AXM-IOLS IO-Link Device User Guide

Revision 1.10
Jan. 16th, 2024

Revision History

Revision	Date	Description
1.00	2023/11/27	Initial release
1.10	2024/01/16	Evaluation with AX58400 EtherCAT to IO-Link Master

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1. Introduction

This user guide introduces the AXM-IOLS IO-Link device evaluation board and ASIX IO-Link device software stack. The AXM-IOLS IO-Link device evaluation board integrates with the ASIX IO-Link Device Software Stack, enabling support for the features of multiple IO-Link sensors. The AXM-IOLS evaluation board provides designers an easy way to evaluate the ASIX IO-Link Device Software Stack solution.

The ASIX IO-Link Device Software Stack supports the following features,

1. Compliant with IO-Link Communication Specification version 1.1.2
2. Support ISDU communication
3. Support process data exchange using alternative buffer.
4. Support data storage
5. Support firmware upgrade via IO-Link
6. Support the L6362A transceiver driver
7. Support COM1, COM2, and COM3 operating speed and SIO mode
8. Support all types of telegrams
9. Provide in ANSI-C 99 standard
10. Support Small footprint
11. Provide application example

The software package also supports the PD data exchange interface for external I2C IO-Link sensors. Designers can easily connect an external I2C IO-Link sensor through the I2C interface of AXM-IOLS evaluation board to verify the functionalities of ASIX IO-Link device software stack. The PD data exchange interface and device stack configuration parameters will be described in below chapters.

2. Board Description

2-1. AXM-IOLS IO-Link Device Evaluation Board

The following illustrates the integrated IO-Link sensor components on the AXM-IOLS IO-Link device evaluation board.

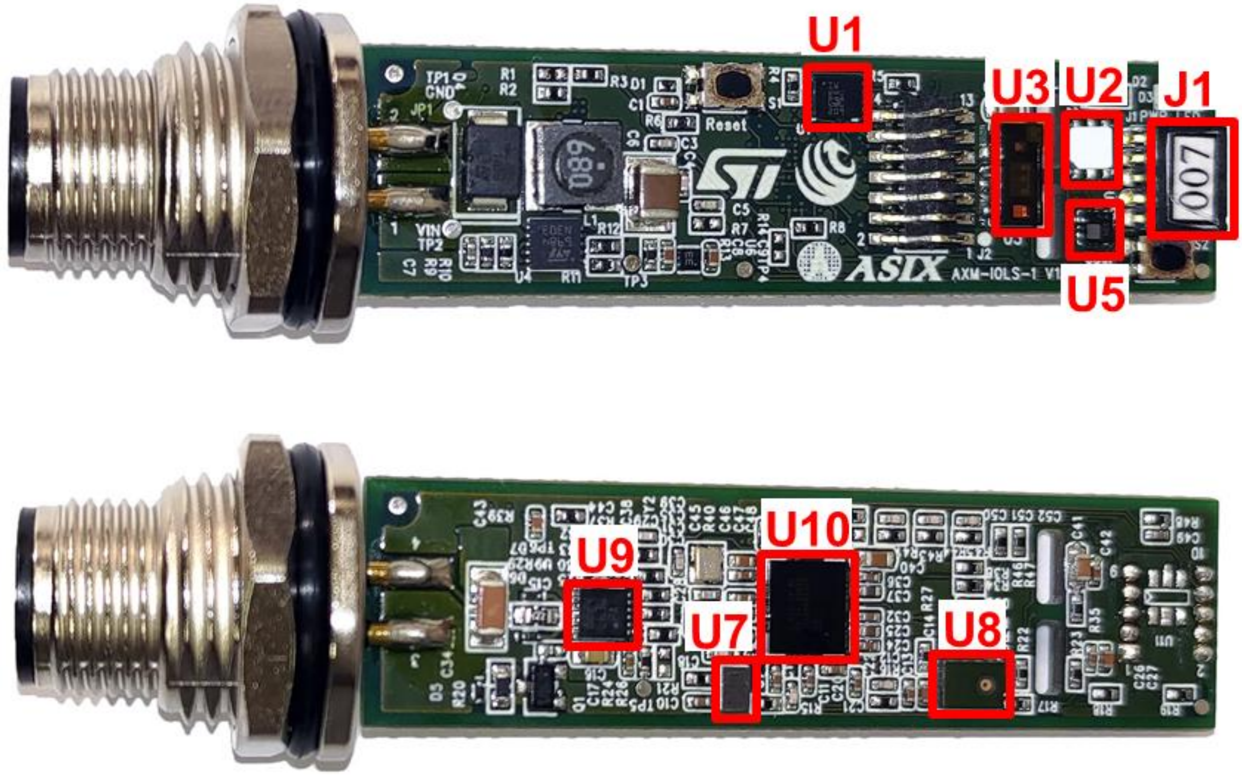


Figure 1. AXM-IOLS IO-Link Device Evaluation Board

2-2. IO-Link Sensor Components

The AXM-IOLS evaluation board is equipped with STMicroelectronics STM32F469AI MCU and integrates various IO-Link sensors, as described below.

Symbol	Part No.	Description
U10	STM32F469AI	ST Arm® Cortex®-M4 MCU
U9	L6362A	ST IO-Link Device Transceiver
U7	M95M01-DF	ST 1Mbits SPI EEPROM
U1	IIS3DWB	ST Ultra-wide bandwidth, low-noise 3-axis digital accelerometer
U2	SI7021-A20	Capacitive digital sensor for relative humidity and temperature (Optional)
U3	VL53L5CX	ST Time-of-Flight(ToF), multizone ranging out with 8x8 separate zones sensor
U5	LPS22DFTR	ST Ultra-compact piezoresistive absolute pressure sensor, 260-1260 hPa, digital output barometer
U8	MP34DT05TR-A	ST MEMS audio sensor omnidirectional stereo digital microphone
J1	I2C Interface	I2C interface for external I2C sensors

2-3. External I2C Interface

The AXM-IOLS evaluation board also supports an I2C interface for evaluating external I2C sensors. Please refer to schematic for detailed I2C pin description.

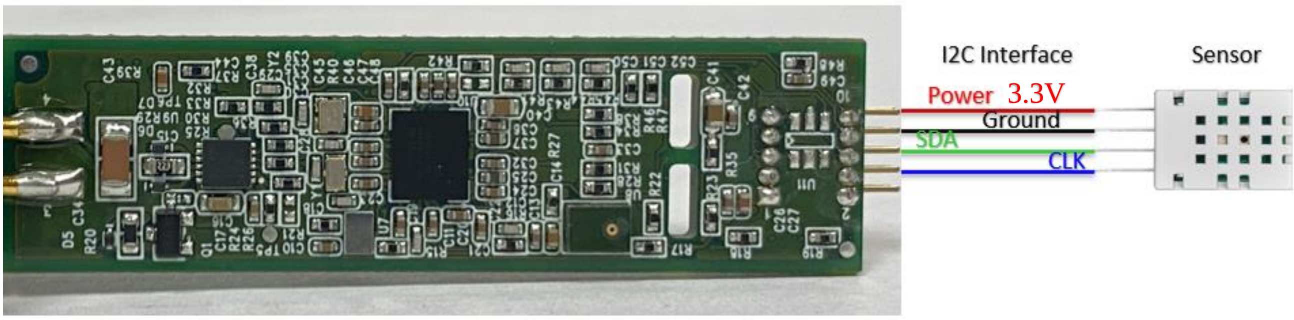


Figure 2. AXM-IOLS EVB - External I2C Interface

3. ASIX IO-Link Device Software Stack Description

The ASIX IO-Link device software stack is designed on the AXM-IOLS IO-Link device evaluation board, equipped with the STM32F469AI MCU, and developed under the STM32CubeIDE development environment. This software stack package includes the ASIX IO-Link device software stack trial library, IO-Link sensor drivers, and a demo application example, etc.

The ASIX IO-Link device software stack trial library provides full functionality of the ASIX IO-Link device software stack, excluding the firmware upgrade function, within a trial period of 72 hours.

3-1. Software Architecture

The software architecture of ASIX IO-Link device software stack, built upon STMicroelectronics STEVAL-BFA001V2 software package, is designed to seamlessly integrate with ASIX's proprietary IO-Link device software stack library and provide the support the AXM-IOLS IO-Link device evaluation board.

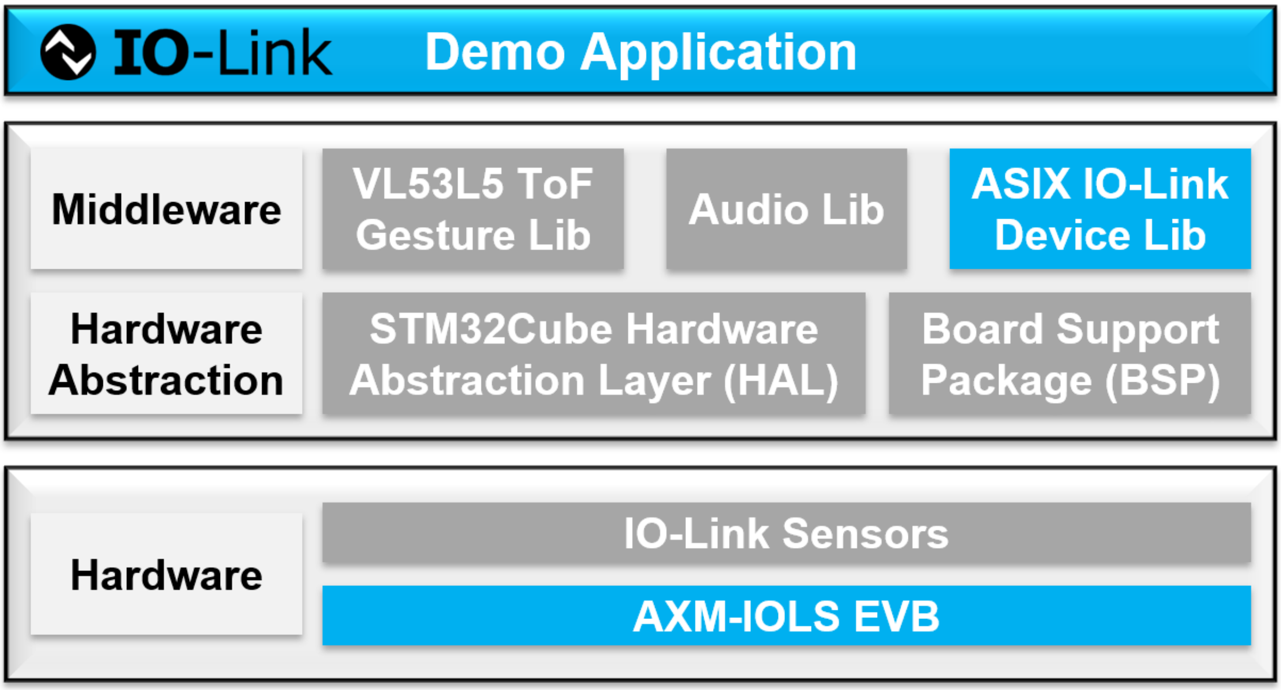


Figure 3. Software Architecture

3-2. Software Package

3-2-1. Software Package Description

The ASIX IO-Link device software stack package is developed under the STM32CubeIDE development environment. The STM32CubeIDE is an advanced C/C++ development platform with peripheral configuration, code generation, code compilation, and debug features for STM32 microcontrollers and microprocessors.

The following shows the STM32CubeIDE project structure of ASIX IO-Link device demo application.

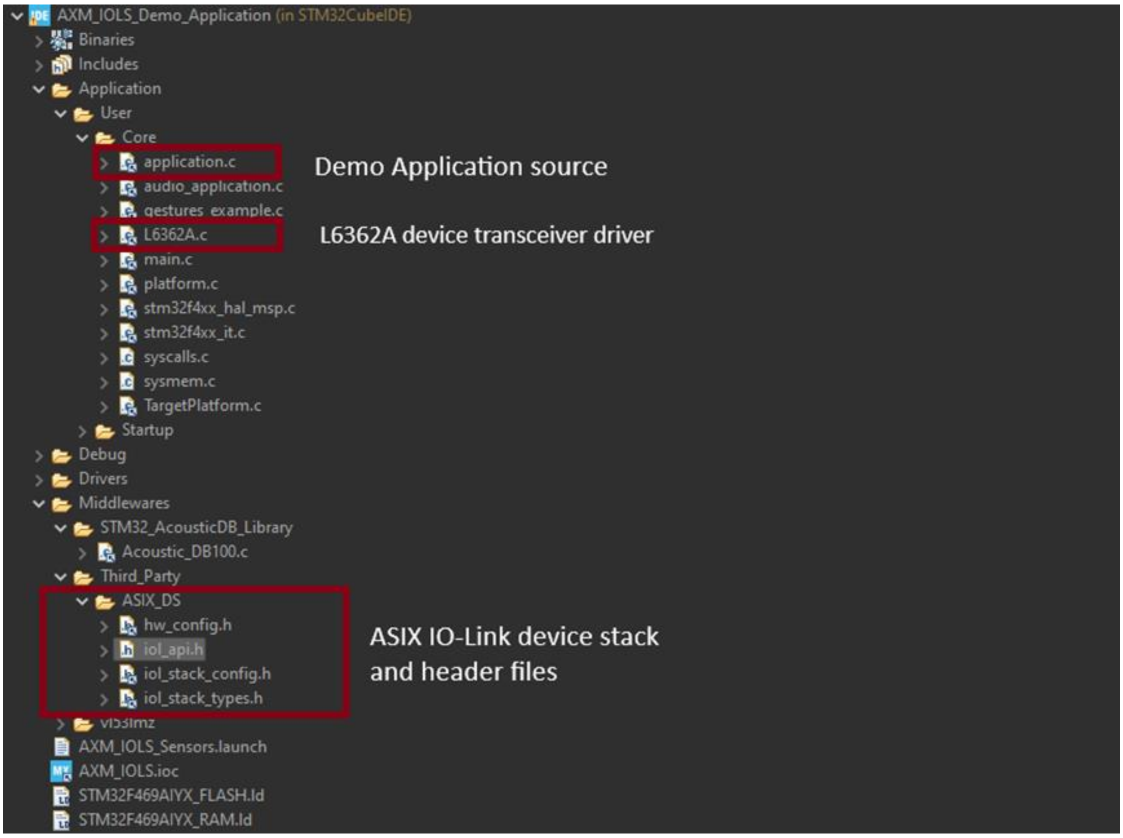


Figure 4. Software Package

3-2-2. Software Stack Library Description

The library and header files are placed under following directory:
Project_Dir\Middlewares\Third_Party\ASIX_DS

This directory contains the following files:

1. libASIX_IOL_Device_Stack_Library.a
   ASIX IO-Link device software stack trail library.

2. iol_stack_types.h
   This file defines used data types, macros, and structures.

3. iol_stack_config.h
   This file defines the IO-Link device parameters such as vendor parameters, cycle time, and m-sequence types.

4. hw_config.h
   This file is used to hook platform dependent resources for IO-Link device stack. Designers need to specify the correspond hardware modules such as timer, WURQ interrupt, clocks, and UART.

5. iol_api.h
   This file defines the IO-Link device stack APIs such as stack initialization, ISDU, PD, and data storage callback registration APIs.

3-2-3. Software Stack Parameters Description

This chapter describes stack parameters defined in iol_stack_config.h

Protocol related definition

_WITH_SIO
Turn on this flag if device support SIO mode when IO-Link protocol is not available.

_WITH_ISDU
Default on, stack component.
Turn off this flag, if device needs to be ran in very small code size.

_WITH_DS
Turn on this flag if device support data storage for storing parameters.

_WITH_FW_UPDATE
Turn on this flag if device support firmware upgrade via IO-Link.
The firmware upgrade function is disable whatever the setting of this flag on trail library.

IO_COM_SPEED
IO-Link communication speed, available options E_COM1, E_COM2, and E_COM3.
Default value is E_COM3.

MIN_CYCLETINE_US
Numeric format which defines the minimum cycle time.

MAX_PDIN_LEN
Numeric format which defines the number of PDIN bytes in operating mode. Default value is 32.

MAX_PDOUT_LEN
Numeric format which defines the number of PDOUT bytes in operating mode. Default value is 32.

MAX_OD_LEN
Numeric format which defines the number of request data bytes.
Default value is 1.

USED_MSEQ_TYPE

M-Sequence type in operating mode, available type shows below:

1. E_TYPE1_1

   2 octets PD read or write

2. E_TYPE2_1

   1 octet OD read or write, 1 octet PDIN data

3. E_TYPE2_2

   1 octet OD read or write, 2 octets PDIN data

4. E_TYPE2_3

   1 octet PDOUT data, 1 octet OD read or write

5. E_TYPE2_4

   2 octets PDOUT data, 1 octet OD read or write

6. E_TYPE2_5

   1 octet PDOUT data, 1 octet OD read or write, 1 octet PDIN data

7. E_TYPE2_6

   2 octets PDOUT data, 1 octet OD read or write, 2 octets PDIN data

8. E_TYPE2_V

   PDOUT_LEN octets PDOUT data, OD_LEN_OPERATE octets OD read or write, PDIN_LEN octets PDIN data

USED_MSEQ_TYPE_PREOPERATE

M-Sequence type in preoperate mode, available type shows below:

1. E_TYPE0

   1 octet OD read or write

2. E_TYPE1_2

   2 octets OD read or write

3. E_TYPE1_V

   OD_LEN_OPERATE octets OD read or write

Vendor and device string parameters

DO_PRODUCTNAME

DO_PRODUCTID

DO_VENDORNAME

DO_VENDORTEXT

DO_PRODUCTTEXT

DO_SERIAL_NUM

DO_HW_REVISION

DO_FW_REVISION

DO_APPLICATION_SPEC

VENDOR_ID
16-bit numeric format assigned by the IO-Link consortium
The vendor id is hardcoded in trail library.
(Be able to modify after license)

IOL_DEVICE_ID
24-bit numeric format for device identification
The device id is hardcoded in trail library.
(Be able to modify after license)

3-2-4. External I2C Software Interface Description

The AXM-IOLS evaluation board supports an I2C interface for evaluating external I2C IO-Link sensors. The following are the I2C interface APIs for I2C sensors data exchange.

Ext_Sor_Data_Len
Numeric format which defines the length of sensor data. Available length is 1, 2, and 4 bytes.

Ext_LOC
Numeric format which specifies data offset on PD data. The default value is 8. The data of external sensor will be put on this offset of PD data.

Ext_Sor_Data_Len ExtSensor_Read_Data (void)
Manufactures can put the external sensor data via this API. For example, manufacturers can read data of external sensor via I2C interface and return the data to the IO-Link device stack in this function.

4. AXM-IOLS Evaluation Board IODD File

To evaluate AXM-IOLS evaluation board with IO-Link master, designers need to import the AXM-IOLS evaluation board IODD (IO Device Description) file into IO-Link master platform. Please refer to the IO-Link master's user manual for details about how to import the IODD file.

4-1. IODD File Description

The AXM-IOLS-yyyymmdd-IODD1.1.xml IODD file is designed for AXM-IOLS IO-Link device evaluation board. This file contains the information about the device's identity, parameters, process data, communication properties and the design of the user interface of IO-Link master tools.

The IO-Link master needs to import this IODD file to get the necessary information of AXM-IOLS evaluation board.

Below shows the outline of AXM-IOLS IODD file.

AXM-IOLS	
Vendor ID	1334 (0x0536)
Vendor Name	ASIX
Vendor Text	ASIX Electronics Corporation
Vendor URL	https://www.asix.com.tw
Device ID	1 (0x000001)
DeviceFamily	AXM-IOLS Device Family
Features	
Block Parameter	no
Data Storage	no
Communication	
IO-Link Revision	V1.1
Transmission Rate	230400 bit/s (COM3)
Minimum Cycle Time	2.3 ms
SIO Mode Supported	yes
M-Sequence Capability	PREOPERATE = TYPE_0 with 1 octet on-request data OPERATE = TYPE_2_V with 32 octets on-request data ISDU supported
Device Variant	**AXM-IOLS**
Description	AXM-IOLS IO-Link Device
Product ID	1
Connection Type	M12-4 connector
- pin 1	brown; L+
- pin 2	white; NC
- pin 3	(light) blue; L-
- pin 4	black; C/Q

Figure 5. AXM-IOLS Evaluation Board IODD File

5. Evaluation with AX58400 EtherCAT to IO-Link Master

AX58400 EtherCAT to IO-Link master which supports 8 IO-Link slave devices. Designers can evaluate AXM-IOLS slave device on AX58400 EtherCAT to IO-Link master. Below chapter will introduce AXM-IOLS slave device operation status on AX58400 EtherCAT to IO-Link master.

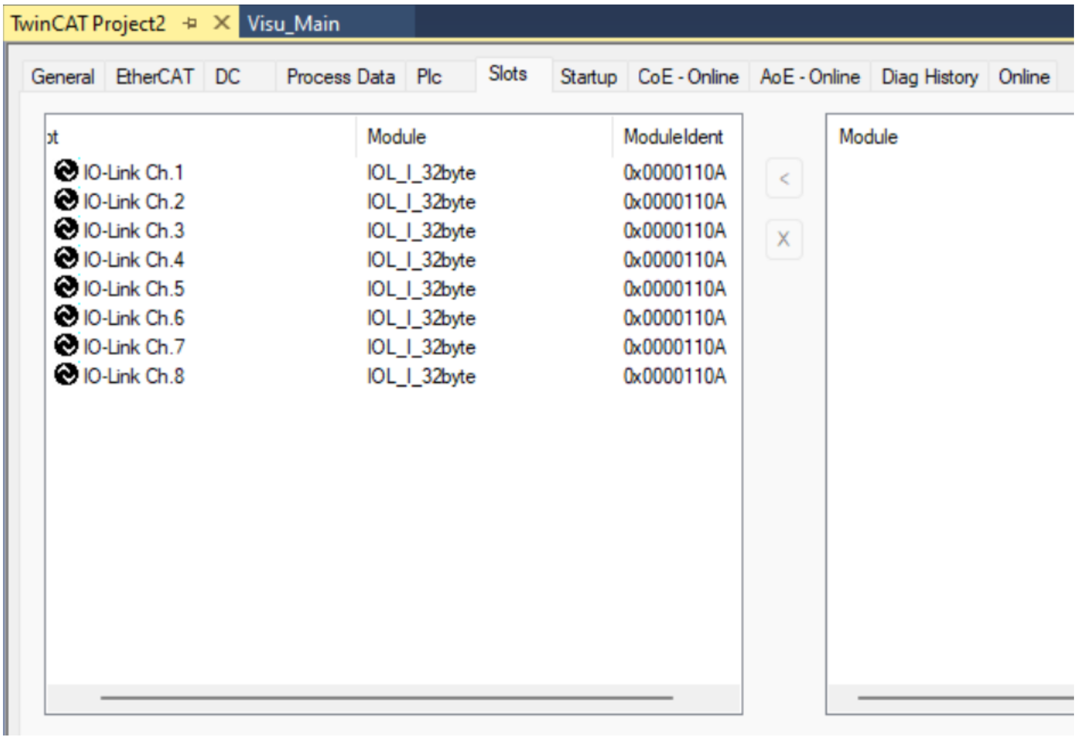
5-1. AX58400 ECAT to IO-Link Master Description

The AX58400 EtherCAT to IO-Link Gateway solution integrates AX58400 EtherCAT Slave Controller with Dual-Core MCU and ASIX's own IO-Link Master Protocol Stack. This solution uses the highest performing ARM Cortex-M7 core of AX58400 to process the IO-Link master protocol stack operation for supporting up to 8 IO-Link devices; and uses the ARM Cortex-M4 core to process EtherCAT slave protocol stack operation in parallel. Using AX58400 dual-core MCU architecture can effectively reduce the CPU load of microcontroller and generate a higher-performance EtherCAT to IO-Link gateway solution. This gateway solution supports up to 16 IO-Link gateways; each gateway can connect up to 8 IO-Link devices.

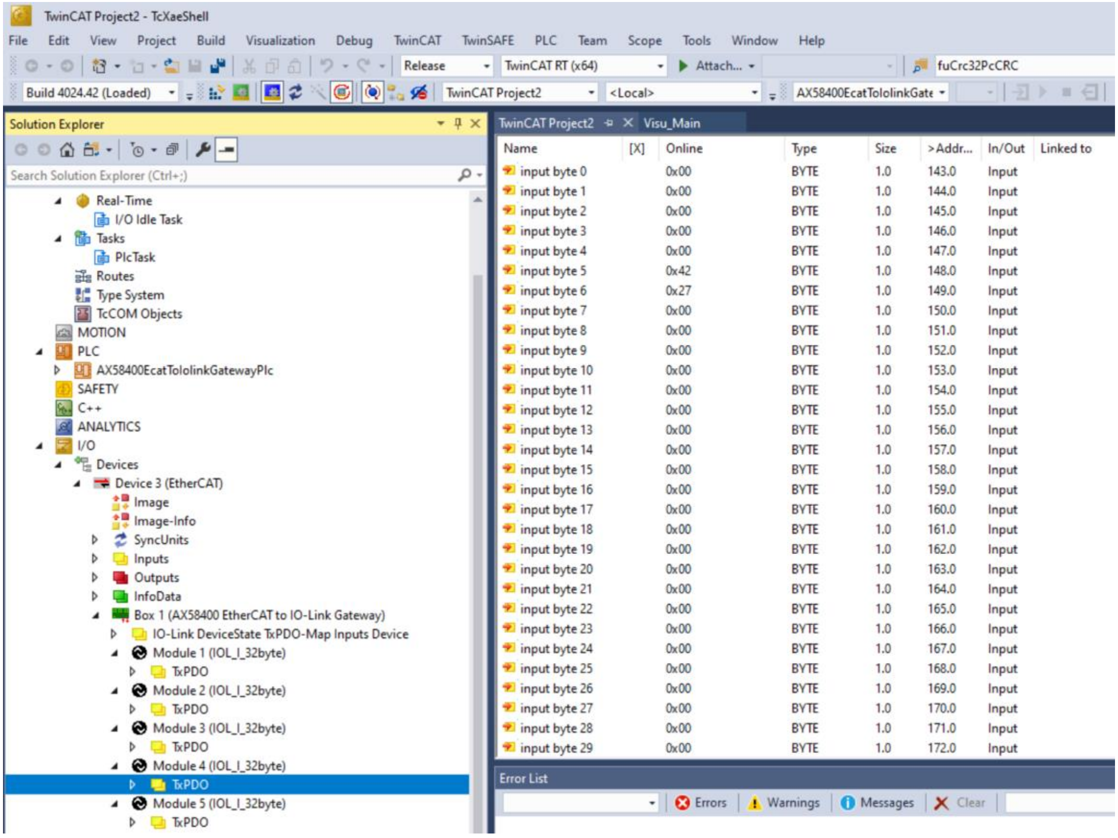
Detailed information please refer to below link:
https://asix.com.tw/en/news/Videos/AX58400_EtherCAT_IOLink_Gateway_and_Motor_Control_Demonstration

5-2. Operation Status

Below screenshot shows the configuration of AXM-IOLS PDIN length. The PDIN length is 32 bytes.



The AXM-IOLS PDIN data will show as below screenshot.



TwinCAT Project2 - TcXaeShell
File Edit View Project Build Visualization Debug TwinCAT TwinSAFE PLC Team Scope Tools Window Help
Release
TwinCAT RT (x64)
Attach...
fuCrc32PcCRC
Build 4024.42 (Loaded)
TwinCAT Project2
<Local>
AX58400EcatTololinkGate
Solution Explorer
Search Solution Explorer (Ctrl+;)
Real-Time
I/O Idle Task
Tasks
PlcTask
Routes
Type System
TcCOM Objects
MOTION
PLC
AX58400EcatTololinkGatewayPlc
SAFETY
C++
ANALYTICS
I/O
Devices
Device 3 (EtherCAT)
Image
Image-Info
SyncUnits
Inputs
Outputs
InfoData
Box 1 (AX58400 EtherCAT to IO-Link Gateway)
IO-Link DeviceState TxPDO-Map Inputs Device
Module 1 (IOL_I_32byte)
TxPDO
Module 2 (IOL_I_32byte)
TxPDO
Module 3 (IOL_I_32byte)
TxPDO
Module 4 (IOL_I_32byte)
TxPDO
Module 5 (IOL_I_32byte)
TxPDO
TwinCAT Project2
Visu_Main
Name [X] Online Type Size >Addr... In/Out Linked to
input byte 0 0x00 BYTE 1.0 143.0 Input
input byte 1 0x00 BYTE 1.0 144.0 Input
input byte 2 0x00 BYTE 1.0 145.0 Input
input byte 3 0x00 BYTE 1.0 146.0 Input
input byte 4 0x00 BYTE 1.0 147.0 Input
input byte 5 0x42 BYTE 1.0 148.0 Input
input byte 6 0x27 BYTE 1.0 149.0 Input
input byte 7 0x00 BYTE 1.0 150.0 Input
input byte 8 0x00 BYTE 1.0 151.0 Input
input byte 9 0x00 BYTE 1.0 152.0 Input
input byte 10 0x00 BYTE 1.0 153.0 Input
input byte 11 0x00 BYTE 1.0 154.0 Input
input byte 12 0x00 BYTE 1.0 155.0 Input
input byte 13 0x00 BYTE 1.0 156.0 Input
input byte 14 0x00 BYTE 1.0 157.0 Input
input byte 15 0x00 BYTE 1.0 158.0 Input
input byte 16 0x00 BYTE 1.0 159.0 Input
input byte 17 0x00 BYTE 1.0 160.0 Input
input byte 18 0x00 BYTE 1.0 161.0 Input
input byte 19 0x00 BYTE 1.0 162.0 Input
input byte 20 0x00 BYTE 1.0 163.0 Input
input byte 21 0x00 BYTE 1.0 164.0 Input
input byte 22 0x00 BYTE 1.0 165.0 Input
input byte 23 0x00 BYTE 1.0 166.0 Input
input byte 24 0x00 BYTE 1.0 167.0 Input
input byte 25 0x00 BYTE 1.0 168.0 Input
input byte 26 0x00 BYTE 1.0 169.0 Input
input byte 27 0x00 BYTE 1.0 170.0 Input
input byte 28 0x00 BYTE 1.0 171.0 Input
input byte 29 0x00 BYTE 1.0 172.0 Input
Error List
Errors
Warnings
Messages
Clear

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