Area “PROFINET interface [X2] – F-parameters”

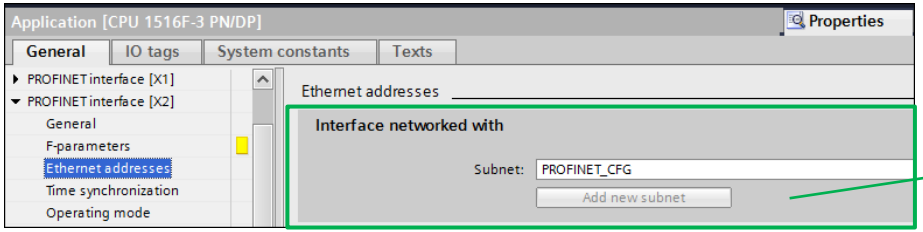


Default monitoring time PROFIsafe communication to PROFIsafe devices at PROFINET interface X2.

Watchdog PROFIsafe communication

- **Pay attention to dependence setting “cycle time F-Runtime group” and value “F-monitoring time”**
- ***Information available at topic “TIA – Safety Administration”***

- Modify settings – Area “PROFINET interface [X2] – Ethernet addresses”

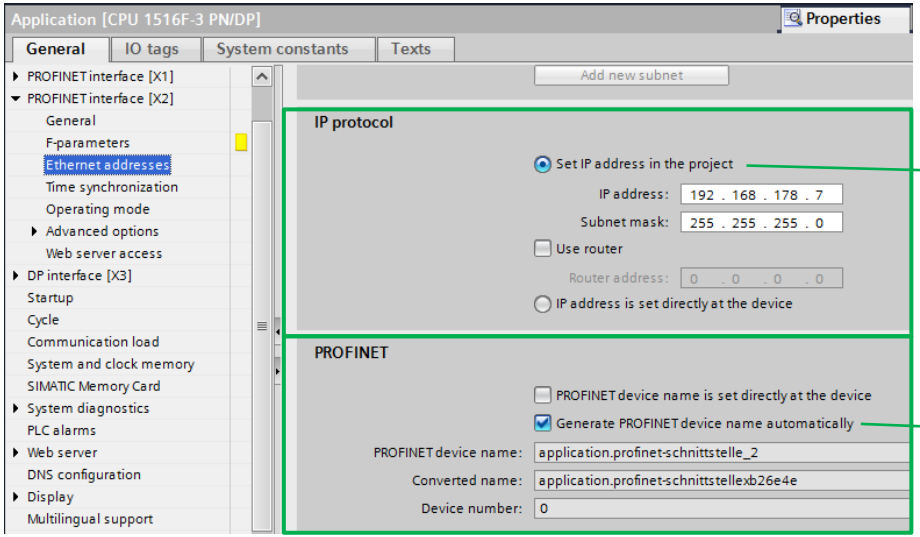


Insert new PROFINET subnet and change name to “PROFINET_CFG” – PROFINET configuration or external access

TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

References “TIA – PROFINET – PLC” – Settings area “PROFINET interface [X2]” (2)

- Modify settings – Area “PROFINET interface [X2] – Ethernet addresses”



IP address of PLC PROFINET interface [X2]

Pay attention to technical manual about topics interface [X1] and [X2] of PLC

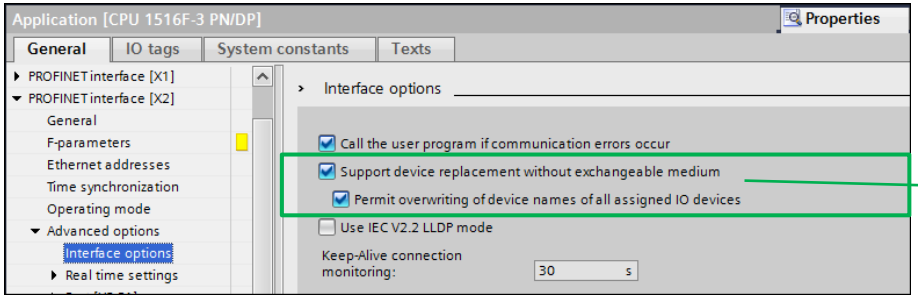
Set options topic “PROFINET device name” of PLC

Example based on practical experience

TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

References “TIA – PROFINET – PLC” – Settings area “PROFINET interface [X2]” (3)

- Modify settings – Area “PROFINET interface [X2] – Ethernet addresses – Advanced options”



Important settings topic “assign device name” and IO-Device replacement without tooling

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To rule out any danger, check whether the suitable device is connected and wired correctly and whether the port interconnection matches the configured preset topology. You should also observe the information in the online help.

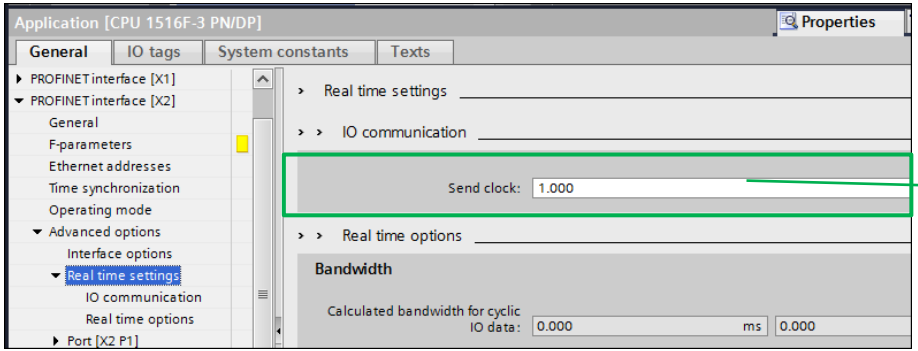
If the option is not selected, the IO controller cannot overwrite the device names of the IO devices. In this case, you must manually assign the PROFINET device name on the IO device if the PROFINET device name changes in the configuration or when a device is replaced, or delete the device names of the IO devices prior to an automatic commissioning.

- ➢ Advice settings device replacement
  - Activate options for device replacement without tooling
  - Device names assigned automatically at start up or replacement
  - Set topology at project necessary
  - **Fundamental settings for device replacement without tooling**

TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

References “TIA – PROFINET – PLC” – Settings area “PROFINET interface [X2]” (4)

- Modify settings – Area “PROFINET interface [X2] – Ethernet addresses – Advanced options”



“Fundamental” send clock of PROFINET interface X2

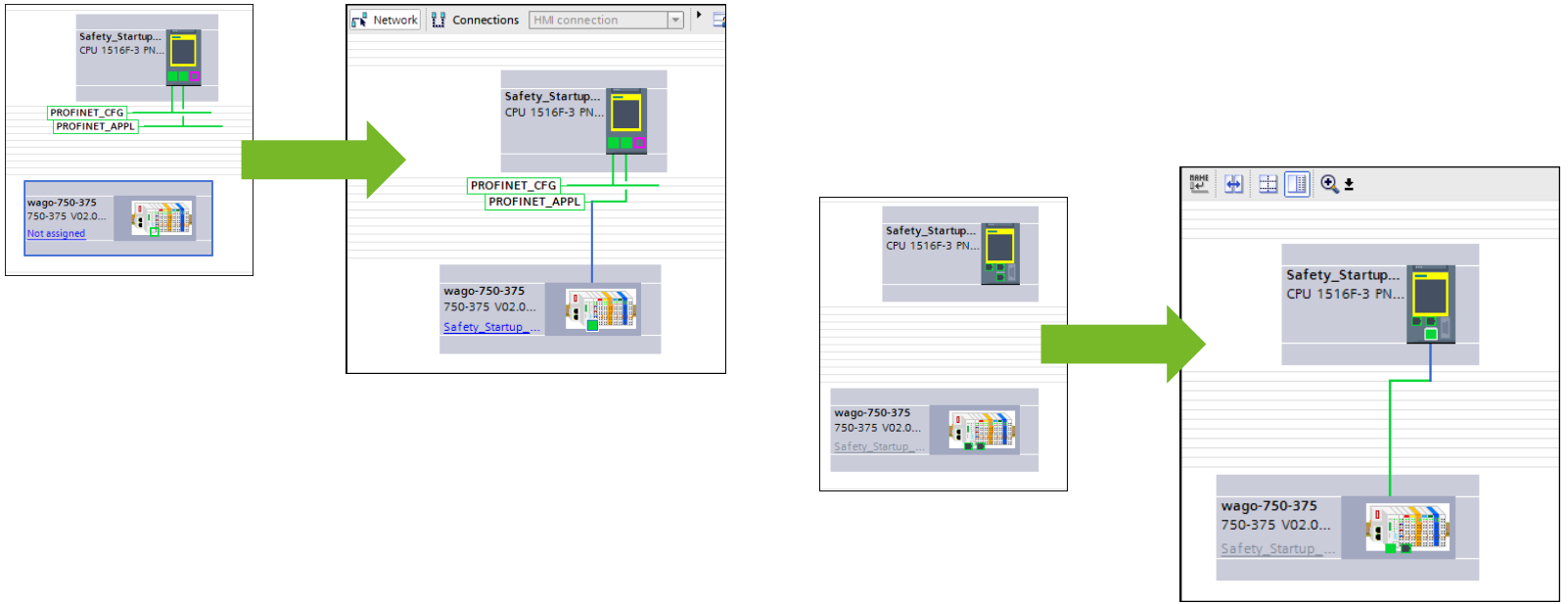
SUMMARY

1. Fundamentals PROFIsafe
2. References “TIA – Application”
3. References “TIA – PROFINET – PLC”
4. References “TIA – PROFINET – IO-Device”
5. References “TIA – Safety-Administration”
6. References “PROFINET fundamentals”
7. References “PROFINET conformance classes”
8. References “PROFINET communication”

TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

References “TIA – PROFINET – IO-Device” – Insert IO-Device at application

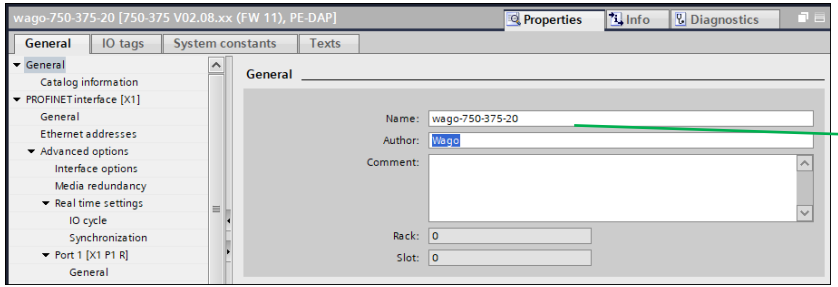
- Insert IO-Device at PROFINET network view and update topology view



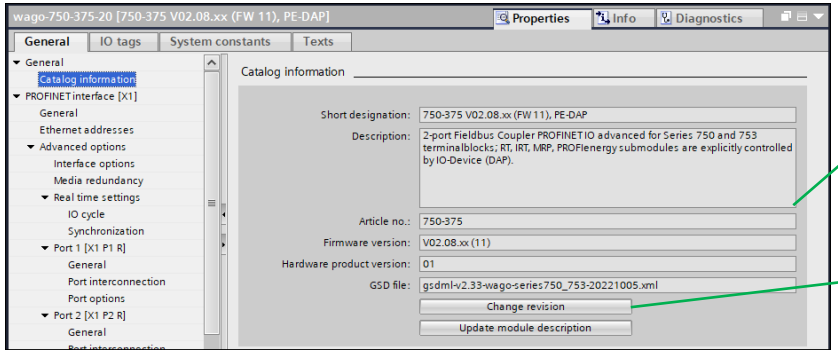
TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

References “TIA – PROFINET – IO-Device” – Modify device settings (1)

- General – Catalog information



Assign PROFINET IO-Device name of PN IO-Device



Information about PROFINET IO-Device:

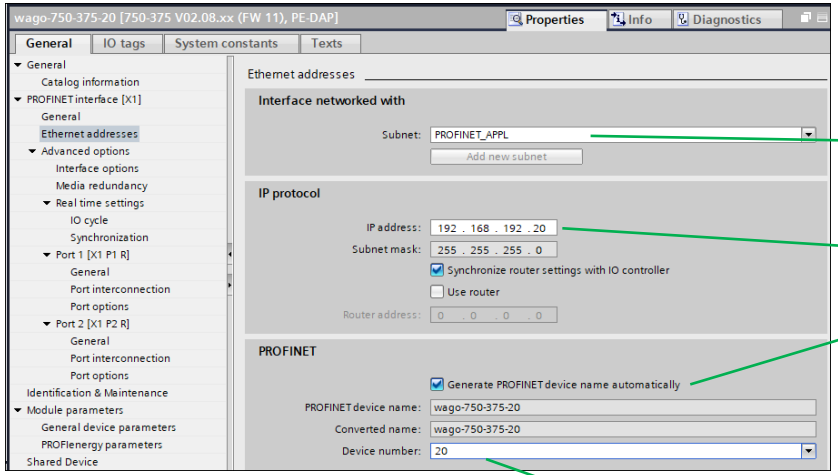
- Required firmware version
- Used GSD file for configuration

Update GSDML file to new version (only same version)

TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

References “TIA – PROFINET – IO-Device” – Modify device settings (2)

- Modify PROFINET interface [X1] – Ethernet address



Indication connected PROFINET subnet of application

Assign IP address of PROFINET IO-Device advanced

Activate this option

Option enabled: The device name will be adopted directly from the module name

When an option is activated (default), the PROFINET device name corresponds to the name of the module and can thus not be edited. This name can only be changed in the module properties under "General".

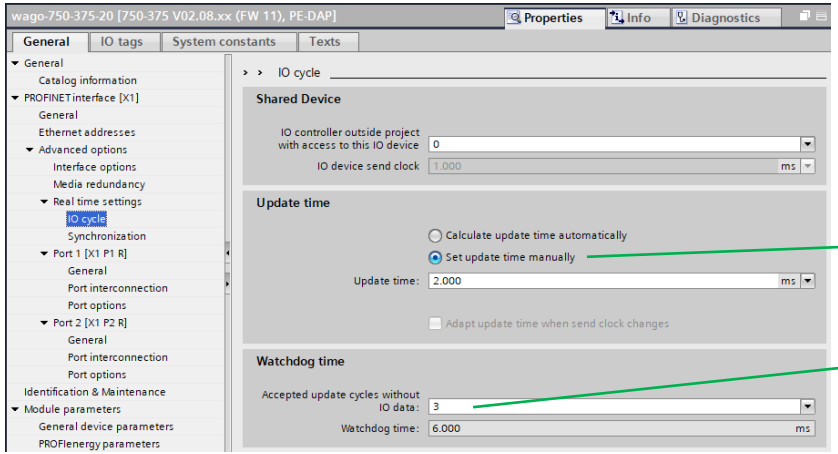
If the option is not activated, you can change the PROFINET device name independently of the name of the module.

“TIA special setting” – PROFINET IO-Device offers a unique device number. In combination with additional function blocks lots of diagnosis data and device information are available

TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

References “TIA – PROFINET – IO-Device” – Modify device settings (3)

- Modify advanced options – Real time settings – IO-Cycle



Change settings to application requirements.

Change setting to “set update time manually” – minimum value 2.0 ms

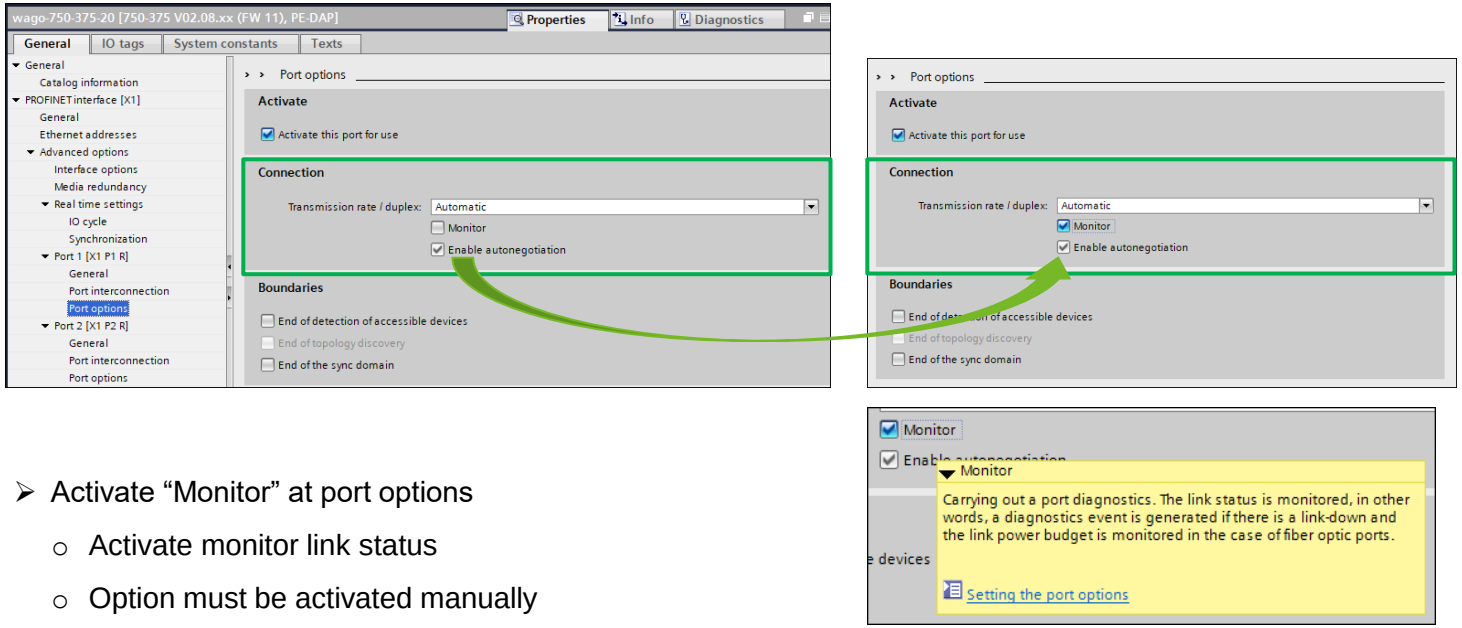
Setting based on practical experience – standard value 3

Minimum value 3 – it takes up to 3 PROFINET telegrams to establish a new or stopped PROFINET communication

TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

References “TIA – PROFINET – IO-Device” – Modify device settings (4)

- Modify advanced options – Port 1 [X1 P1 R] – Port options

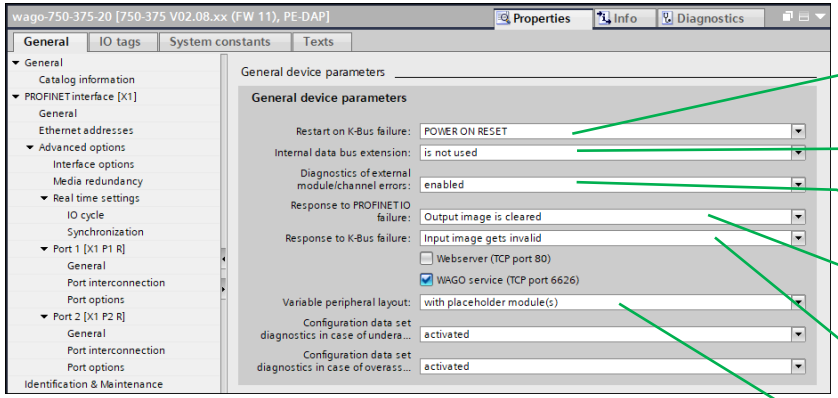


- ➢ Activate “Monitor” at port options
  - Activate monitor link status
  - Option must be activated manually
  - By disconnecting port – disable monitor at settings too

TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

References “TIA – PROFINET – IO-Device” – Modify device settings (5)

- Modify general device parameters



Default value // AUTORESET not recommended

Based on actual configuration – With safety “is not used” recommended

Enable diagnosis messages

Behavior in case of PROFINET failure

Behavior in case of KBUS error:
“Input image invalid” – Diagnosis messages possible in case of error
“PROFINET communication stopped” – Diagnosis message impossible

Settings for “variation of peripheral layout” – standard “placeholder”

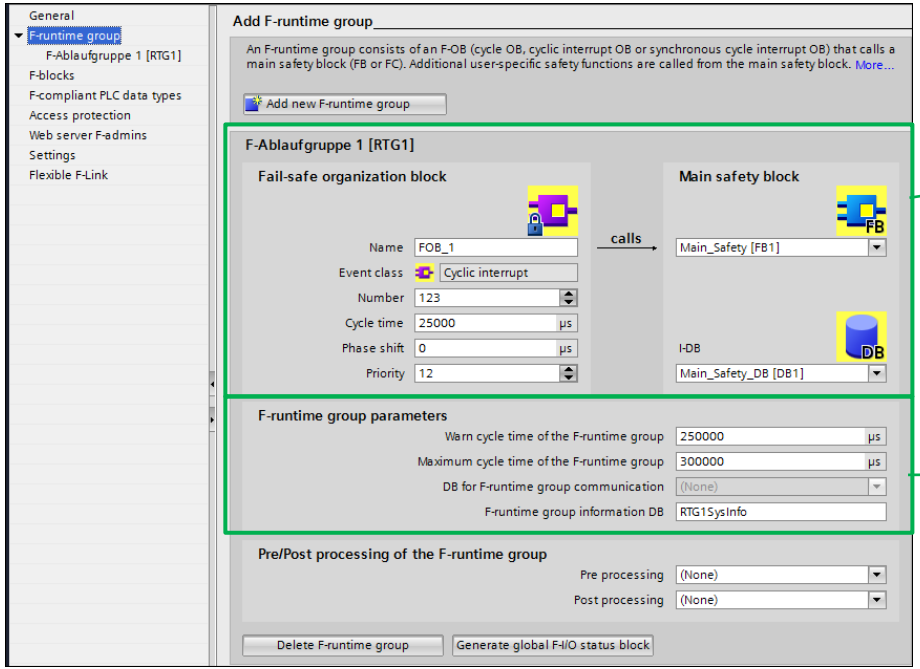
SUMMARY

1. Fundamentals PROFIsafe
2. References “TIA – Application”
3. References “TIA – PROFINET – PLC”
4. References “TIA – PROFINET – IO-Device”
5. References “TIA – Safety-Administration”
6. References “PROFINET fundamentals”
7. References “PROFINET conformance classes”
8. References “PROFINET communication”

TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

References “TIA – Safety-Administration” – Settings “Safety Administration” (1)

- Modify settings – Area “Safety Administration – F-runtime group”



Fundamental settings created automatically by inserting safety PLC at TIA project – modifications possible

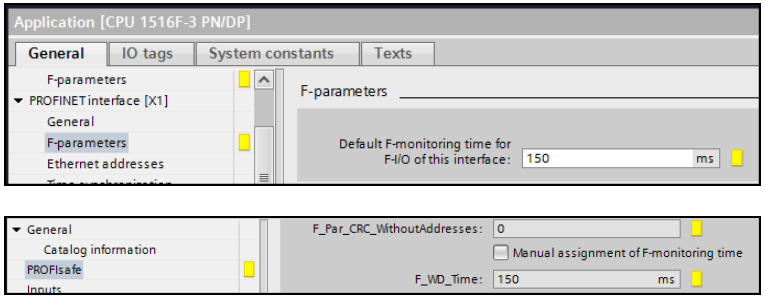
Modify settings about warning and maximum cycle of F-runtime group

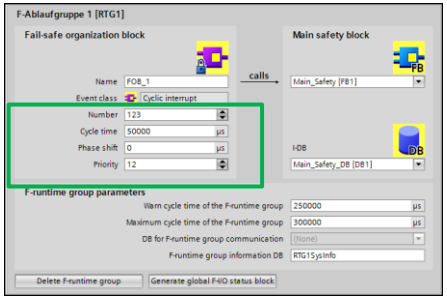
Pay attention to technical manual’s safety programming, safety PLC, …

TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

References “TIA – Safety-Administration” – Settings “Safety Administration” (2)

- References dependences settings “cycle time F-Runtime group” and value “F-monitoring time”
  - ➢ Settings “F-monitoring time” at TIA application





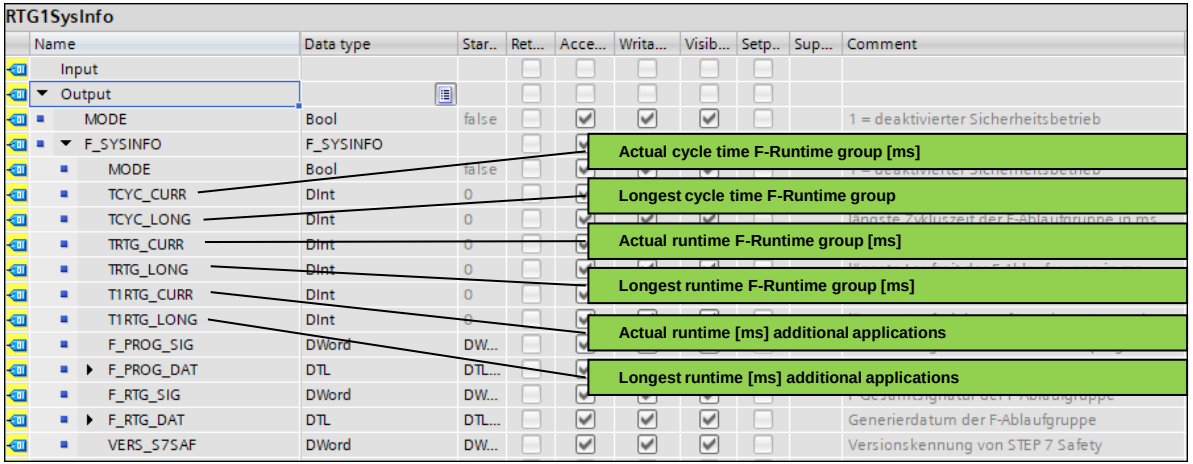
    - Global setting at “network settings”
    - Selection per PROFIsafe device – global setting or local value

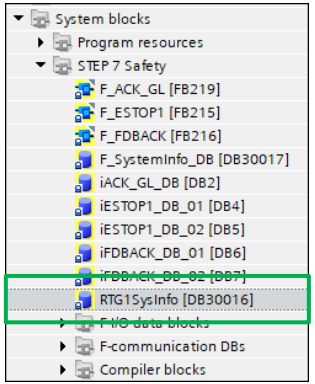
  - ➢ **Practical experience set value watchdog time**
    - Set value “F_WD_TIME“ $F\_WD\_TIME \geq \text{Cycle time } F - Runtime\ group * 3$ (4)
    - *Factor 3 or 4 based on used network infrastructure PROFINET*

TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

References “TIA – Safety-Administration” – Settings “Safety Administration” (3)

- References dependences settings “cycle time F-Runtime group” and value “F-monitoring time”
  - **Check actual runtime of safety application after modifications**
  - Data block area “Step 7 Safety”
    - Example “RTG1SysInfo” – Overview information



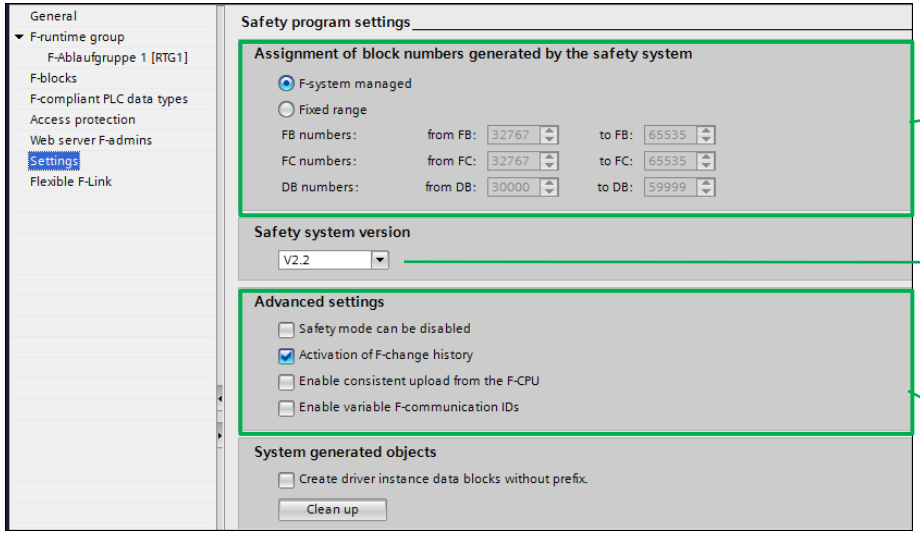


    - Addition information available at TIA online help / technical manual safety programming TIA

TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

References “TIA – Safety-Administration” – Settings “Safety Administration” (4)

- Modify settings – Area “Safety Administration – Settings”



Fundamental settings created automatically by inserting safety PLC at TIA project – modifications possible

Activate latest available “Safety system version”

Settings based on application requirements and workflows in combination with safety application

Pay attention to technical manual’s safety programming, safety PLC, …

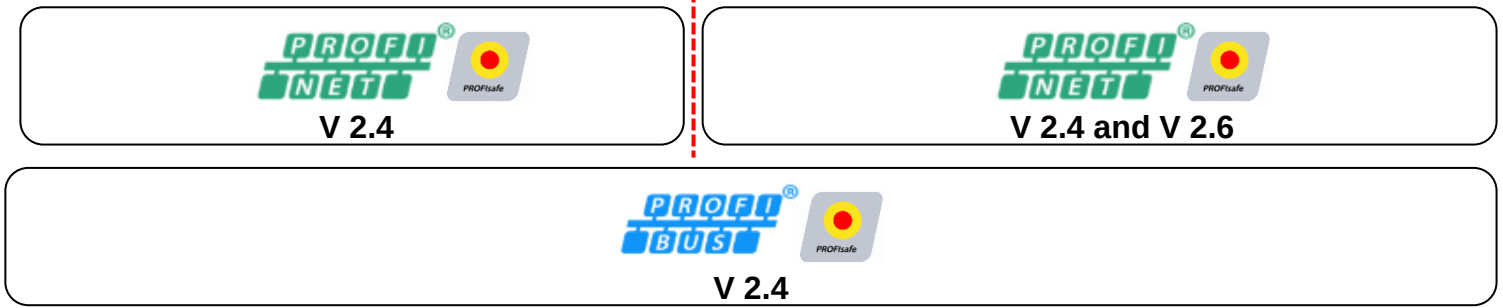
➢ Available parameters based on TIA version

TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

References “TIA – Safety-Administration” – Settings “Safety Administration” (5)

- References TIA version – Firmware PLC and “Safety System Version”
  - ➢ Based on practical experience

From TIA version	V14 SP1	V14 SP1	V14 SP1	V15.1	V16	V17	V18	V19
Firmware PLC 15xxF	V 2.0	V 2.1	V 2.1	V 2.6	V 2.8	V 2.9	V 2.9 / V 3.0	V 2.9 / V 3.x
Safety System Version	V 1.6	V 2.0	V 2.1	V 2.2	V 2.3	V 2.4	V 2.5	V 2.6

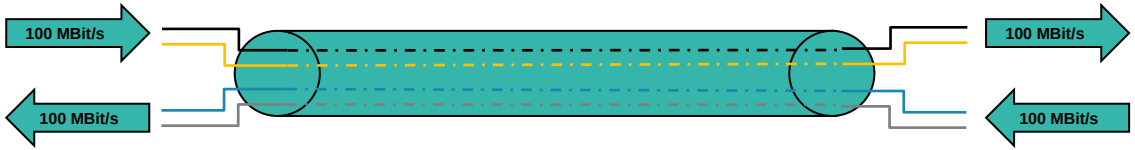


SUMMARY

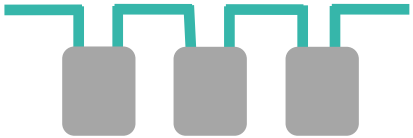
TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

- References “PROFINET fundamentals” – Overview

- **Pr**ocess **Fi**eld **Net**work
  - Open Industrial Ethernet Standard of **”PROFIBUS & PROFINET International“**
  - Full duplex mode with 100 Mbit/s

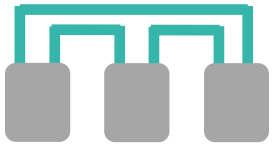


  - “Switched Ethernet“ – switches connected “in line”

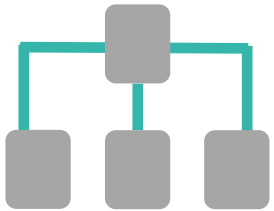


  - Network load influenced by topology

line



ring

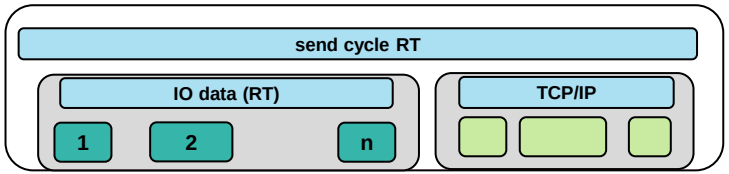


star

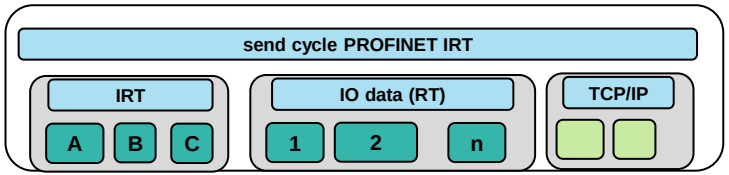
TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

- References “PROFINET fundamentals” – Protocols

- PROFINET IO protocols
  - ➢ **R**eal-**T**ime (RT) communication (class A & B)
    - Real time communication
    - Cycle time 2 up to 10 ms



  - ➢ **I**sochronous **R**eal-**T**ime (IRT) communication (class C)
    - Clock synchronized communication
    - Cycle time < 2 ms
    - **Reserved bandwidth for IRT**



- *PROFINET CBA (Component Based Automation)*
  - ➢ *Component based communication – application modules*
  - ➢ *Cycle time 50 up to 100 ms*

TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

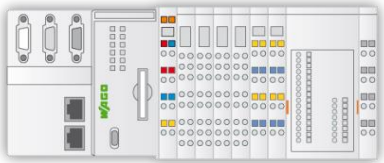
- References “PROFINET fundamentals” – Conformance classes

- Conformance Classes / power class – PROFINET devices
  - *Class A (CC-A)*
    - *RT communication, cyclic IO communication, parameter, alarms*
    - *Not recommended for use in industrial applications*
  - Class B (CC-B)
    - Requirements class A
    - Network diagnosis, topology information, system redundancy
    - Minimum requirement from hands-on experience at realizations
  - Class C (CC-C)
    - Requirements class B
    - Reserved bandwidth – IRT communication
    - Synchronization

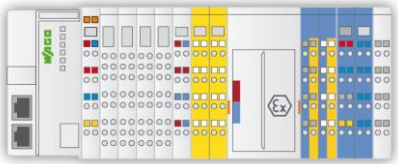
TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

- References “PROFINET fundamentals” – Notations

- IO-Controller (IO-C)
  - ➢ PLC used for cyclic data exchange



- IO-Device (IO-D)
  - ➢ “Decentralized periphery“, drives , …

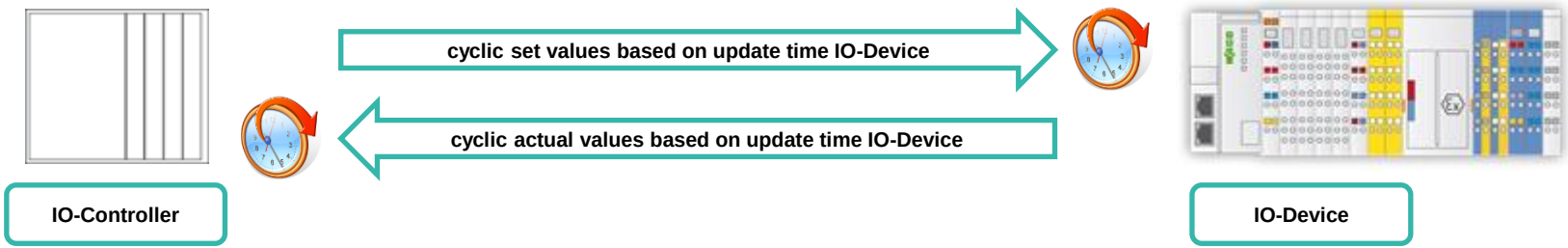


- IO-Supervisor
  - ➢ Tooling – parameterization, programming, start up,…

TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

- References “PROFINET fundamentals” – Data exchange (1)

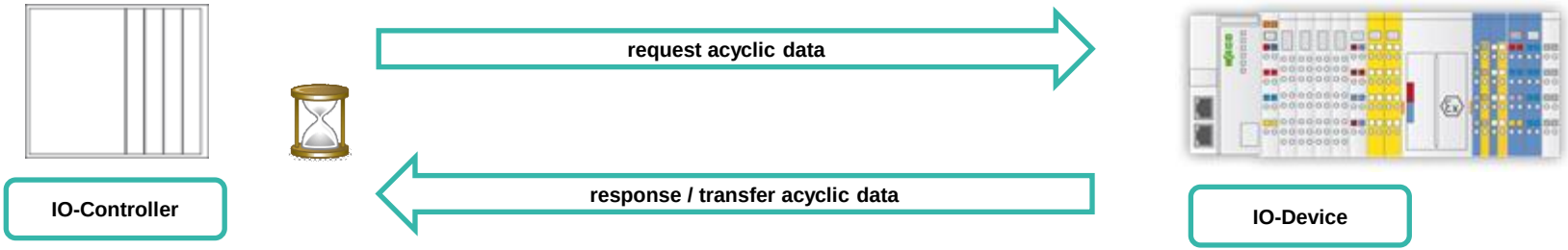
- Cyclic data exchange (IO-Data CR)
  - ➢ Data exchange between IO-Controller and IO-Device
  - ➢ Additional information transferred beside IO-Data
  - ➢ References
    - Update time defined per IO-Device
    - Timeout control realized per IO-Device



TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

- References “PROFINET fundamentals” – Data exchange (2)

- Acyclic data exchange (Record-Data CR)
  - Communication based on requests – no cyclic communication
  - Parameterization, configuration, read status information, manufacturer data set
  - References
    - Data exchange based on request
    - Transfer independent to defined update time IO-Device



TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

- References “PROFINET fundamentals” – Data exchange (3)

- Event-driven data exchange (Alarm CR)
  - ➢ Alarm concept for system and user defined events

  - ➢ References
    - Data exchange based on event
    - Evaluation at IO-Controller or IO-Supervisor

TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

- References “PROFINET fundamentals” – Data exchange (4)

- Data cross traffic – MCR (Multicast Communication Relation)
  - Direct cross communication between PROFINET devices
  - Reduction of network load by using MCR
  - References
    - Direct data exchange “without detour IO-Controller”
    - Cross communication based on communication relationships
    - Used at motion control applications

TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

- References “PROFINET fundamentals” – Assign device name (1)

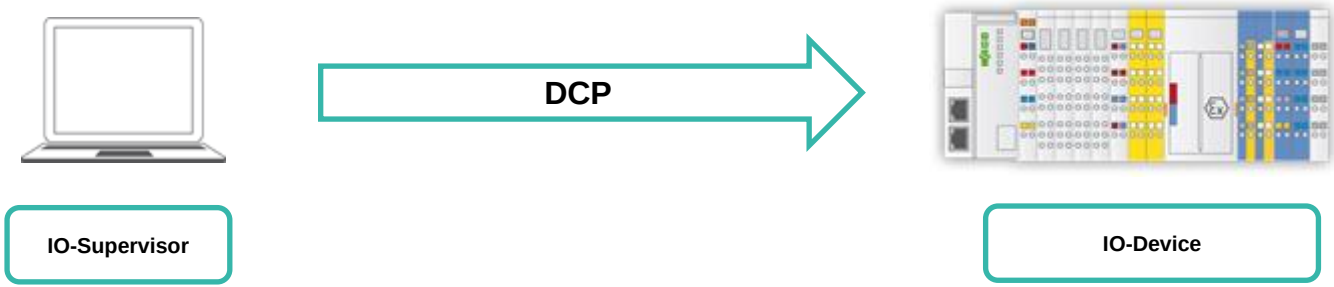
- General
  - PROFINET devices identified by individual and precise device name
  - IP address assignment based on device name

- Methods set device name
  - IO-Supervisor (PC)
    - Device name assigned with list of detected IO-Devices – based on MAC addresses
  - IO-Controller – based on defined set topology
    - Based on information neighborhood detection – device name assigned by IO-Controller automatically
  - DIP switch at IO-Device
    - Precise name of IO-Device with additional information at device name – special function at IO-Device

TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

- References “PROFINET fundamentals” – Assign device name (2)

- References assign device name with IO-Supervisor

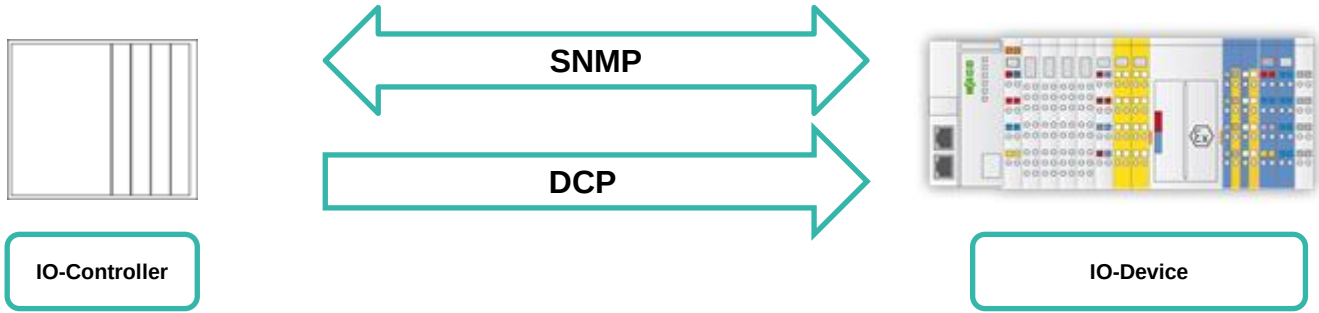


- ➢ Assignment with software tool and user
- ➢ Latest solution on the market
  - Network scan by user – result device list of available devices in combination with MAC address
  - Device name set by user based on MAC address
- ➢ Expensive at first start-up
- ➢ Source of trouble – wrong assignment between IO-Device and device name

TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

- References “PROFINET fundamentals” – Assign device name (3)

- References assign device name with IO-Controller



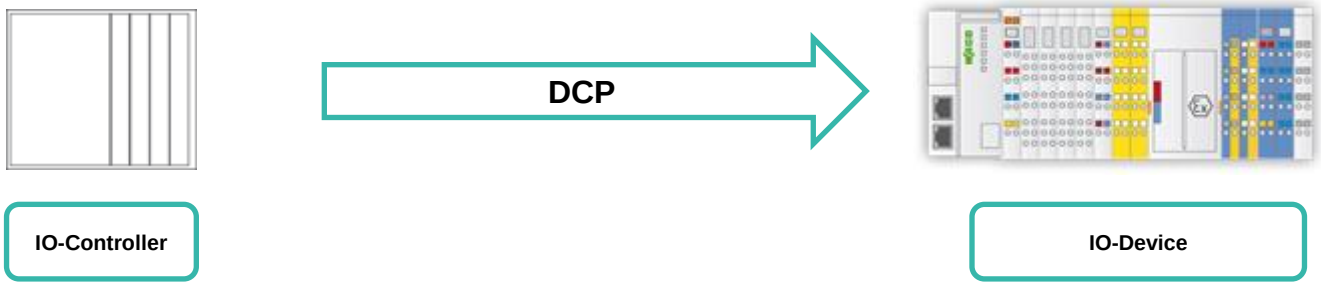
➢ Assignment with IO-Controller – based on defined set topology of application
  - Neighborhood detection based on LLDP (Link Layer Discovery Protocol)
  - Request of IO-Controller with DCP “defined station name” or “alias name“
  - “Alias name“ consists of information from “neighborhood detection”

➢ **Requirement minimum conformance class B for all components including switches**

TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

- References “PROFINET fundamentals” – Assign device name (4)

- References assign device name with DIP switch at IO-Device



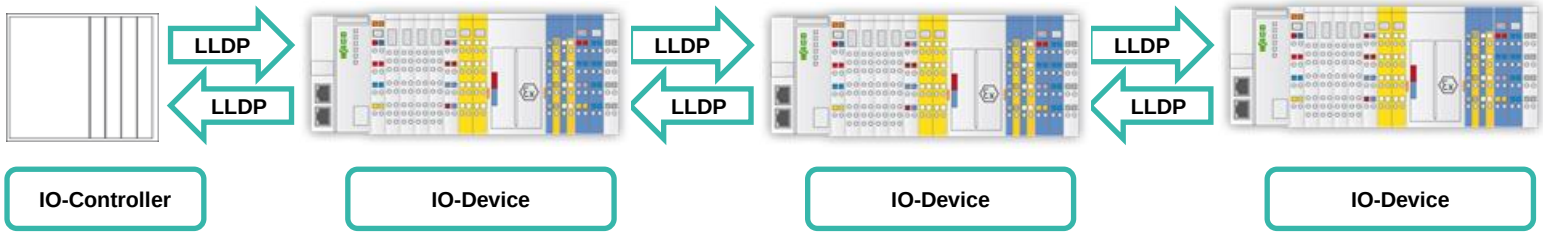
➢ Special function at IO-Device – no standard function
  - DIP switch defines name of IO-Device
  - Assignment of IP address with IO-Controller based on IO-Device name

➢ Workflow device replacement similar as using “PROFIBUS-DP slave“

TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

- References “PROFINET fundamentals” – Assign device name (5)

- References neighborhood detection with LLDP



- LLDP information transferred to neighbor by each device – periodic transfer
  - Result actual topology of network / application

- “Agents” at device receive LLDP information (MIB-2 data)
- Query of LLDP information with SNMP clients
- **All PROFINET devices with at least Conformance Class B (CC-B)**

SUMMARY

1. Fundamentals PROFIsafe
2. References “TIA – Application”
3. References “TIA – PROFINET – PLC”
4. References “TIA – PROFINET – IO-Device”
5. References “TIA – Safety-Administration”
6. References “PROFINET fundamentals”
7. References “PROFINET conformance classes”
8. References “PROFINET communication”

TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

- References “PROFINET conformance classes” – Overview

- Conformance Classes / power class – PROFINET devices
  - *Class A (CC-A)*
    - *RT communication, cyclic IO communication, parameter, alarms*
    - *Not recommended for use in industrial applications*
  - Class B (CC-B)
    - Requirements class A
    - Network diagnosis, topology information, system redundancy
    - Minimum requirement from hands-on experience at realizations
  - Class C (CC-C)
    - Requirements class B
    - Reserved bandwidth – IRT communication
    - Synchronization

TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

- References “PROFINET conformance classes” – Conformance class A – CC-A

- IEEE802.3 network with PROFINET real time communication
  - Auto negotiation and auto crossover
  - 100 Mbit/s full duplex

- Optional services possible (MRP, MCR, iPar-Server,…)
- Data exchange via copper cable, fiber optic or wireless

- Function and technology restrictions
  - Device exchange without tooling not possible
  - Set device name by PROFINET IO-Controller automatically not possible
  - Restricted diagnosis information
  - TCI CC3 communication not guaranteed
  - **Security Problem – All communication ports available without restrictions**
- **Not recommended for use in industrial applications**

TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

- References “PROFINET conformance classes” – Conformance class B – CC-B

- Range of functions conformance class A
- LLDP-MIB and MIB2 supported (frames neighborhood detection)
- Handling like “PROFINET IO-Device”
  - GSD file with GSDML format necessary
  - **Certification necessary**

- Functions and technologies
  - Device exchange without tooling possible
  - Set device name by PROFINET IO-Controller automatically
  - Topology detection and large-scale diagnostics
  - TCI CC3 communication available

- **Recommended** for use in industrial applications

TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

- References “PROFINET conformance classes” – Conformance class C – CC-C

- Range of functions conformance class B
- Synchronized data exchange (IRT, MRPD)
- Handling like “PROFINET IO-Device”
  - GSD file with GSDML format necessary
  - **Certification necessary**

- Functions and technologies
  - Device exchange without tooling possible
  - Set device name by PROFINET IO-Controller automatically
  - Topology detection and large-scale diagnostics
  - TCI CC3 communication available

TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

- References “PROFINET conformance classes” – References realizations (1)

- General overview

Function / requirement	Requirement's configuration	Comments
Support device replacement without exchangeable medium (LLDP functions)	• LLDP function activated at IO-Controller • Set topology mandatory at application • PROFINET CC-B switch part of set topology • Adjust port settings per IO-Device	• IO-Devices complies PROFINET CC-B requirements • Switches comply PROFINET CC-B requirements • Set topology mandatory
Assign IO-Device name with PROFINET IO-Controller	• Requirements “Support device replacement without exchangeable medium” • LLDP functions	• Pay attention to “Support device replacement without exchangeable medium”

TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

- References “PROFINET conformance classes” – References realizations (2)

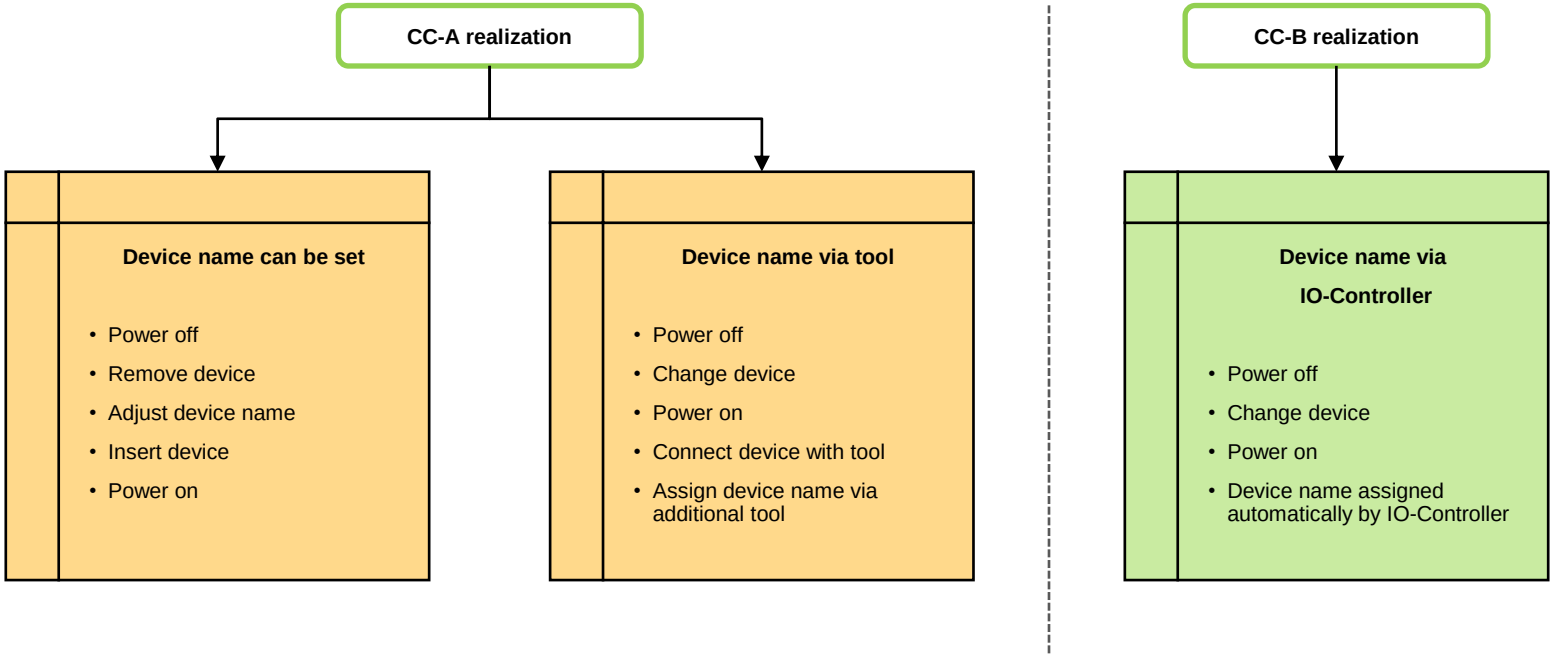
- General overview

Function / requirement	Requirement's configuration	Comments
Using PROFINET with conformance class A (CC-A) components **Not recommended for use in industrial applications**	• Deactivation of LLDP function at IO-Controller	• Assign PROFINET IO-Device name with tooling per IO-Device (Option WAGO IO-Device naming via DIP switch)
	• Remove set topology at application • Adjust port settings per IO-Device	• Replacement of IO-Device only with additional tooling (Exception: WAGO IO device naming via DIP switch)
	• Pay attention to PROFINET regulations of PROFIBUS and PROFINET International	• Adaptation of the application for the implementation of the missing diagnostic functions in the area of communication
	• Check PROFINET network load factor (Automatic check at application in combination with CC-A realizations with engineering impossible)	• Network overload possible • Stable PROFINET communications and functions are not possible • Parameterizations in combination with TCI interface without functional guarantee
	• **Security Problem – All communication ports available without restrictions**	• **Observing security requirements for PROFINET IO controllers in CC-A applications – Manufacturer's manual**

TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

- References “PROFINET conformance classes” – References startup / replace IO-Device

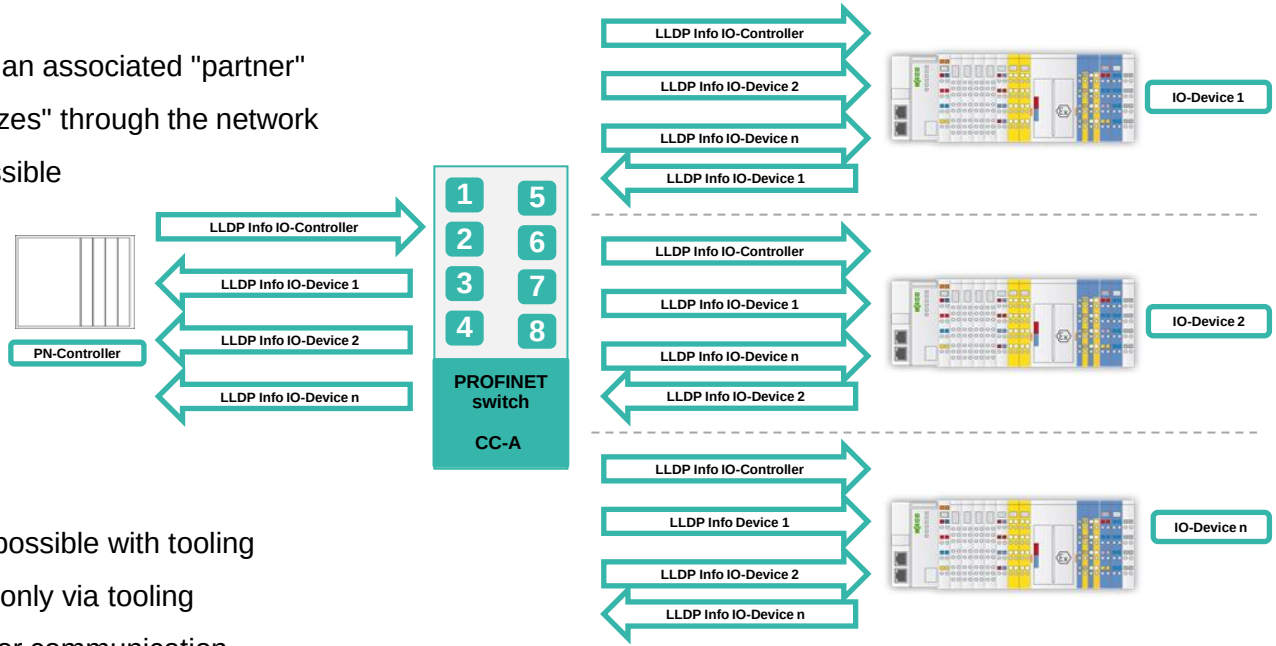
- Overview



TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

- References “PROFINET conformance classes” – References network load at CC-A realization

- General principles
  - PN Device does not have an associated "partner"
  - All LLDP information "buzzes" through the network
  - No topology detection possible

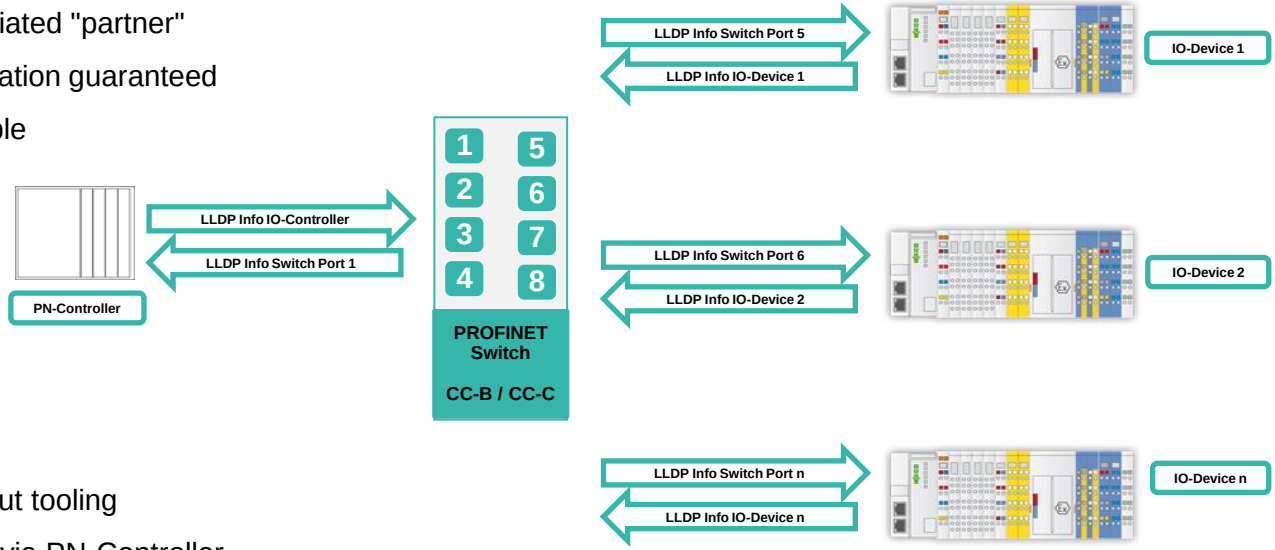


  - Device replacement only possible with tooling
  - Device name assignment only via tooling
  - No diagnostics available for communication
  - **Shutdown LLDP function recommended to reduce network load**

TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

- References “PROFINET conformance classes” – References network load at CC-B realization

- General principles
  - PN Device have an associated "partner"
  - Exchange of LLDP information guaranteed
  - Topology detection possible



  - Device replacement without tooling
  - Device name assignment via PN-Controller
  - Diagnostics about communications available
  - **Recommended** for use in industrial applications

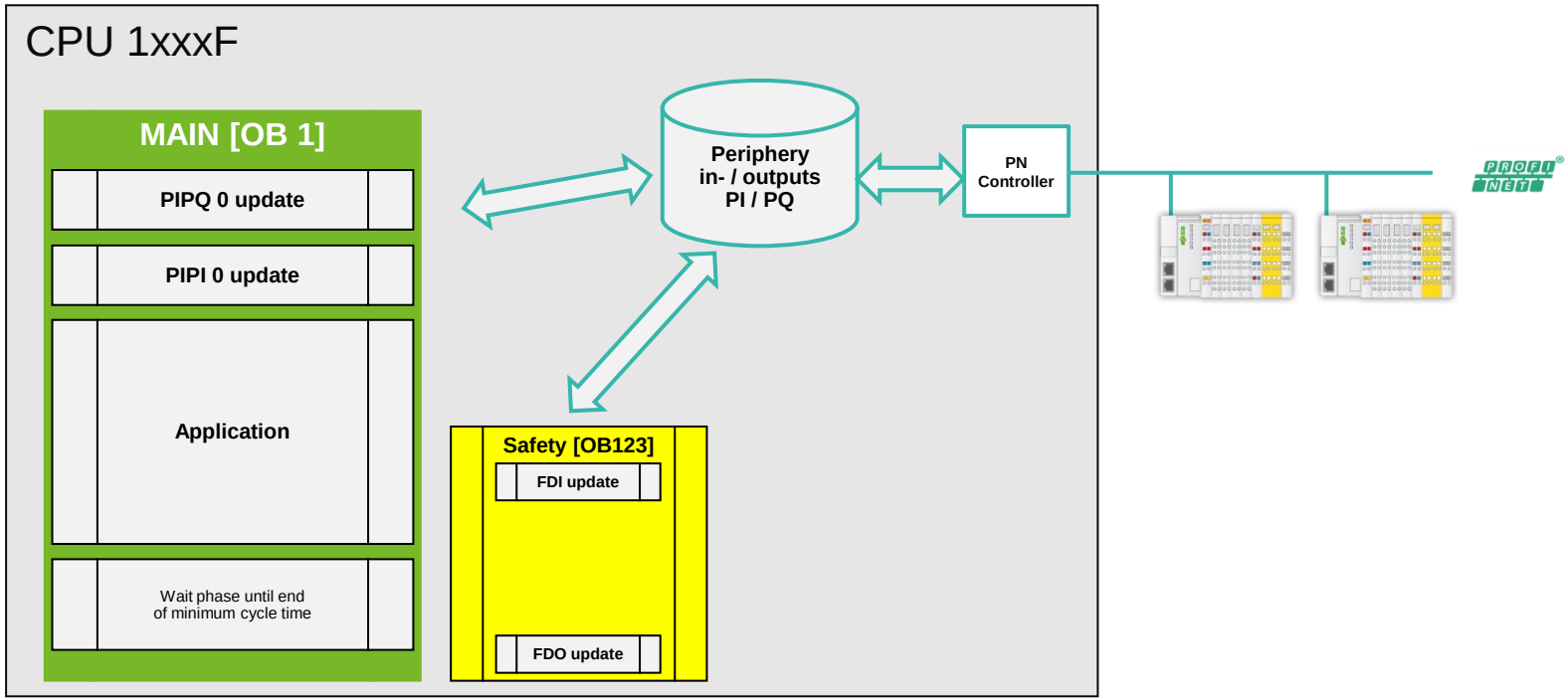
SUMMARY

1. Fundamentals PROFIsafe
2. References “TIA – Application”
3. References “TIA – PROFINET – PLC”
4. References “TIA – PROFINET – IO-Device”
5. References “TIA – Safety-Administration”
6. References “PROFINET fundamentals”
7. References “PROFINET conformance classes”
8. References “PROFINET communication”

TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

- References “PROFINET communication” (1)

- Global overview PROFINET IO values at safety application



TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

- References “PROFINET communication” (2)

- References “PROFINET controller”
  - Independent controller – PROFINET communication to IO-Devices
  - PROFINET network management

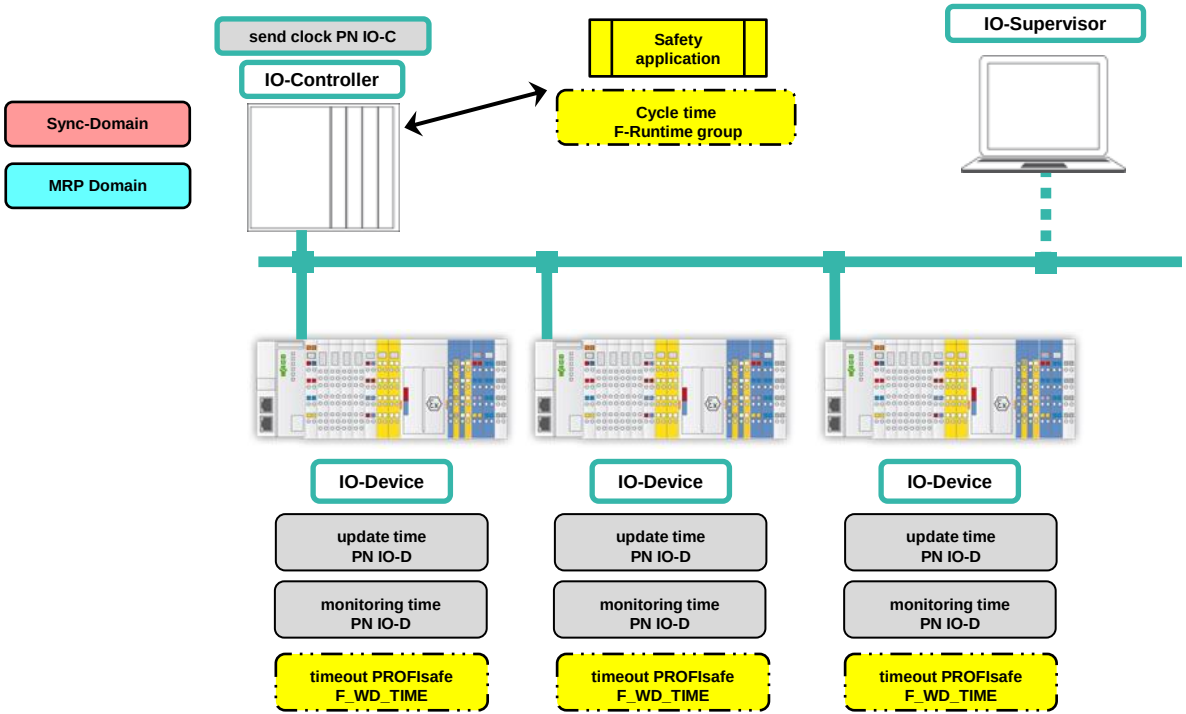
- References “IO update” at “MAIN [OB1]
  - Update PIPQ 0 – Write outputs
  - Update PIPI 0 – Read inputs
    - Update FDI values based on “MAIN[OB1]” cycle – Differences to “IO update” at “Safety” possible

- References “IO update” at “Safety [OB123]
  - Update safety inputs
  - Processing safety application
  - Write safety outputs

TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

- References “PROFINET communication” (3)

- Global overview PROFINET application



TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

- References “PROFINET communication” (4)

- **send clock PN IO-C**
  - “Send clock” settings for PROFINET IO-Controller
  - Update time PROFINET IO-Device based on “send clock” PROFINET IO-Controller

- **update time PN IO-D** **monitoring time PN IO-D**
  - Update time PROFINET IO-Device parameterizable
    - Automatic – calculation at “save and compile”
    - Set value by user per IO-Device at device configuration
  - Set value monitoring time / watchdog PROFINET IO-Device
    - Communication monitoring per PROFINET IO-Device
    - Behavior IO-Device at communication error parameterizable

TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

- References “PROFINET communication” (5)

- **Sync-Domain**
  - Settings if PROFINET IRT used
    - All PROFINET devices offer conformance class C – CC-C

- **MRP Domain**
  - Settings if MRP used at PROFINET RT
    - All PROFINET devices offer minimum conformance class B – CC-B

TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

- References “PROFINET communication” (6)

- **Cycle time F-Runtime group**
  - Set value at “Safety Administration” TIA application
  - Cycle time F-Runtime group with influence to monitoring time F_WD_TIME

- **timeout PROFIsafe F_WD_TIME**
  - Monitoring time PROFIsafe communication
  - Set value per PROFIsafe device
    - Practical experience F_WD_Time > at least 3(4)x cycle time F-Runtime group
    - F_WD_TIME set per PROFIsafe device or global setting
  - Note using MRP with PROFINET RT
    - Set value F_WD_TIME > 200 ms – maximum of switch time of MRP if cable break
    - Safety calculation based on “long” F_WD_TIME if MRP used

TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

- References “PROFINET communication” (7)

- References send clock, reduction ratio and send cycle
  - ➢ **send clock PN IO-C**
    - “Basis clock rate” for data exchange with time base 31,25 µs
    - Update time and monitoring time of IO-Devices based on send clock PROFINET IO-Controller

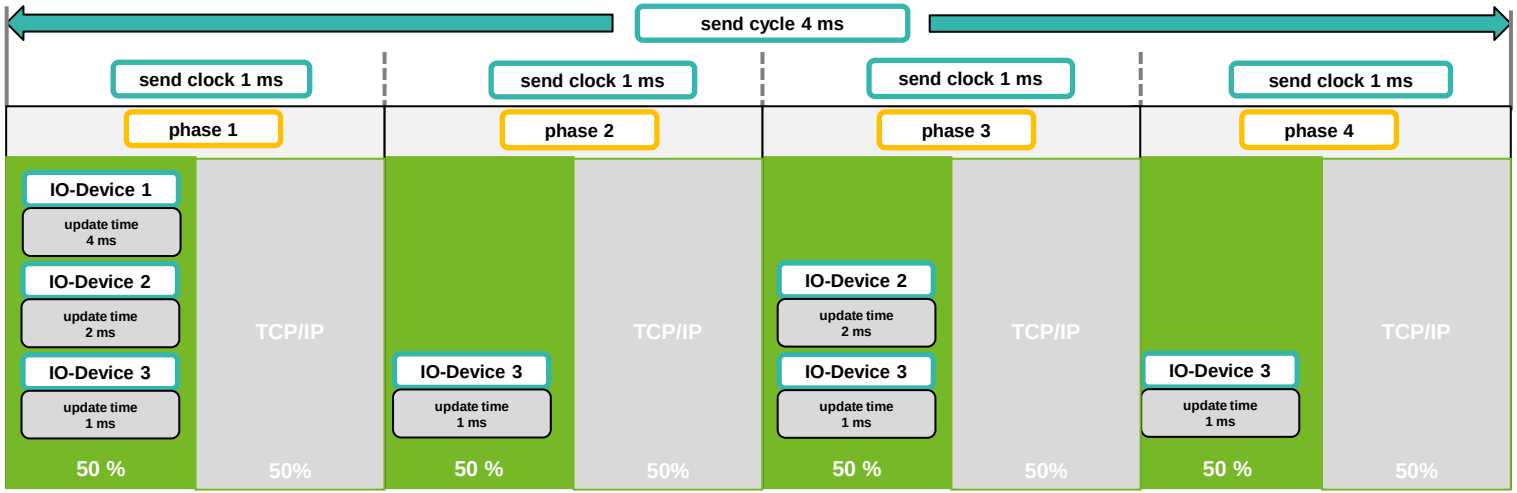
    - “Reduction ratio“
      - Factor next cycle of data exchange
      - Reduction ratio defined as multiplier to send cycle

    - Communication phase
      - Phase is part of send cycle
      - $Amount\ of\ phases = \frac{max.\ SendCycle}{min.\ SendCycle}$
      - IO-Devices assigned to relevant phases automatically at TIA

TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

- References “PROFINET communication” (8)

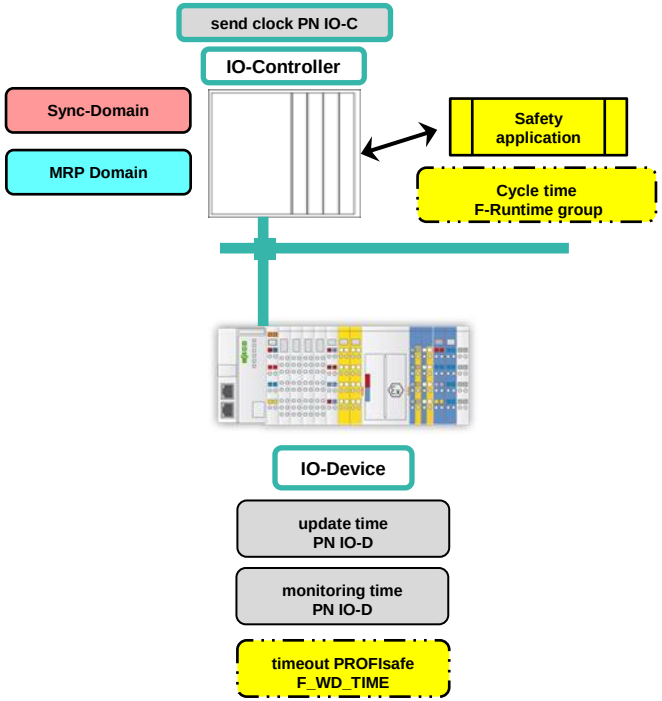
- Example
  - 3x PN IO-Device with update time 4 ms, 2 ms , 1 ms
  - Send clock IO-Controller 1 ms – send cycle 4 ms
  - Communication phase per 1 ms

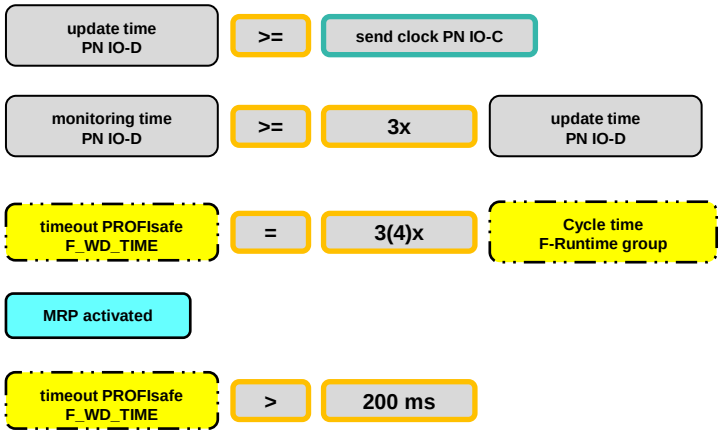


TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

- References “PROFINET communication” (9)

- Summary Global overview PROFINET application



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TROUBLESHOOTING PROFISAFE MODULES G4 – PROFISAFE TIA

Version information

Date	Version	
29.01.24	0.0	• 1st version