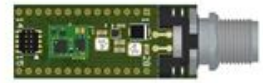

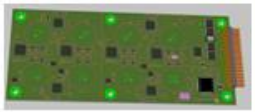

Technologie
Management Gruppe
Technologie und Engineering

Industrial Communication Technology

TMG Technologie und Engineering

We make technology work for you.

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Consulting

Development

Products

30 Years
Enabling Technology

PROFINET® PROFIBUS®

Accredited as
PROFIBUS & PROFINET
Competence Center

IO-Link

Accredited as
IO-Link
Competence & Test Center

EtherNet/IP™

EtherCAT®

functional safety

PROFIsafe

Safety over EtherCAT®

IO-Link safety

device engineering, IoT and edge gateways

- Device Engineering Tools
- Communication Drivers
- WEB Services
- Cloud Services
- IT Integration

TCI TOOL CALLING INTERFACE

SMI-TCP

MQTT

TMG-UDP

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Our Range of Services - TMG Technologie und Engineering GmbH

Consulting

- Workshops and Technology Trainings
- Realization of system and architecture analyses
- Problem oriented choice of technology

Development

- Specification and design
- Development and integration of software solutions
- Embedded Software Development
- Third party certification support

Products

- Industrial Communication Stacks
- Engineering & Test Tools
- IO-Link Master & Device Products

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The complete Story : Industrial Communication @ TMG TE GmbH

Engineering, Operating and Observing

Cloud

IOT
Industrie 4.0

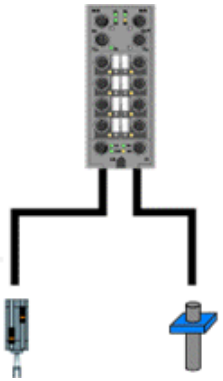
PLC/Control

Big Data

Edge Gateways

MES / ERP

Real Time Fieldbusses



IO-Link

Functional Safety

Production Floor

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Member & Partner Ship

Technology

molex
one company › a world of innovation

maxim integrated™

RENESAS

Texas Instruments

Distribution & Services

MKY LLC

JSL Technology

HongKe 虹科

Membership

ODVA

PI
PROFIBUS · PROFINET

IO-Link

EtherCAT®
Technology Group

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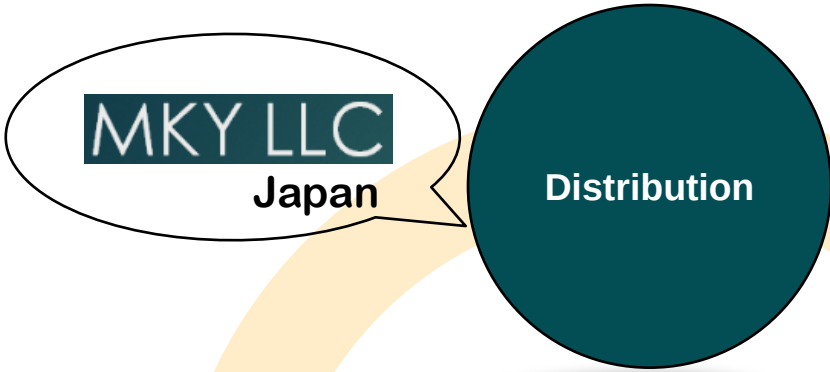
Partnership for Services and Distribution in ASIA : MKY LLC, JSL, HongKe, TMG TE GmbH

A strong Partnership for Industrial Communication



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Industrial Communication Competence Center - TMG Technologie und Engineering

Consulting

- Business Area Planning
- Choice of Technology
- Platform Concepts
- Choice of Technology Components
- Trainings & Workshops

Certification and Test Support

- Expertise
- Interoperability Tests
- Operate demo systems
- Certification support
- IO-Link Device Test System
- Accredited as **IO-Link Test Center** (Master and Devices)

Engagement in PI, ODVA, ETG & IO-Link Community

- Collaboration in many technical and marketing working groups
- Member of IO-Link steering committee
- Collaboration in user and development workshops of IO-Link and PROFINET

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Technology Components

- IO-Link Master and Device Stacks (IO-Link & IO-Link Safety)
  - For many µController platforms, IDE and transceiver chips
  - Globally leading
- Fieldbus Integration
  - PROFINET, PROFIBUS, EtherNet/IP, EtherCat and others
- Master Manufacturer and Fieldbus Crossing Engineering Tool
- IO-Link Device Test System (also for IO-Link Safety)
  - Released by IO-Link Community. Binding prescribed for manufacturer declaration.

- PROFINET IO Device Stack (CCB, CCC)
  - System Redundancy S2 and Dynamic Reconfiguration

powered by molex

- EtherNet/IP Adapter Stack

- PROFIBUS DP/PA Slave Stacks
  - Without the need of an ASIC
- PROFIBUS Master Stacks

- FSOE Master and Slave Stacks

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… Device Development and Technology Integration
respectively for Industrial Information and Communication Technology by …

- Realization of system and architecture analyses
- Problem oriented technology choice
- Specification and design
- Development and integration
- Porting and integration of software solutions
- Third party certification support
- Technology trainings und technology workshops

- Even if hardware development is not our core competence we help to review our customer's hardware designs for communication aspects and we offer hardware development together with partners

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Integration know how

- For many different hardware and software architectures
  - Micro controllers 8,16 and 32 bit
    - Altera, Analog Devices, Cypress, Hilscher, Infineon, Intel, Maxim, Microchip, Microchip-ATMEL, NXP, Renesas, Siemens, STMicroelectronics, Texas Instruments, Xilinx and others
  - All IO-Link transceiver manufacturers
    - Maxim, Texas Instruments, STMicroelectronics, Dialog and others
- Use of many different compiler and development systems
  - Atmel Studio, Code Composer Studio, E2 Studio, Eclipse and GNU based IDEs, IAR, Keil, Visual Studio and others
- For many different embedded real time operating systems
  - Thread X, VxWorks, Linux, PxROS, EMBOS, ECOS, RCX, FreeRTOS, QNX, Sciopta and others

Also with communication stacks or ASICs from partners

- Ethernet & Internet technologies
  - TCP/IP, UDP, WEB server, FTP, SNMP, SMTP, NTP, IOT, MQTT, JASON and others
  - SPE, APL, WIFI, Bluetooth

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TMG TE Software Development Process

Edition: 17th July 2011

Technologie Management Gruppe Karlsruhe

Phases	Requirement Specification Phase	Design Specification Phase	Implementation Phase	Integration Phase	System Test Phase	Certification Phase	Project Release
Main Tasks	Requirement specification	Specification	Implementation	Integration	System test	Support of certification	Lessons learned
		Module specification	Development test	Integration test	Preparation of certification		
		Test specification	Module test implementation				
		Module test specifikation	Module test processing				
			User documentation				
Guidelines	Template Reqirement Matrix	Specification-Template.doc ModuleSpec-Template.doc TestSpec-Template.xls	Codierungsrichtlinie TMG				
Tools	Excel	Word / Exel	Doxygen (if available for the IDE)				
					optional		mandatory

- Mandatory marked tasks should be documented at TMG TE or customer
- Optional tasks will be processed, if required, offered and ordered
- The listed guidelines and tools will be used, if there is no other requirement by the customer
- Software Development Process for functional safety available (experience 10 years)

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PROFINET IO Device Stack

- Compatibility to PROFINET
  - PROFINET Version V24MU1_Mar20, test bundle 20200520
- Functionality
  - Conformance Class A, B, C (IRT with Sitara/AMIC from Texas Instruments)
  - Features: Fast Start Up, Shared Device, Device Access, MRP (Medium Redundancy)
  - System Redundancy S2, Dynamic Reconfiguration and multi Instances for PA Profile 4.0
  - Prepared for Profiles/API like PROFIsafe, PROFIenergy and IO-Link Integration
  - Used in first applications with APL (Advanced Physical Layer)
- Portable to many platforms
  - RTOS like FreeRTOS, embos, TI RTOS, sciopta or Linux with preemptive RT patch
  - Multiprotocol platforms like TI Sitara/AMIC or Renesas RZ/N
  - Single Chip Microcontroller STM32 M3, M4, H7 / Rx6xx / PIC32

    With and without external switches e.g. microchip KSZ8863
- Small Footprint (Code ~ 300 Kbyte, RAM > 250 Kbyte RAM)

powered by molex

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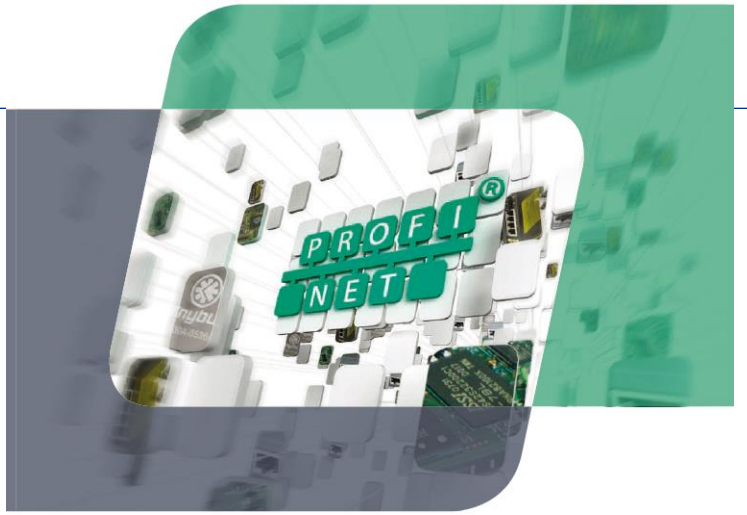
PROFINET IO Device (with and without) IRT



… **PROFINET device implementation** respectively for factory automation and process automation …

- PROFINET IO Device Stack
  - Reference certification according Conformance Class A, B, C
- PROFINET IO-Link Integration ED2 V1.1
- Reference designs with Renesas and Texas Instruments
- Projects with functional safety / PROFIsafe & IO-Link Safety
- Projects with netX from Hilscher
  - As well with other protocols like EtherNet/IP, MODBUS-TCP, EtherCAT, PowerLink …

powered by molex

RENESAS

Texas Instruments

PROFIsafe

hilscher COMPETENCE IN COMMUNICATION

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… EtherNet/IP development also combined with internet technology and other industrial protocols

- EtherNet/IP Adapter Stack
  - Easy to port to different platforms
  - Platform packages for Renesas RZ/N
  - Sample integration (SDK) for Texas Instruments Sitara/AMIC

powered by molex

- We took over the development, support and sales from Molex in 2018

EtherNet/IP™

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PROFIBUS technology realized by TMG

… **PROFIBUS DP V1 slave implementation** respectively for factory and process automation …

- Solutions with SPC4 and SPC3 ASIC from Siemens
- Solutions for PROFIBUS PA with SPC4, Find 1, Finch, ..
- Solutions for PROFIBUS DP 12 MBaud without special ASIC on microcontrollers from

.. and others

- Software stack developed by TMG
- More than 25 years experience as well as large world wide market share

… **PROFIBUS DP V1 master implementation** respectively for factory and process automation …

- Solutions with ASPC2 ASIC of Siemens
- Solutions for PROFIBUS PA with SPC4 or Find 1
- Solutions for PROFIBUS DP V1 without special ASIC (Mono Master)
- Software stack developed by TMG

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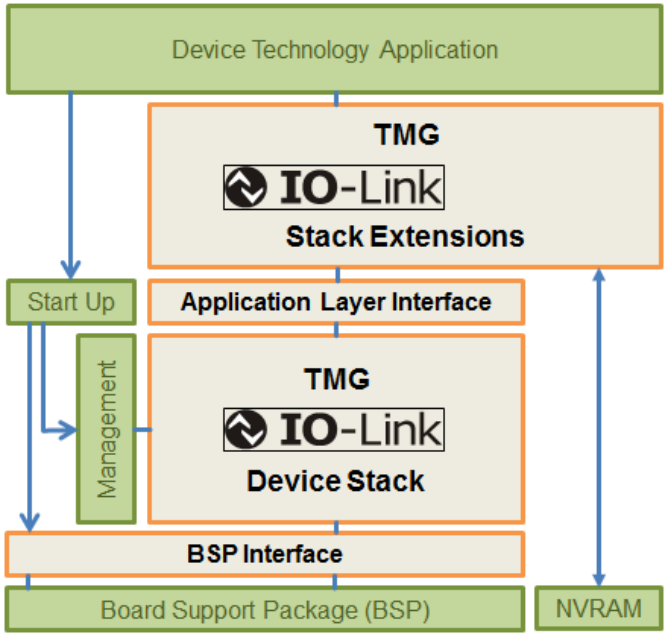
- **IO-Link V1.1.2 Device Stack** (V1.1.3 in preparation)
  - complete functionality, all telegram types
  - supports also IO-Link V1.0 masters
  - easy to port to all microcontrollers (8/16/32)
  - works with all transceivers
  - very small footprint
  - configurable to specific device application



- **IO-Link V1.1.2 Stack Extensions** (V1.1.3 in preparation)
  - Implements the IO-Link related device application with
    - Parameter Manager, Data storage, Block Parameterization,
    - Device Access Locks, Event Dispatcher,
    - Device Status and Detailed Device Status
    - Parameter Consistency Check, Reset to factory settings
  - Production settings (like serial number, calibration and pre parameterization of variants
  - Best practice implementation proved in many customer projects

- **IO-Link Device – Firmware Update**
  - Firmware download via IO-Link boot loader
  - Supported from IO-Link Device Tool V5.1
  - Firmware Packager based on IODD; supports firmware encryption

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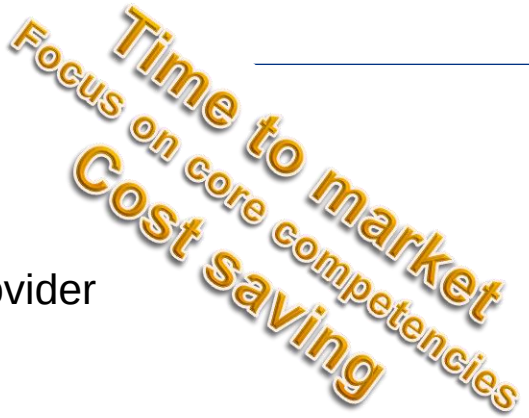
IO-Link Device – Technology Enabling Projects



We help our customers to start with IO-Link

Target of the enabling project is know how transfer

Further developments should be possible without the help of a service provider

- IO-Link Technology Workshop
  - Overview for developers, product managers, support and test
- IO-Link Device Specification Workshop
  - Use innovation potential of IO-Link instead to provide only existing functionality
  - The target is to work all requirements to create the IODD and start integration
- Integration of IO-Link related software on target hardware
  - Create IODD and coordinate with the product management of our customer
  - Board support, IO-Link communication, IODD implementation, Interface to device application
  - Functionality for End of Production Settings (like serial no, calibration, …)
  - Preliminary IO-Link conformance check
- Software Hand over Workshop
  - Software handover and introduction in application interface and device test
- Conformance Test or conformance test workshop

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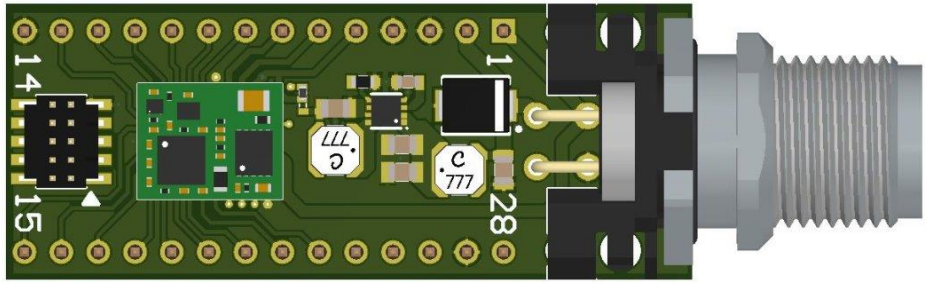
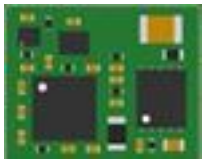
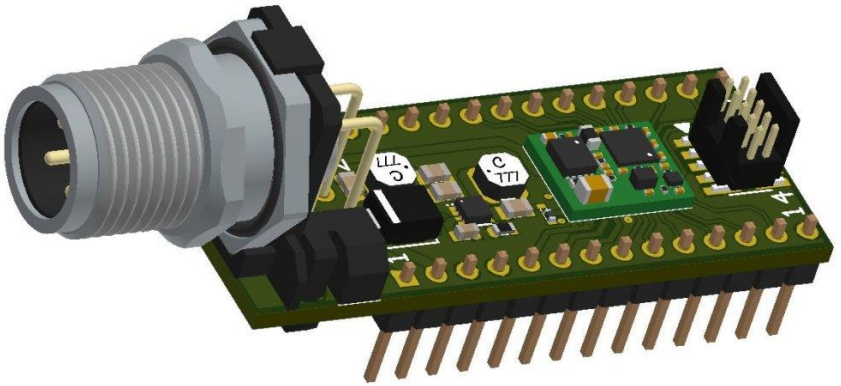
IO-Link Device Module Type 1







- Cortex M4 – (up to 120MHz)
- For automatically population
- Delivery on reel
- Break out board for prototyping and evaluation
- 8mm x 10mm
- Product variants
  - With IO-Link Software
  - Evaluation Board

- IO-Link Device V1.1.2 (V1.1.3 in preparation)
- All IO-Link functions like Data Storage, Block Parameterizing and Diagnosis, Common Profile
- Firmware Update, End of Production Line Parameterization
- Several generic configurable basic applications available; customizing possible
- Serial communication to application controller

available soon

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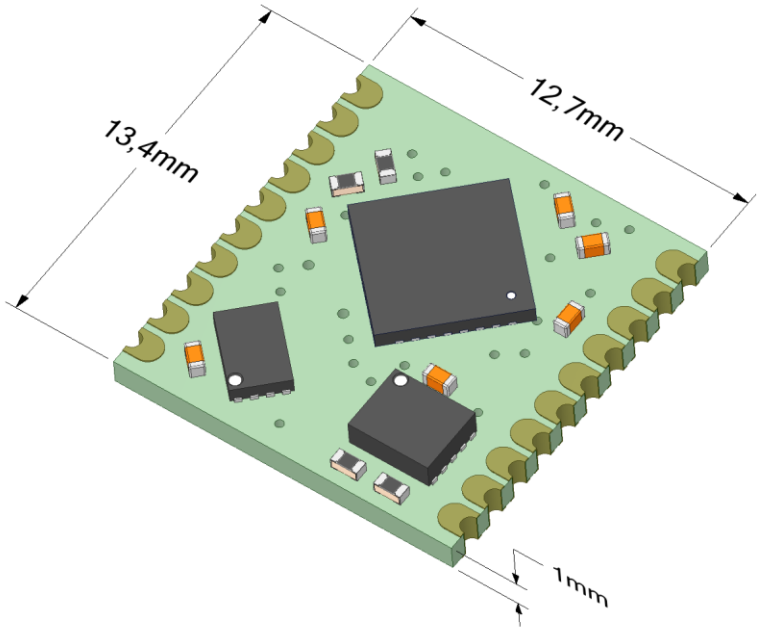
IO-Link Device Module Type 2



- Cortex M4 – (up to 72MHz)
- Easier population
- Delivery on reel
- Simplified prototyping and evaluation by using pin headers
- 12,7mm x 13,4mm

- IO-Link Device V1.1.2 (V1.1.3 in preparation)
- All IO-Link functions like Data Storage, Block Parameterizing and Diagnosis, Common Profile
- Firmware Update, End of Production Line Parameterization
- Several generic configurable basic applications available; customizing possible
- Serial communication to application controller

available soon

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IO-Link Master Technology from TMG (1)

- **IO-Link V1.1.2 Master Stack** (V1.1.3 in preparation)
  - supports all telegram types (230kBit/s, 400µs cycle time)
  - easy to port to several microcontrollers
  - Includes parameter server (data storage)
  - Already implemented to V850, Rx, RZ/N , 78K0R, 80C164, PIC32, STM32, R32, ARM9, CORTEX M3/M4, Sitara/AMIC and others
  - Support of many master transceivers
  - Number of ports depends only on µC resources

- **IO-Link V1.1.2 In Design Solution** (V1.1.3 in preparation)
  - based on STM32 Cortex M4 and Maxim Transceiver
  - 2, 4 or 8 ports
  - SPI communication to host controller
  - Host library, portable, ANSI-C Source Code
  - Pre certified with TMG test report
  - Can be evaluated with
    - MAXIM MAXREFDEF165#

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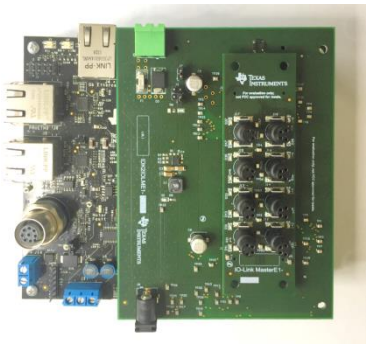
IO-Link Master Plattform Solutions

- Texas Instruments – Sitara AM 437 – Evaluation Board
  - 8 Channel IO-Link Master with TI device Phy IOL111
  - PROFINET (EtherNet/IP and EtherCat)
  - TMG Interface Protocol and IO-Link Device Tool V5.1 – Professional Edition
  - We did also IO-Link Master on AM335 with Maxim transceiver

- Renesas RZ/N 1S, 1D
  - 8 Channel IO-Link Master with Chreative or Maxim Master Transceiver
  - PROFINET, EtherNet/IP and EtherCat
  - TMG Interface Protocol and IO-Link Device Tool V5.1 – Professional Edition



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IO-Link Master Technology from TMG (2)

- **IO-Link Device Tool Communication Protocol**
  - Fieldbus independent protocol for
    - IO-Link Device Tool
    - Master Test
    - Industrie 4.0 applications, 2nd Channel
  - Based on UDP
  - New version in preparation “SMI-TCP”
    - based on TCP/IP
    - Standard Master Interface (SMI)
    - Modular Systems
    - Support of sub networks

- **Fieldbus Integration**
  - Based on Standard Master Interface (SMI)
  - PROFINET
    - Integration specification ED 2
  - EthetNet/IP
  - EtherCat, MODBUS TCP, Powerlink
  - PROFIBUS
  - and others

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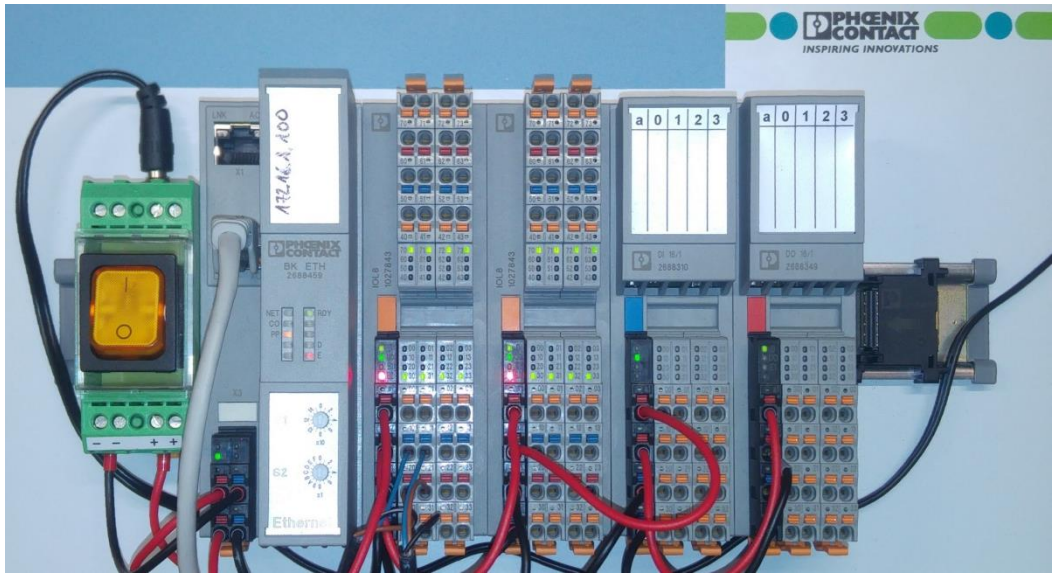
SMI-TCP

- IO-Link Device Tool V5.1 - PE
- IO-Link Master Test
- Industrie 4.0 and IOT applications
  - 2nd Channel, Y-Connection
- based on
  - TCP/IP
  - Standard Master Interface (SMI)
    - Mandatory with IO-Link V1.1.3
- Support of
  - Modular IO Systems
  - Sub networks (up to 3 levels)
- Small footprint
- Open specification



IO-Link

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Master manufacturer and fieldbus crossing operation

- According to the requirements of the automotive industry
- Executable as independently Windows application
- Integration into PLC engineering tools like TIA Portal

IO-Link master / port configuration

- Operation of IO-Link master without PLC possible
- Master Plug-In for customizing
- Data Storage content transfer and storage
- Multiple Communication interfaces available
  - USB, UDP, TCP/IP, TCI-Communication-Server, Customized interfaces possible

IO-Link device operation and observation

- IODD V1.0.1 / V1.1 interpreter
- All IO-Link devices world-wide without restriction
- Open IO Device GUI (Extension for graphical user interface)
- IODD Viewer
- IO-Link Device Firmware Update Support
- IO-Link Safety (parameterization and commissioning)
- IODDFinder Support

OEM Version possible

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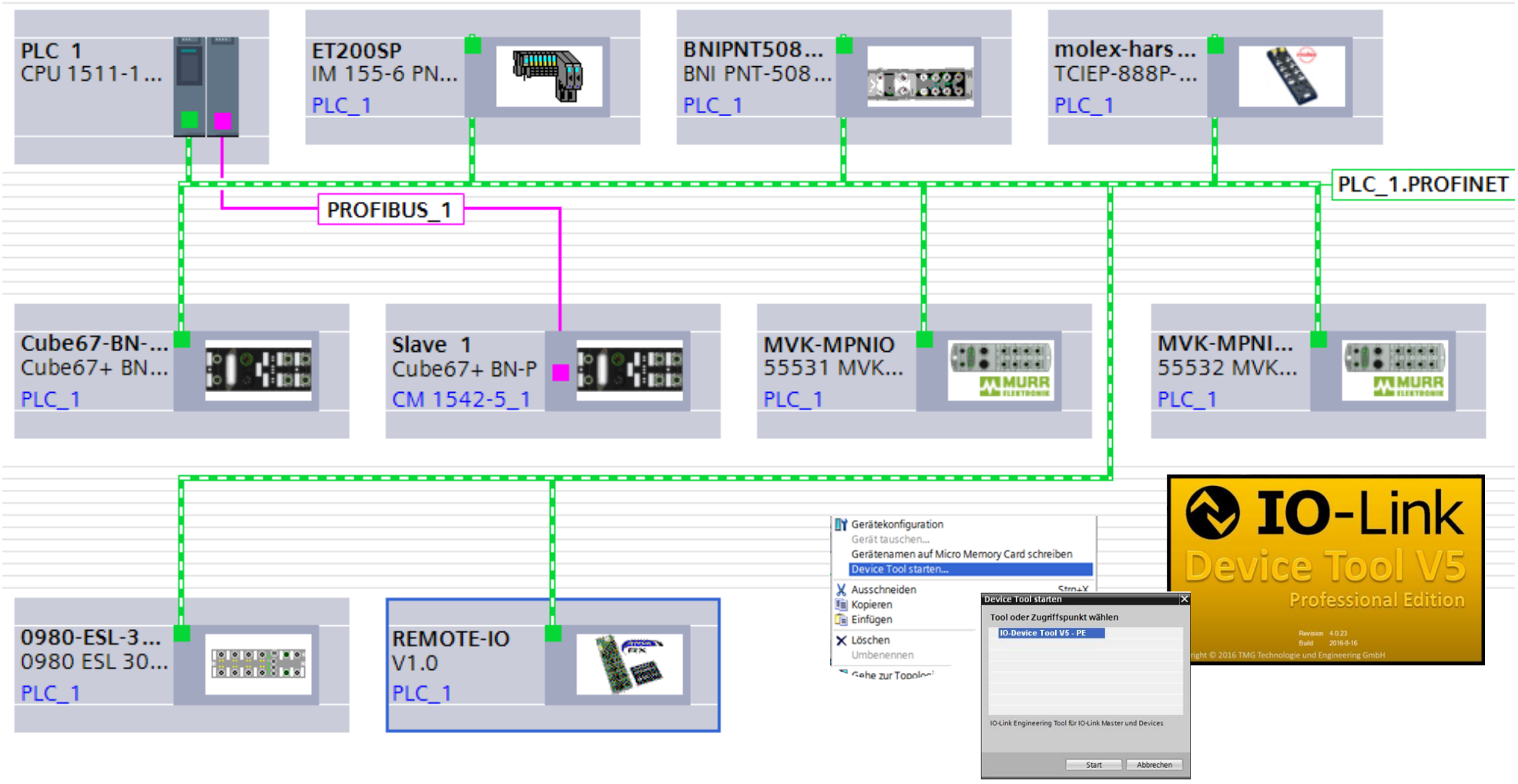
IO-Link Device Tool – TCI : Call from PROFINET/PROFIBUS Configuration



- PROFINET & PROFIBUS Hardware Configuration with IO-Link masters of multiple vendors
- Supported from IO-Link Device Tool – use right mouse click „Start Device Tool“

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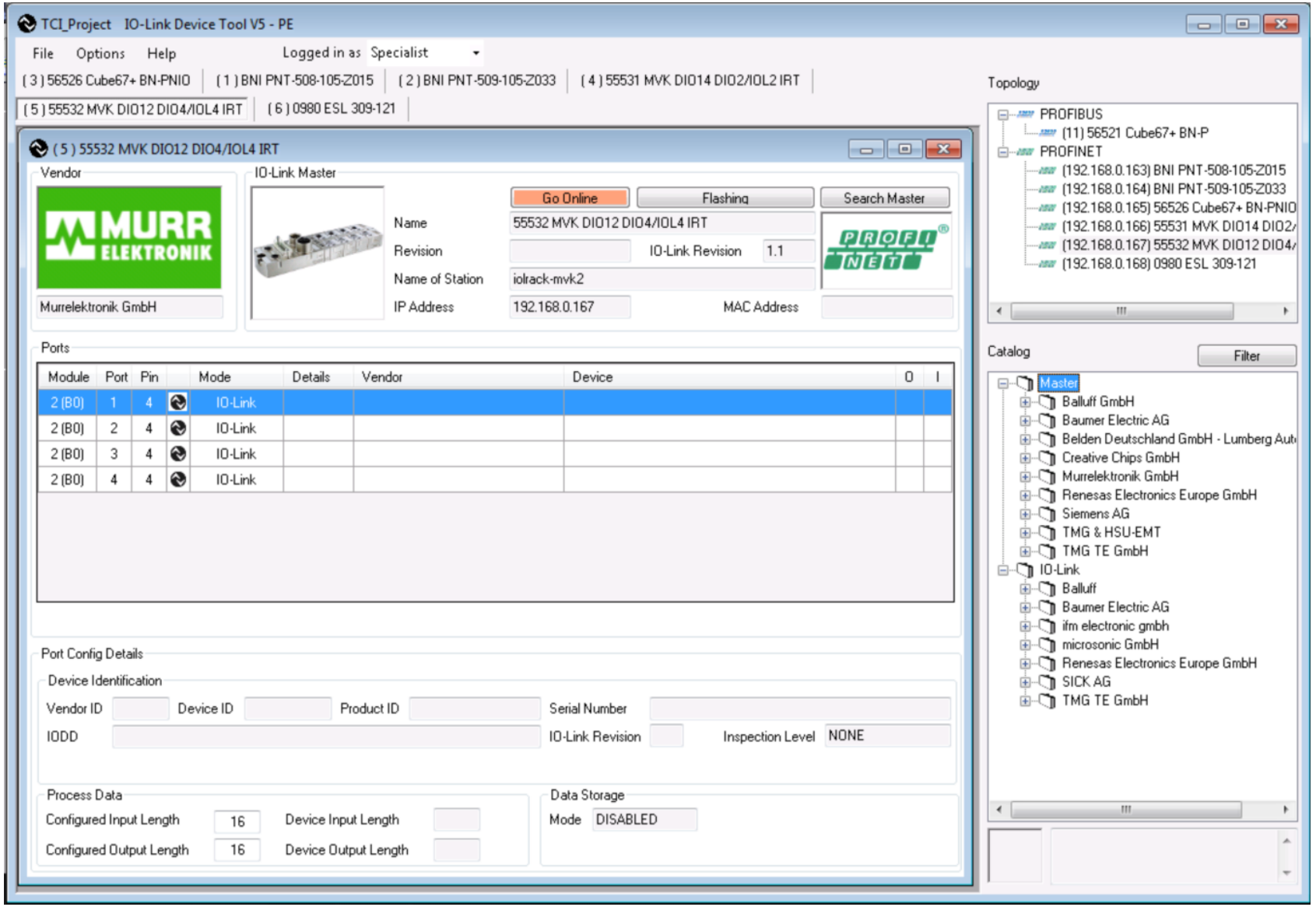
IO-Link Device Tool – TCI : Call from PROFINET/PROFIBUS Configuration



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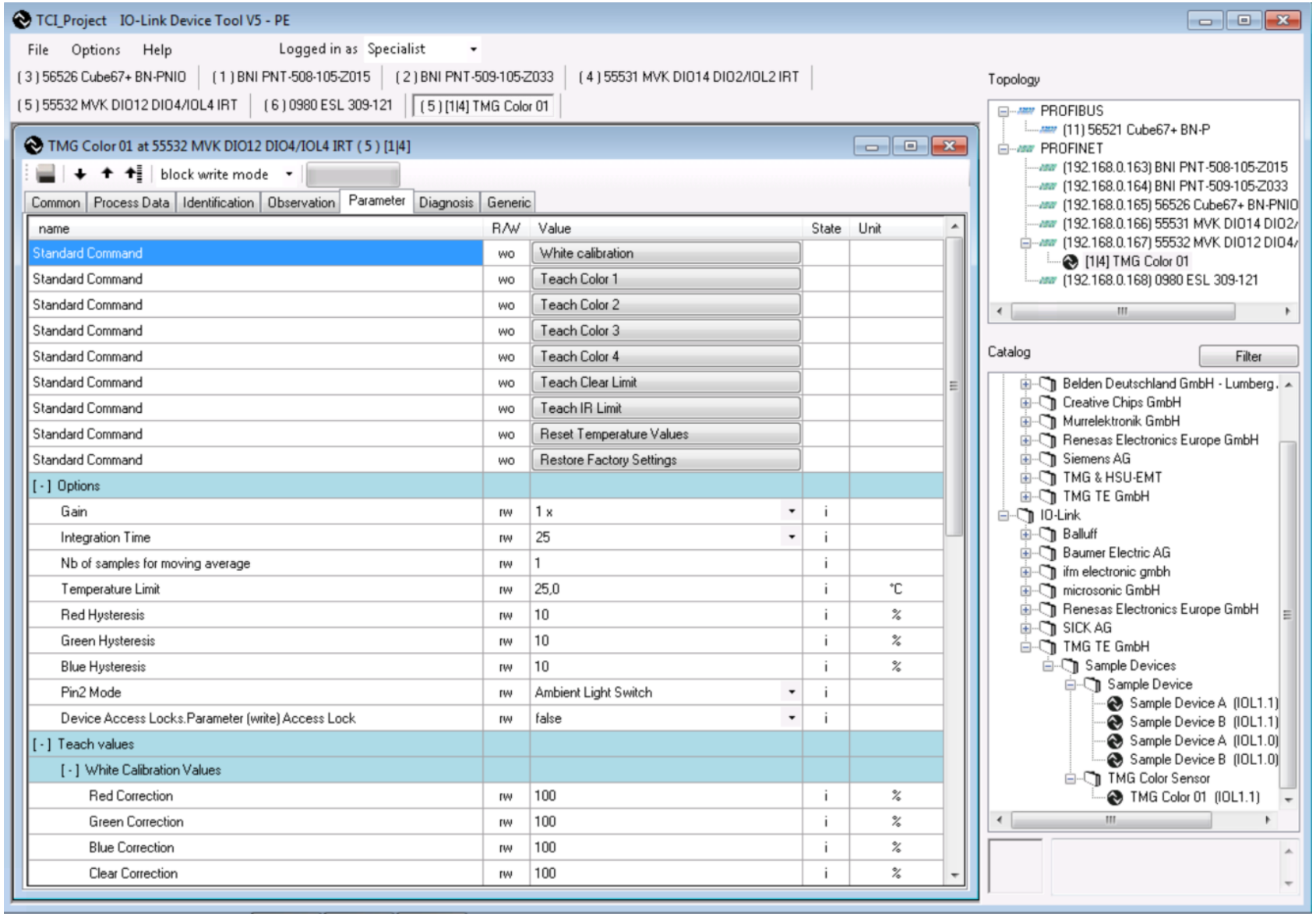
IO-Link Device Tool – IODD Interpreter



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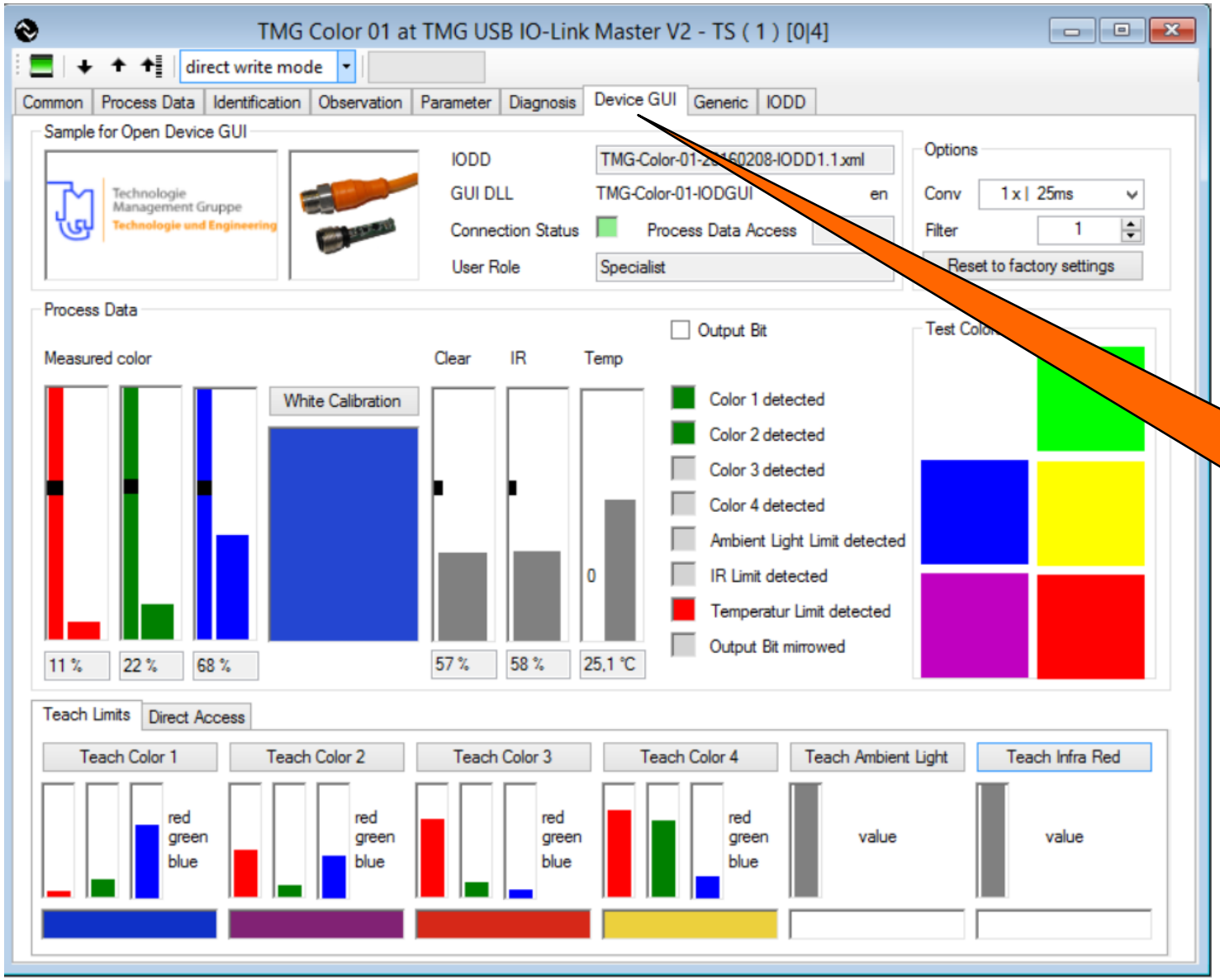
IO-Link Device Tool – Open IO Device Graphical User Interface – New TAB



Additional TAB Device GUI
if Device DLL is installed with IODD

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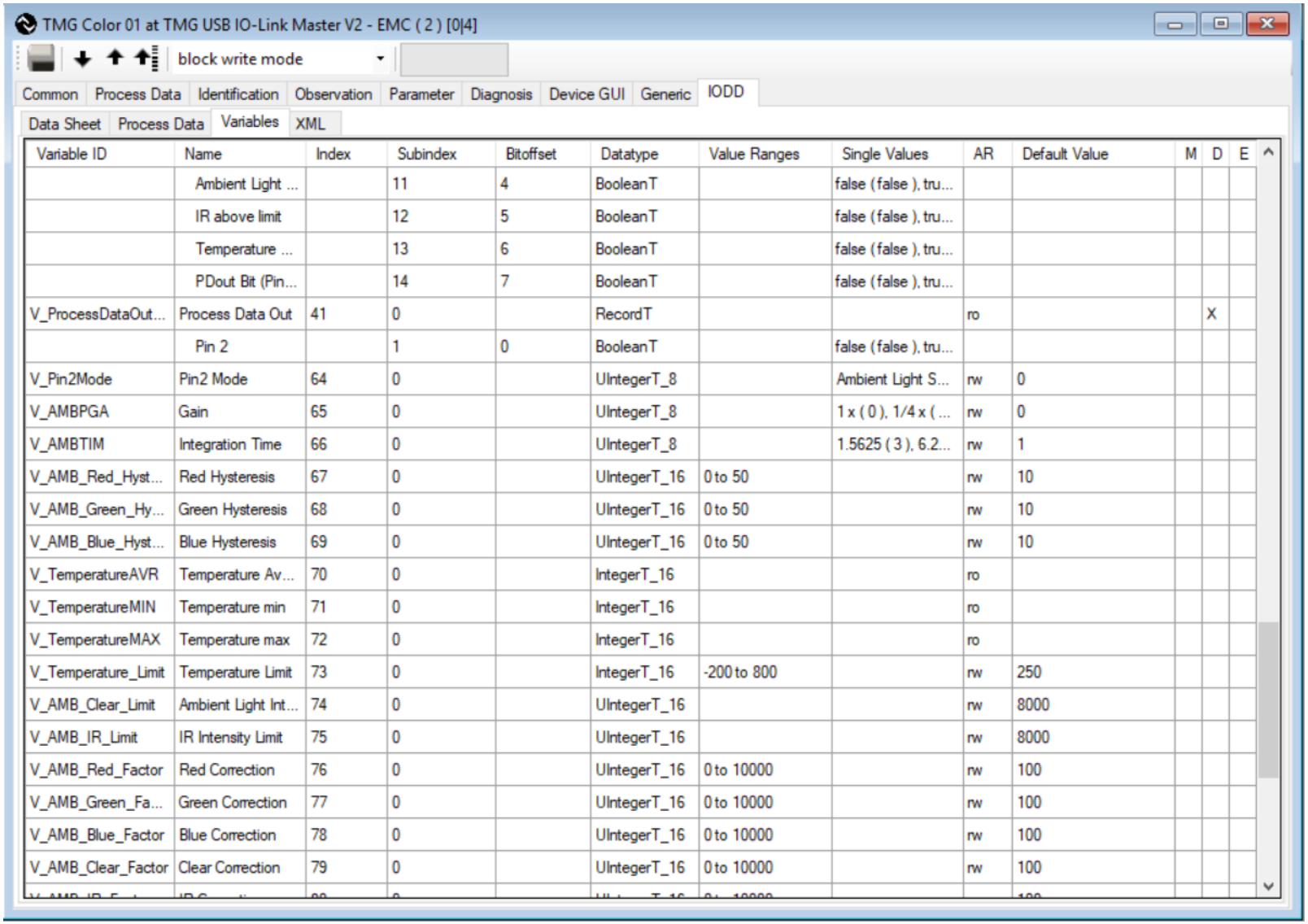
IO-Link Device Tool – IODD Viewer



Variable ID	Name	Index	Subindex	Bitoffset	Datatype	Value Ranges	Single Values	AR	Default Value	M	D	E
	Ambient Light ...		11	4	BooleanT		false (false), tru...					
	IR above limit		12	5	BooleanT		false (false), tru...					
	Temperature ...		13	6	BooleanT		false (false), tru...					
	PDout Bit (Pin...		14	7	BooleanT		false (false), tru...					
V_ProcessDataOut...	Process Data Out	41	0		RecordT			ro			X	
	Pin 2		1	0	BooleanT		false (false), tru...					
V_Pin2Mode	Pin2 Mode	64	0		UIntegerT_8		Ambient Light S...	rw	0			
V_AMBPGA	Gain	65	0		UIntegerT_8		1 x (0), 1/4 x (...	rw	0			
V_AMBTIM	Integration Time	66	0		UIntegerT_8		1.5625 (3), 6.2...	rw	1			
V_AMB_Red_Hyst...	Red Hysteresis	67	0		UIntegerT_16	0 to 50		rw	10			
V_AMB_Green_Hy...	Green Hysteresis	68	0		UIntegerT_16	0 to 50		rw	10			
V_AMB_Blue_Hyst...	Blue Hysteresis	69	0		UIntegerT_16	0 to 50		rw	10			
V_TemperatureAVR	Temperature Av...	70	0		IntegerT_16			ro				
V_TemperatureMIN	Temperature min	71	0		IntegerT_16			ro				
V_TemperatureMAX	Temperature max	72	0		IntegerT_16			ro				
V_Temperature_Limit	Temperature Limit	73	0		IntegerT_16	-200 to 800		rw	250			
V_AMB_Clear_Limit	Ambient Light Int...	74	0		UIntegerT_16			rw	8000			
V_AMB_IR_Limit	IR Intensity Limit	75	0		UIntegerT_16			rw	8000			
V_AMB_Red_Factor	Red Correction	76	0		UIntegerT_16	0 to 10000		rw	100			
V_AMB_Green_Fa...	Green Correction	77	0		UIntegerT_16	0 to 10000		rw	100			
V_AMB_Blue_Factor	Blue Correction	78	0		UIntegerT_16	0 to 10000		rw	100			
V_AMB_Clear_Factor	Clear Correction	79	0		UIntegerT_16	0 to 10000		rw	100			

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- **Standard Edition (Service and Sales)**
  - Parameterization, observation and diagnosis of IO-Link devices
  - IODD V1.0.1 and V1.1
  - Please ask us for brand labeling options

- **Device Test System**
  - Functionality of Development Edition +
    - Execution of certification test for IO-Link V1.1 and V1.0 devices
    - Test configuration from IODD
    - Creates test report for self certification

- **USB IO-Link Master V2 – EMC**
  - EMC Test Master to perform IO-Link EMC Test
  - Very easy to use

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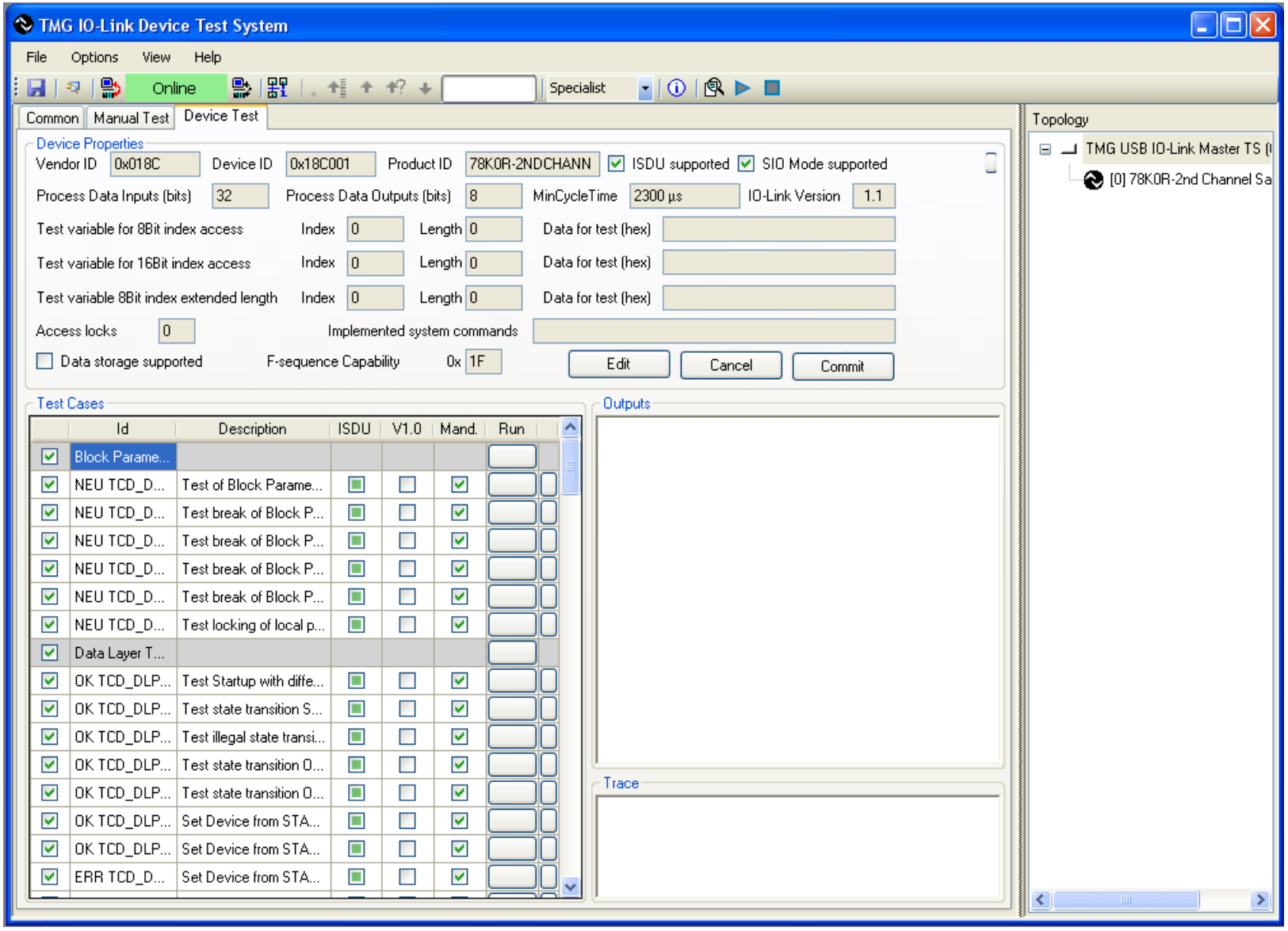
IO-Link Device Tool – Test System



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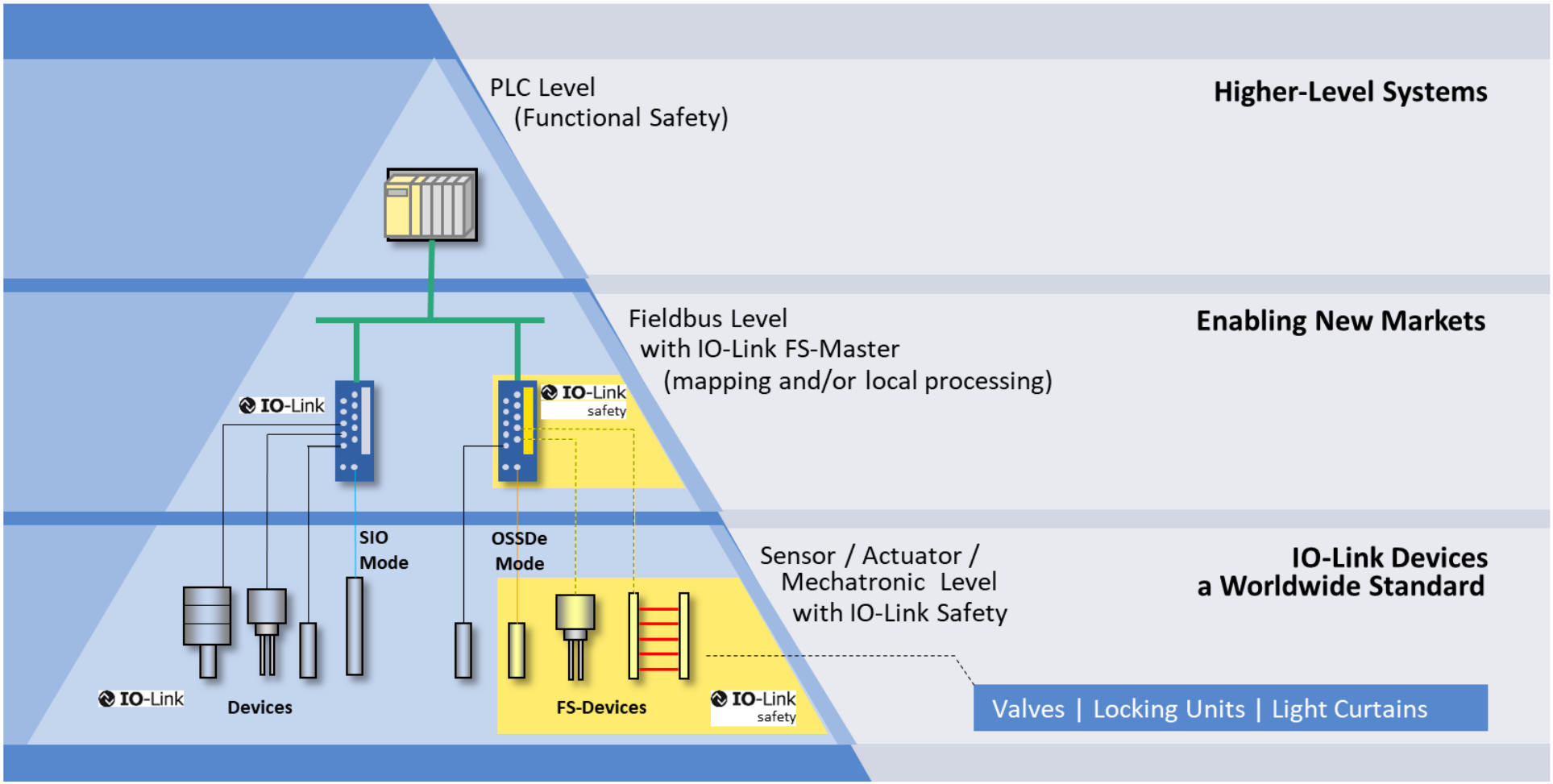
IO-Link Safety – Complete Basic Technology and Tools from TMG



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IO-Link Safety Device and Master Stack

- Safety Libraries with configuration, verification and SCL layer
  - Delivered as certified component
  - Portable source code, secured against unintentional change
  - Platform and architecture independent approach
    - e.g. 2 or 3 microcontrollers, safe operation system or dual core

- User and integration manual with sample integration code
  - For synchronization of the safety controllers for SIL 3 design
  - Watchdog, Black channel and application interface
  - For IO-Link Safety Masters:
    - Standardized Master Interfaces (SMI) for configuration
    - master safety application: FSCP Mapping, Master Test Interface, Safety Application like F-PLC

- Prototype available, assessment and certification in preparation

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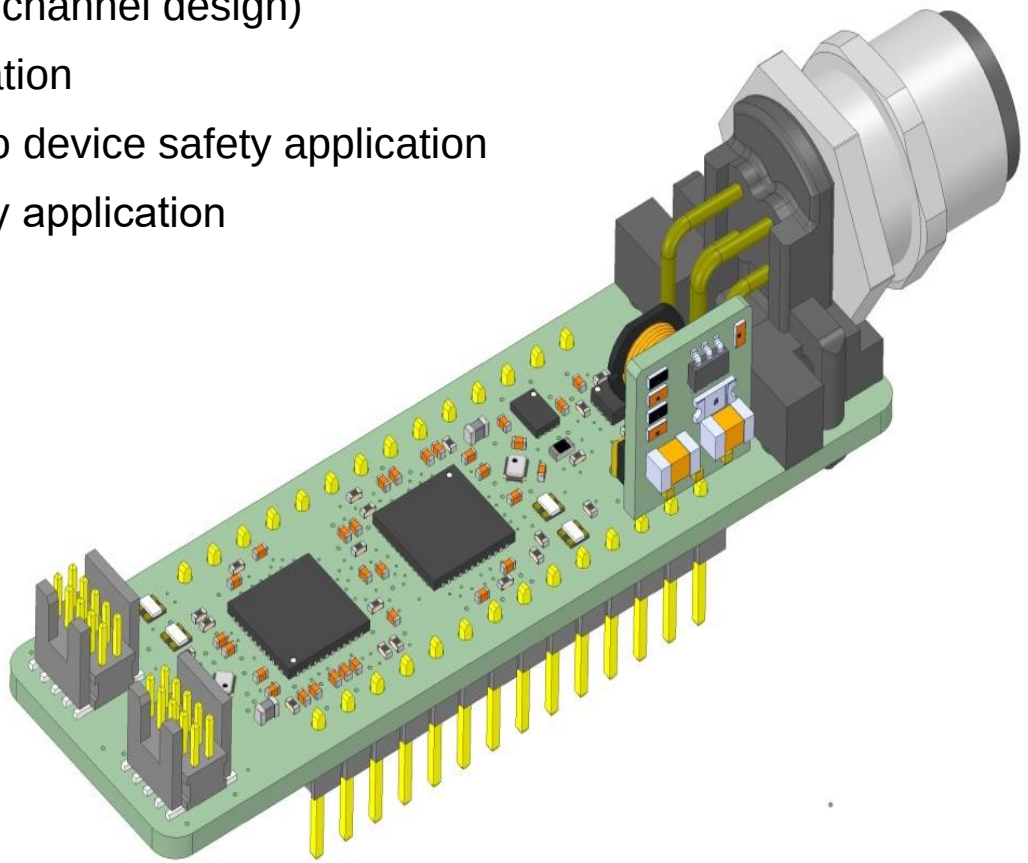
IO-Link Safety Device Evaluation Board

- 2 x ATMEL Cortex M4 microcontrollers
  - Each with own clock
- EEPROM
- TIOL 111 IO-Link transceiver
- TMG IO-Link Device Stack and Stack Extensions (IO-Link related application functions)
- IO-Link Safety Device Stack (2 channel design)
- UART Interface for synchronization
- Serial interfaces (UART, SPI) to device safety application
- GPIO, AIO for “on board” safety application



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Development and Commissioning Master

- Based on TMG USB IO-Link Master TS
- One channel design only for commissioning, development and test
- Enables IO-Link Safety device development also with IO-Link safety masters not available
- Operation modes:
  - Pre parameterization (IO-Link)
  - Commissioning (IO-Link Safety SCL running)
  - Armed operation (IO-Link Safety SCL running)
    - **Only for development and test!!!**

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IO-Link Safety Engineering Tool with USB IO-Link Master

IO-Link Device Tool V5.1
Master & Device
Device Engineering

FSP CRC calculator

DTI Interface
Online & Offline Configuration
- Invocation (TPF)
- Back channel (TBF)
- Communication Server (Online)

IO-Link safety

IODD

IOPD Dedicated Tool

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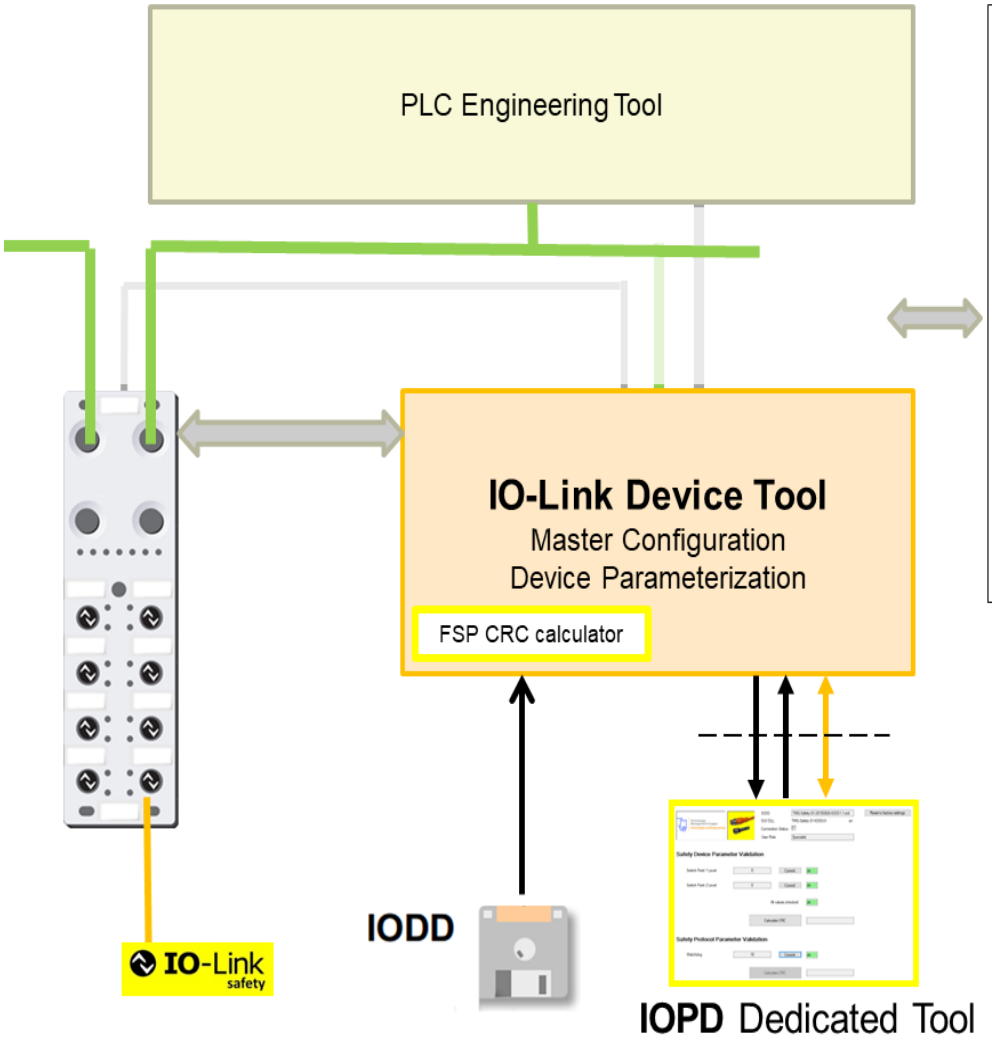
IO-Link Safety Engineering Tool (multi master vendor approach)



The IO-Link Device Tool provides the connection to the IO-Link Safety Master via e.g.

- Protocol on Ethernet
- Local Interface (like USB)
- SW interface like TCI CS

Depending on the PLC Engineering System the IO-Link Engineering Tool will use SW interfaces to exchange engineering information also for integration in upper FSCP

DTI Interface

Online & Offline Configuration

- Invocation (TPF)
- Back channel (TBF)
- Communication Server (Online)

Can also be customized as OEM version

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IO-Link Device Tool V5.1 with Safety Extensions

- According to IO-Link V1.1, IODD V1.1 and IO-Link Safety V1.1
- Open for IO-Link Masters from many manufacturers (more than 10)
- Open IO Device GUI, IODD Finder, IODD Viewer, Process data scope
- IO-Link Safety:
  - IO-Link Safety Device Catalog
  - DTI for dedicated tools
  - Protocol Parameter CRC Check and fulfilling all IO-Link Safety IODD conventions

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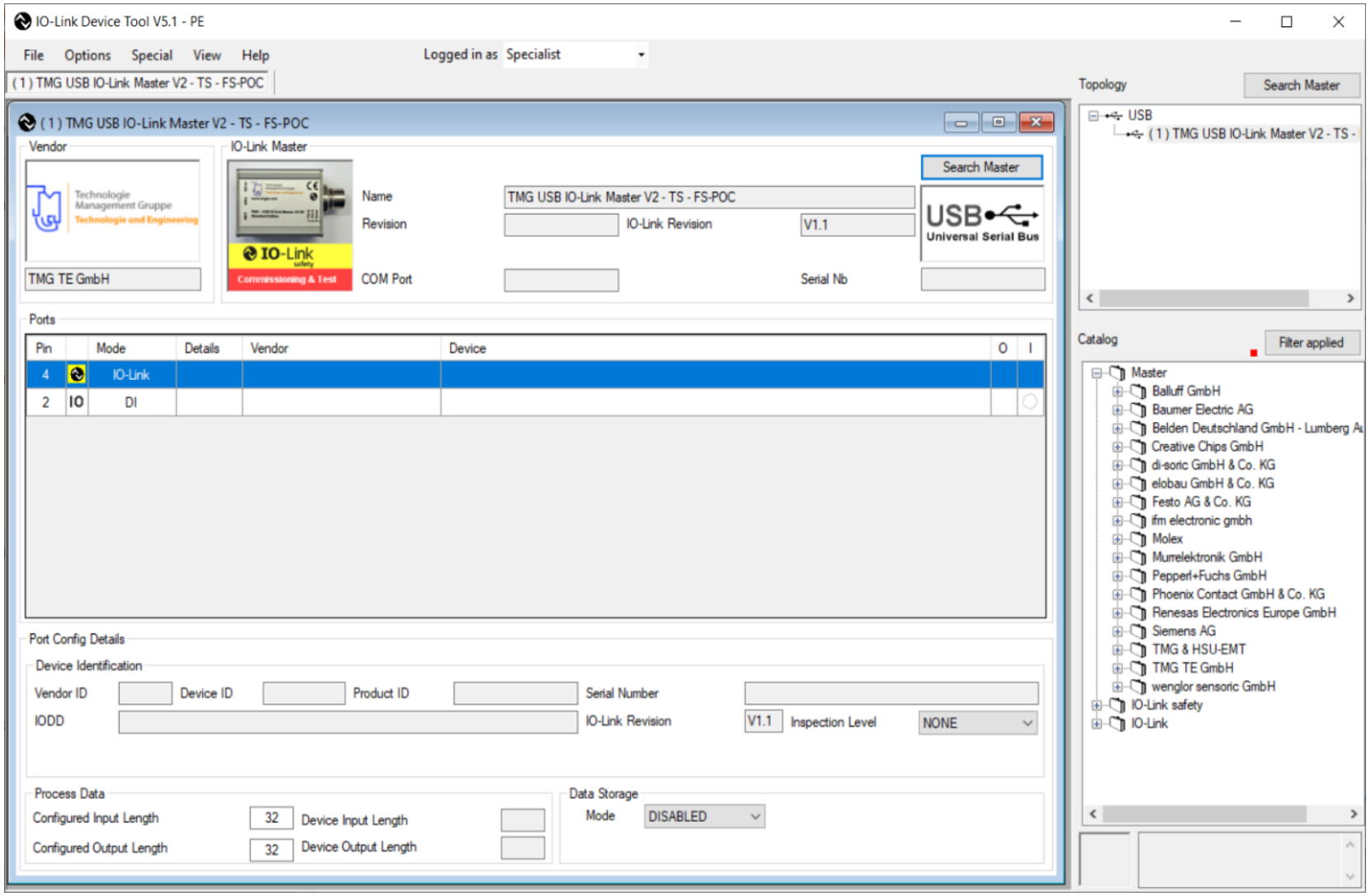
IO-Link Device Tool V5.1 - Workbench



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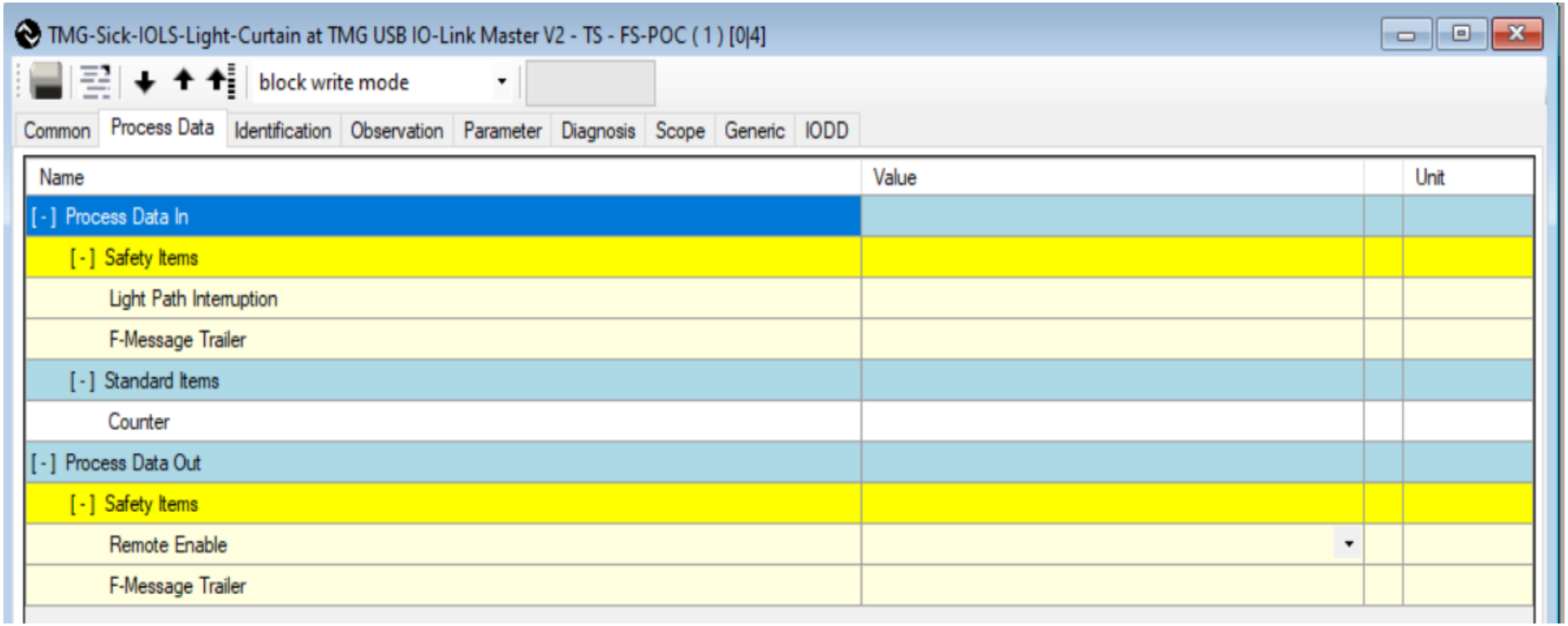
Visualization of Safety Process Data Items

- Automatic generated headlines for safety and standard items
- Highlighting the safety items



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Visualization of the Safety Parametrization

TMG-Sick-IOLS-Light-Curtain at TMG USB IO-Link Master V2 - TS - FS-POC (1) [0|4]

block write mode

Common | Process Data | Identification | Observation | Parameter | Diagnosis | Scope | Generic | IODD

name	R/W	Value	State	Unit
[-] Standard (non-safety) parameter				
Triggered since power on	ro		e	
Standard Command	wo	Reset Counter Value		
Standard Command	wo	Restore Factory Settings		
[-] Fail-safe technology parameter				
Reset mode	rw	auto	i	
Reach setting	rw	near	i	
Resolution	rw	low	i	
[-] Fail-safe protocol parameter				
Authenticity.FSCP_Authenticity_1	rw	0	i	
Authenticity.FSCP_Authenticity_2	rw	0	i	
Authenticity.FSP_Port	rw	0	i	
Authenticity.FSP_AuthentCRC	rw	0	i	
Protocol.FSP_ProtVersion	rw	V1	i	
Protocol.FSP_ProtMode	rw	16 Bit CRC	i	
Protocol.FSP_Watchdog	rw	100	i	
Protocol.FSP_IO_StructCRC	rw	5115	i	
Protocol.FSP_TechParCRC	rw	0	i	
Protocol.FSP_ProtParCRC	rw	0	i	
FS_Password	wo			
Reset_FS_Password	wo			

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IO-Link Safety Device - Test System

- Based on TMG USB IO-Link Master V2 TS
  - Port Class A (OSSDe tolerated)
  - All Master devices with FW Rev 3.x can be updated
    - IO-Link Safety Test Option (Software license)
  - Based on TMG IO-Link Device Tool – Test System

- Scope of the Test with the IO-Link Safety Device Test System
  - IO-Link Protocol and Timing Test
  - IO-Link Safety Protocol Test (Safety Communication Layer and Configuration)
  - For all IO-Link Safety Devices
- Not scope of the Test with the IO-Link Safety Device Test System
  - Physical layer test, OSSDe test, EMC test, DTI test

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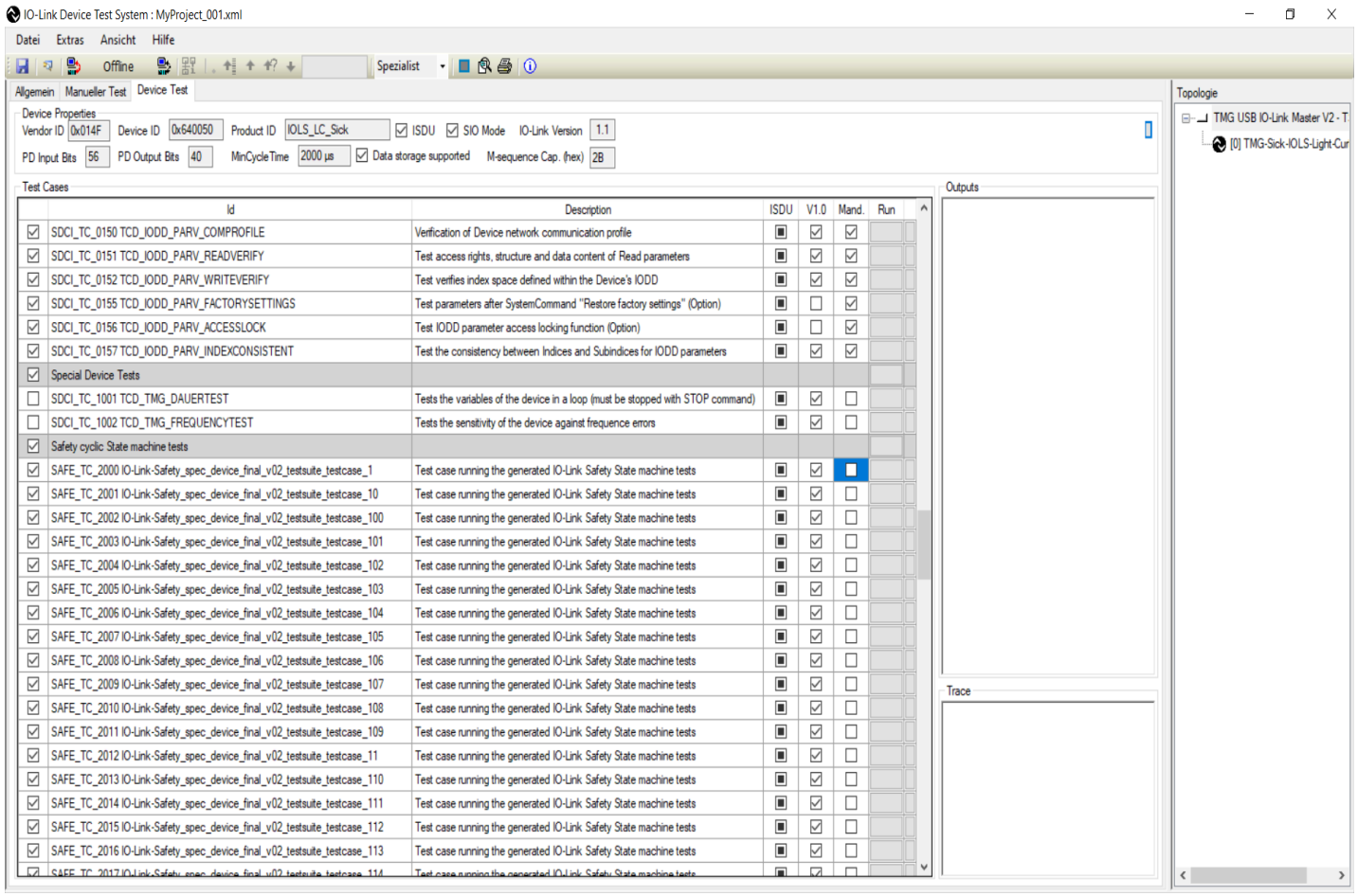
Plug-In in TMG IO-Link Device Tool – Test System



- All IO-Link Safety related test cases are shown as additional test case groups in the test case list
- The IO-Link Device Safety test cases are encapsulated in an own library which is versioned, encrypted and secured against manipulation

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Safety over EtherCAT (FSOE)

- FSOE Master Stack
  - ANSI C
  - Modul tests on RL78 (Renesas)
  - Software Development Process according to SIL 3
- FSOE Slave Stack
  - ANSI C
  - Modul tests on RL78 (Renesas)
  - Software Development Process according to SIL 3
- Can also be used outside of EtherCAT, e.g. TCP/IP, UDP, PROFINET, EtherNet/IP or MODBUS TCP

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