How to use ISaGRAF via I-8123W to control the CANopen Slave devices?

Download FAQ-145 Demo.

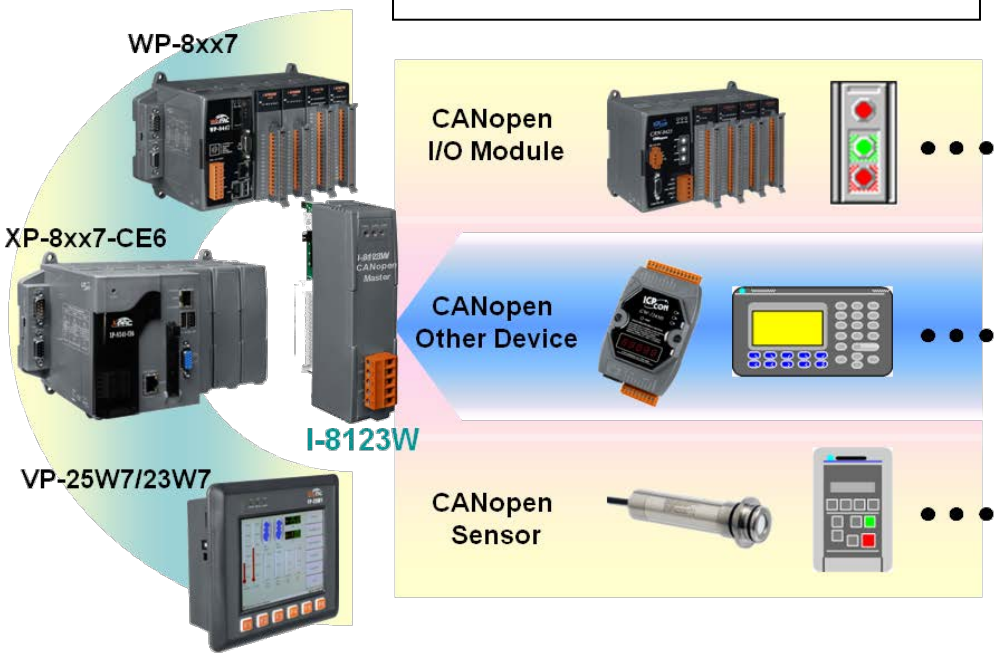
Note that some of the following ISaGRAF PAC have been phased out, visit to the ISaGRAF website for more information ablout new products.
https://www.icpdas.com/en/product/guide+Software+Development__Tools+ISaGRAF

● Application Introduction

This document is about using ISaGRAF program via operating the I-8123W CANopen Master module to construct the CANopen network and control the CANopen Slave devices in the network.

ISaGRAF PAC supports the I-8123W to control the CANopen Slave devices through CANopen network since the following version.

WP-8xx7:	Ver.1.38 or later
VP-25W7/23W7:	Ver.1.30 or later
XP-8x47-CE6:	Ver.1.18 or later
XP-8xx7-Atom-CE6:	Ver.1.01 or later



I-8123W can be plugged in the slot 1 ~ 7 of XP-8xx7-CE6 (the most left slot is slot 1 in the XP-8xx7-CE6) or the slot 0 ~ 7 of WP-8xx7 or the slot 0 ~ 2 of VP-2xW7.

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The link to download this document and demo programs:
https://www.icpdas.com/en/faq/index.php?kind=280#751 FAQ-145

Related ISaGRAF files:
https://www.icpdas.com/en/download/index.php?nation=US&kind1=&model=&kw=isagraf

More information about I-8123W:
http://www.icpdas.com/en/product/I-8123W-G

● The difference between CAN and CANopen communication protocol

Here we introduce the difference between CAN and CANopen communication protocol before entering 1.1: I-8123W Introduction.

CAN bus is one of the serial communication interfaces. For easy understanding, here we can image that CAN is similar to the RS-485 interface, but the physical hardware and algorithm is different as RS-485. CAN bus has two branches, CANopen and DeviceNet. Then CANopen fits the spec. of CAN bus. For easy understanding, user can image that CANopen is something similar to the RS-485 Modbus RTU protocol.

Each CAN bus package (or called frame) shows as below.

ID	RTR	DLC	8-byte Data

ID: an identification number of the CAN frame. If it is a **CAN 2.0A** frame, the ID field has 11 bits. So its value can be 0 ~ 7FF (Hex.). While 29 bits for **CAN 2.0B** frame, so its value can be 0 to 1FFFFFFF (Hex.). CANopen belongs to 2.0A Specification.

RTR: 1 bit. **If its value is 1**, it means the frame is using as “Remote-transmit requests”, or called “Remote frame”. It is for requesting the other CAN device to send proper data back. There is no Data field for “Remote frame”. **If “RTR” is 0**, then the frame is called “Standard frame”. It is for sending data to other CAN devices. So “Standard frame” must have Data field.

DLC: It indicates the byte amount of the following Data field. Its value can be 0 to 8.

CANopen frame has same format as CAN bus. But it divides the ID filed into 2 sub-fields:

Function Code, 4 bits	Node ID, 7 bits

Node ID: Bit 1 to 7 indicates the CANopen “Node-ID” (or called CANopen “Station No.”). This value can be 1 to 7F (Hex., its decimal value is 1 to 127.). Value 0 has special usage. (Ex, to switch one CANopen device to be in “operational state” is using “Node ID” as 0). So, one CANopen network can connect max. 127 CANopen devices.

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Function Code:

It has 4 bits (bit 8 to 11). It defines the function of the CANopen frame. For example, some function code is for requesting Application Data, some is for sending Application Data to others. Here cannot talk more about the CANopen and CAN protocols, please refer to the user's manual of each 3rd party CAN products.

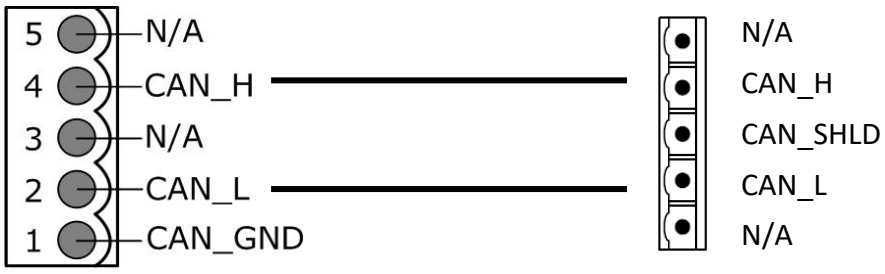
To use ISaGRAF PAC to link to CAN or CANopen devices, user must know the spec. of the CAN device, ex. the Node-ID, the function code to send the Application data, data format… etc.

Note: Please don't mix CAN devices and CANopen devices in the same CAN bus network. That is because the CAN ID field may conflict with each other. If all devices in the same CAN bus are all CANopen devices, there will be no problem if they has different CANopen Node ID number (can be 1 to 127)

1.1 I-8123W Introduction

I-8123W can provide an economical solution of CANopen application and as a master device in the CANopen network. It follows the standard CIA DS-301 V4.02 and provides a variety of communication services to the devices. The following is an illustration and notice for setting the I-8123W hardware.

1.1.1 I-8123W Hardware Pin-Assignment



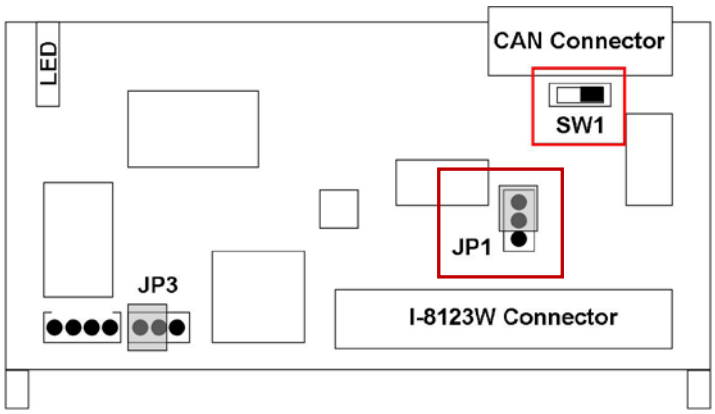
CANopen device

Pin	Signal	Description
1	GND	Ground
2	CAN_L	CAN_L bus line
3	N/A	Non-available
4	CAN_H	CAN_H bus line
5	N/A	Non-available

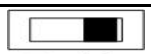
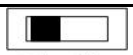
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1.1.2 Terminal Resistors and Firmware Write-Protection Switch

I-8123W is built-in a 120Ω terminal resistor for setup the SW1 to enable or disable. There are usually 2 terminal resisters in a CAN network. Refer to the I-8123W user manual for more details.
http://www.icpdas.com/en/download/show.php?num=1778&model=I-8123W-G



When upgrade I-8123W firmware, please set **JP1** to "**Unlock**", but set it to "Lock" in usual time.

Jumper	Description	Usage	
SW1	The terminal resistor on the CAN side.	 Enable	 Disable
JP1	Firmware Write-Protection	 Lock	 Unlock

1.2 Restore the ISaGRAF Library and ISaGRAF Demo Project

To design an ISaGRAF project to connect the CANopen device, please restore the following files into the PC/ISaGRAF.

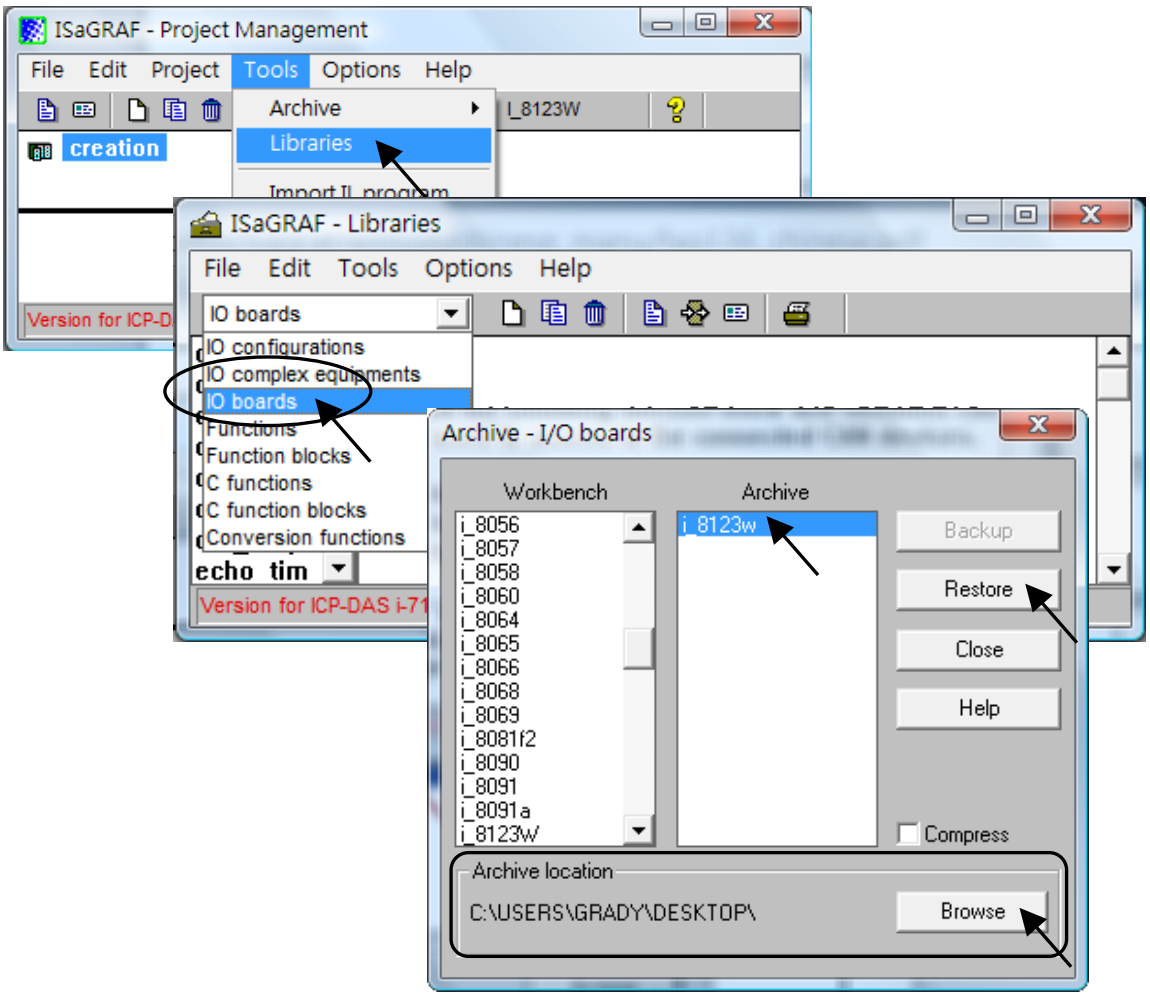
1. I/O board "i-8123W.bia"
2. C-function block "PDO_RxTx.fia"
3. C-function block "SDO_RxTx.fia"

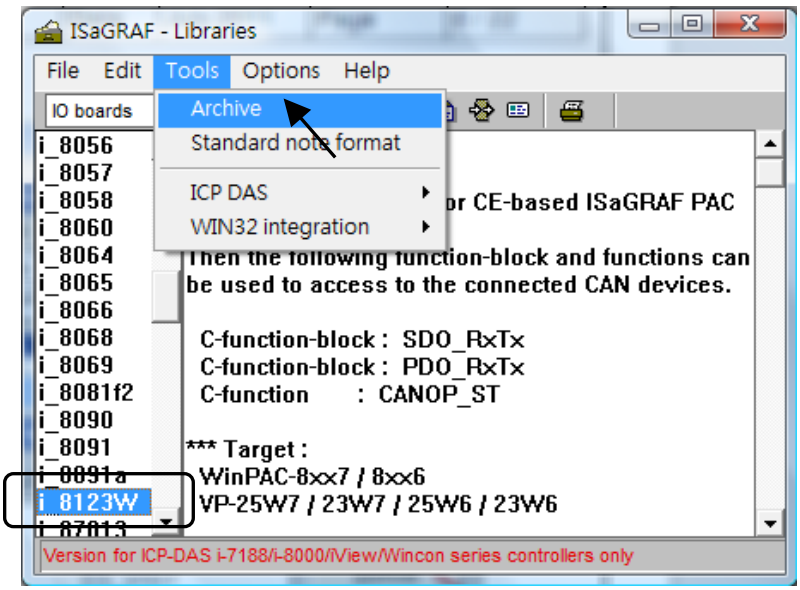
User can download the file "faq_145_chinese.zip" that includes the files listed above, this PDF document and demo projects "faq145_1.pia" ~ "faq145_3.pia" at ISaGRAF FAQ website https://www.icpdas.com/en/faq/index.php?kind=280#751 > 145 and restore them into your PC/ISaGRAF.

For ISaGRAF software operation, refer to the Section 1.1, 1.2 & Chapter 2 of ISaGRAF User Manual that can be get from the webpage.
http://www.icpdas.com/en/download/show.php?num=333&nation=US&kind1=&model=&kw=isagraf

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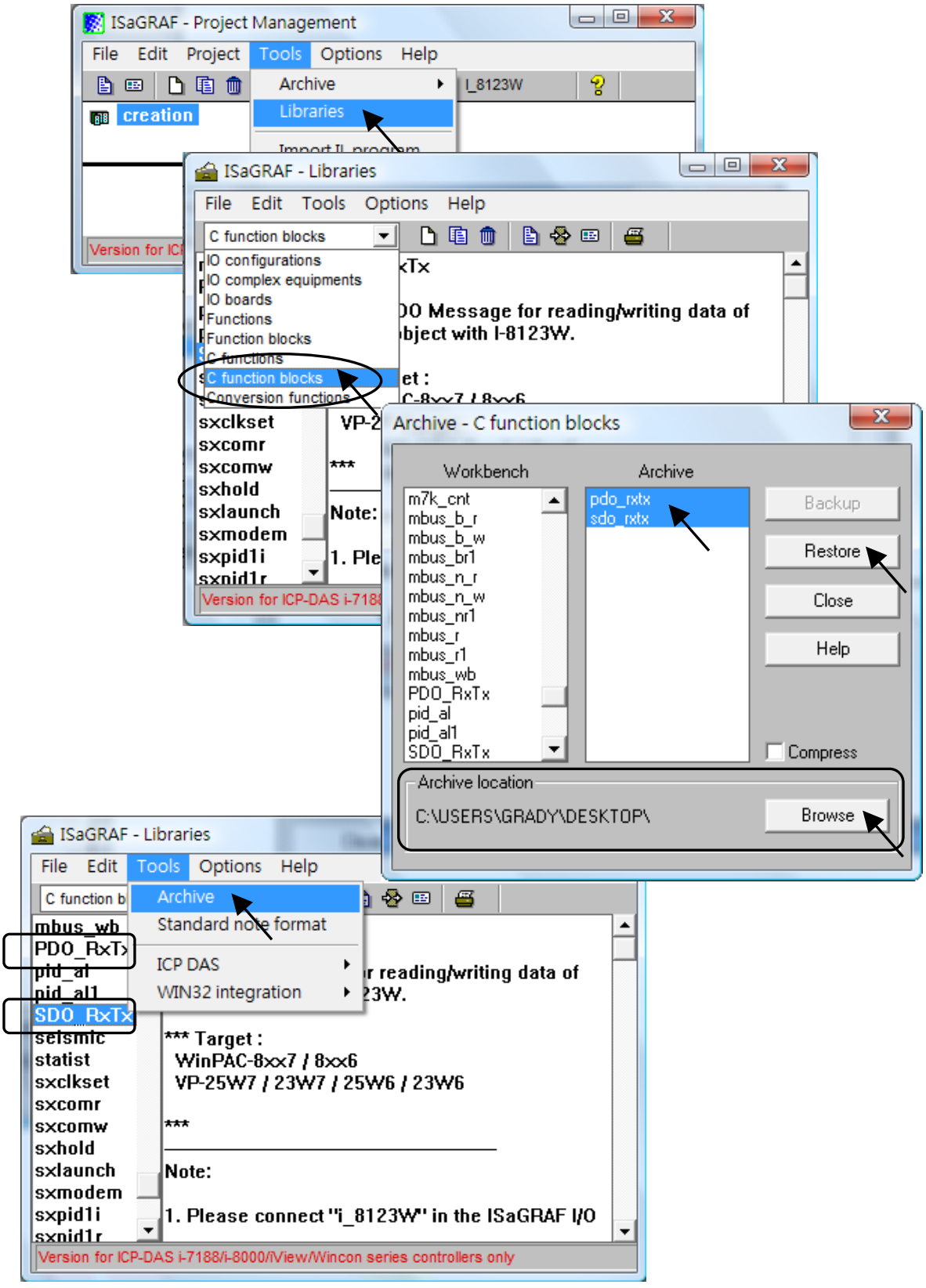
1.2.1 Restore I/O Board “i_8123W.bia”





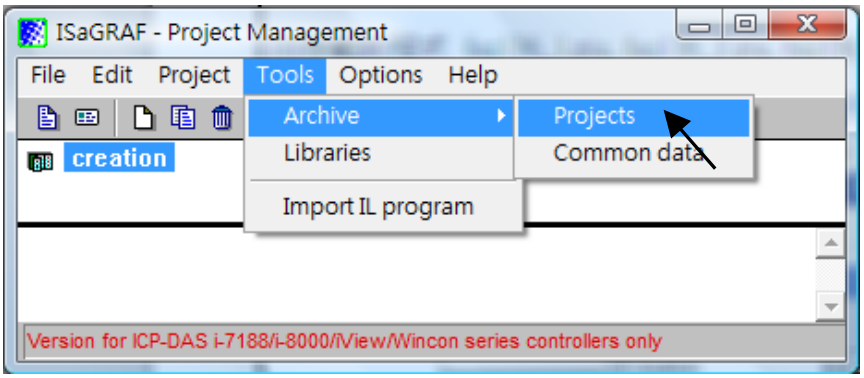
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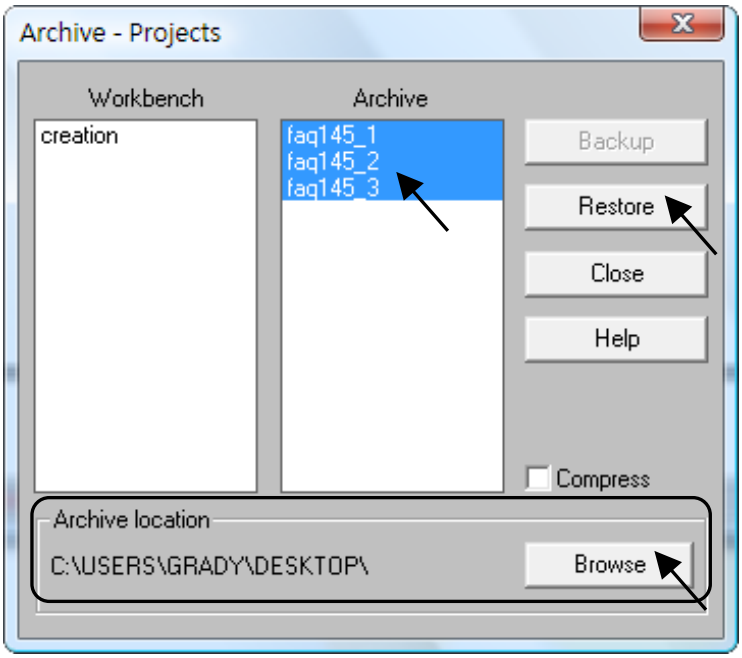
1.2.2 Restore C-function Block “PDO_RxTx.fia” & “SDO_RxTx.fia”:

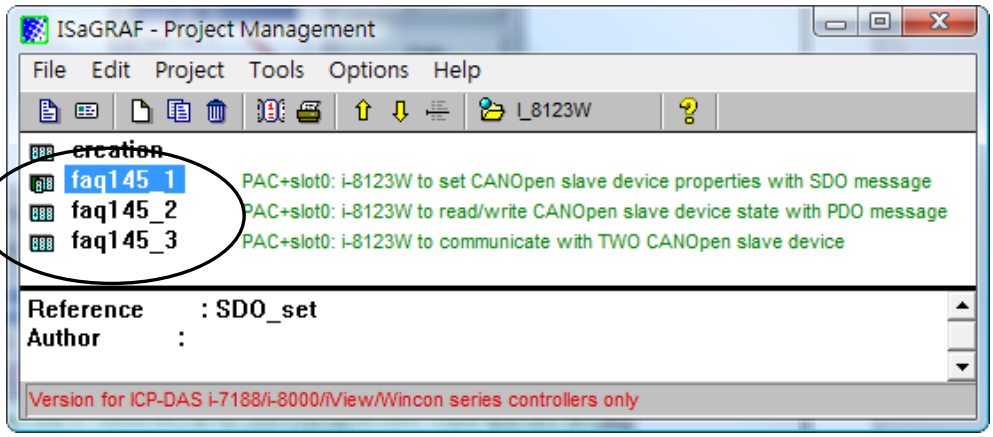


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1.2.3 Restore Demo Projects faq145_1, faq145_2, faq145_3







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1.3 Project Descriptions for ISaGRAF PAC operating I-8123W

faq145_1	Use SDO message to write/read the setting of CANopen.
faq145_2	Use PDO message to write/read the status of CANopen.
faq145_3	Composite exercise: use I-8123 to control multi CANopen Slave devices.

Using I-8123W card on the XP-8x47-CE6, WP-8xx7 or VP-25W7/VP-23W7 ISaGRAF PAC, user must make sure the version of ISaGRAF driver is in the version list of the page 1.

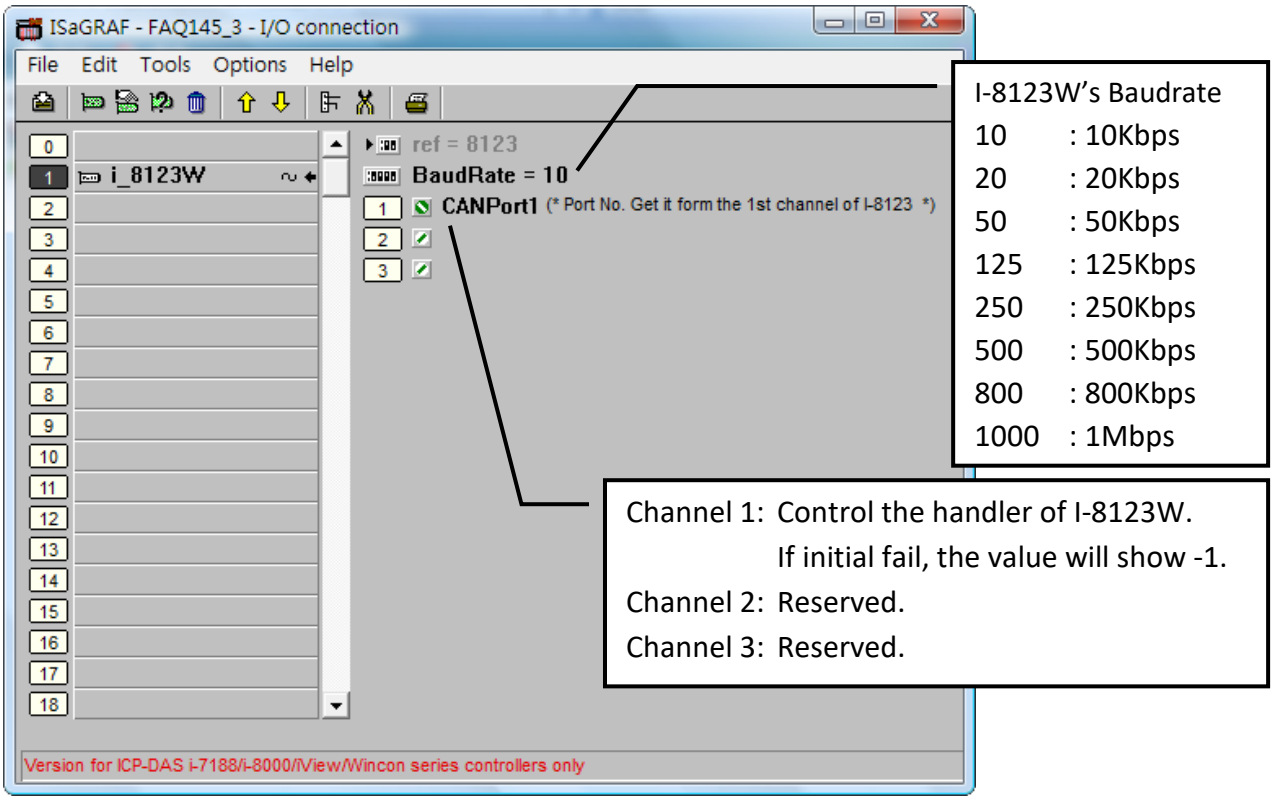
Next, set the “IO connection” of ISaGRAF software to “i_8123W” in the correct slot. The picture below shows the program “faq145_3” enabling an I-8123W card in the slot 1 of the ISaGRAF PAC.

NOTE:

A. The most left I/O slot of XP-8xx7-CE6 is slot 1.

B. The most left I/O slot of WP-8xx7, VP-25W7/VP-23W7 is slot 0.

1.3.1 Descriptions for linking the I/O board “i_8123W”



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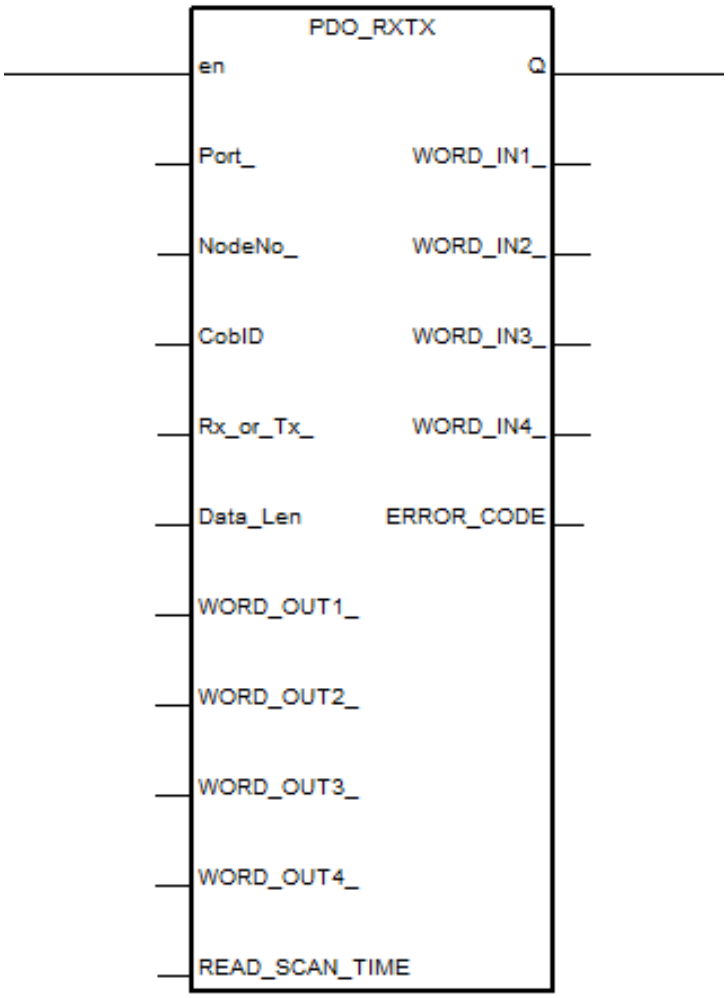
1.3.2 C-function Block “PDO_RxTx” Description:

- **PDO (Process Data Object) Introduction**

PDO protocol is used to process real time data among various nodes. You can transfer up to 8 bytes (64bits) data per one PDO either from or to the device.

One **PDO** can contain multiple object dictionary entries. In ISaGRAF, user can use C-function block **PDO_RxTx** to communicate with CANopen devices.

- **C-function Block “PDO_RxTx” Appearance**



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- **C-function Block "PDO_RxTx" Parameters:**

Input Parameters:

Parameter Name	Type	Descriptions
En	Boolean	The function block works only when the value is TRUE.
Port_	Integer	This parameter can be got from the 1st channel of I-8123 in the IO connection.
NodeNo_	Integer	Slave device Node-ID that relating to COBID.
CobID	Integer	CAN object number
Rx_or_Tx	Boolean	If TURE, write the WORD_OUT1_ ~ 4_ values to PDO ID. If FALSE, read the PDO ID status to WORD_IN1_ ~ 4_ .
Data_Len	Integer	If Rx_or_Tx is TRUE, it's the length of the writing data. Unit is byte and it's not larger than 8. If it's 1, write the Low Byte of WORD_OUT1_. If it's 3, write the Low Byte of WORD_OUT1_ and WORD_OUT2_. If **Rx_or_Tx is FALSE, it's no use,** please **input 0.**
WORD_OUT1_ WORD_OUT2_ WORD_OUT3_ WORD_OUT4_	Integer	If Rx_or_Tx is TRUE, it's the writing data. Each value must between -32767 to 65535, or will not write the data. If **Rx_or_Tx is FALSE, it's no use,** please **input 0.**
READ_SCAN_TIME	Timer	If **Rx_or_Tx is TRUE, it's no use,** please **input T#0s.** If Rx_or_Tx is FALSE, when input "T#1s", it returns the PDO ID status per second.

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Returns:

Return value	Type	Descriptions
Q_	Boolean	TRUE: The communication with the device of NodeNo_ is fine. FALSE: The communication with the device of NodeNo_ is unusual.
WORD_IN1_ WORD_IN2_ WORD_IN3_ WORD_IN4_	Integer	**If Rx_or_Tx is TRUE, do not input these columns.** If Rx_or_Tx is FALSE, these columns will return the read status.
ERROR_CODE_	Integer	Error code: 1 : OK. -27 : the length of writing data is wrong -28 : COB-ID is not exist or wrong -36 : communication time out -37 : the data length setting wrong -256: the writing data is wrong

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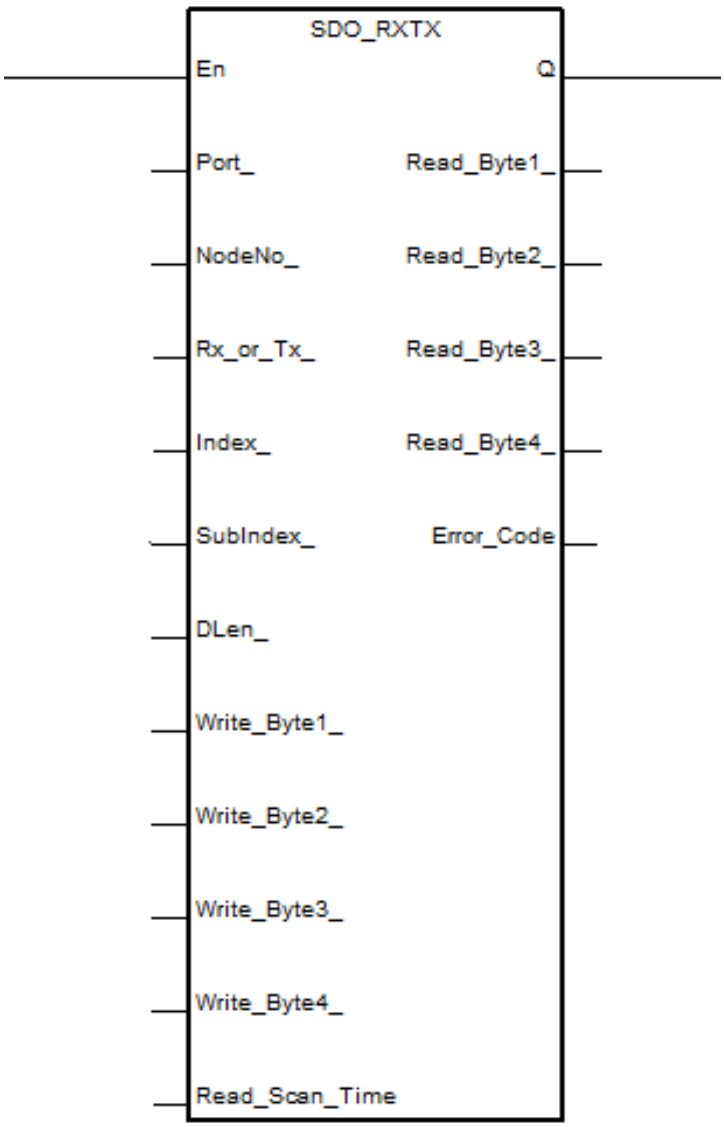
1.3.3 C-function Block “SDO_RxTx” Description

- **SDO (Service Data Object) Introduction**

The **SDO** protocol is used to set and read values from the object dictionary of a remote device. The device whose object dictionary is accessed is the SDO server and the device accessing the remote device is the SDO client. User can set the device initial parameters via the SDO.

In ISaGRAF, user can use C-function block “**SDO_RxTx**” to set/read the related parameters of CANopen device.

- **C-function Block “SDO_RxTx” Appearance**



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● C-function Block "SDO_RxTx" Parameters

Input Parameters:

Parameter Name	Type	Descriptions
En	Boolean	The function block works only when the value is TRUE.
Port_	Integer	This parameter can be got from the 1st channel of I-8123 in the IO connection.
NodeNo_	Integer	Slave device Node-ID that relating to COBID.
Rx_or_Tx	Boolean	If TURE, write the Write_Byte1_ ~ 4_ values to the assigned objects. If FALSE, read the assigned objects' status to Read_byte1_ ~ 4_ .
Index_	Integer	Slave device specifics the Index of object in the object dictionary.
SubIndex	Integer	Slave device specifics the Subindex of object in the object dictionary.
Data_Len	Integer	If Rx_or_Tx is TRUE, it's the length of the writing data. Unit is byte and it's not larger than 4. If it's 1, write to the Write_Byte1_ . If it's 2, write to the Write_Byte1_ and Write_Byte2_. If **Rx_or_Tx is FALSE, it's no use,** please **input 0.**
Write_Byte1_ Write_Byte2_ Write_Byte3_ Write_Byte4_	Integer	If Rx_or_Tx is TRUE, it's the writing data. Each value must between -128 ~255, or will not write the data. If **Rx_or_Tx is FALSE, it's no use,** please **input 0.**
READ_SCAN_TIME	Timer	If **Rx_or_Tx is TRUE, it's no use,** please **input T#0s.** If Rx_or_Tx is FALSE, when input "T#1s", it returns the PDO status per second.

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Returns:

Return value	Type	Descriptions
Q_	Boolean	TRUE: The communication with the device of NodeNo_ is fine. FALSE: The communication with the device of NodeNo_ is unusual.
Read_Byte1_ Read_Byte2_ Read_Byte3_ Read_Byte4_	Integer	**If Rx_or_Tx is TRUE, no need to input these columns.** If Rx_or_Tx is FALSE, these columns will return the read status.
ERROR_CODE_	Integer	Error code: 1 : OK. -36 : communication time out -37 : the data length is wrong -256: the writing data is wrong

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1.3.4 C-function Block "CanOp_st" Description

● CanOp_st Introduction

Before working the CANopen device, user has to add the CANopen device into the network using C-function block "CanOp_st", and then can control/operate that device (using "PDO_RxTx" or "SDO_RxTx").

● C-function Block "CanOp_st" Parameters

Input Parameters:

Parameter Name	Type	Descriptions
PORT_	Integer	Input the value of I-8123's channel 1 in the I/O board.
BOO_	Boolean	Specify the mode to detect the disconnection. True : using the Heart Beat mode False: using the Guarding mode This parameter function is supported since the following PAC driver version: WP-8xx7: 1.43 or later VP-25W7/23W7: 1.35 or later XP-8xx7-CE6: 1.23 or later
ID_	Integer	The ID number of the CANopen device Value range: 1~127
TOUT_	Integer	Set the time for the timeout Value range: 0~ 65535 Unit: microsecond

Returns:

Return value	Type	Descriptions
Q_	Boolean	TRUE: add the device into the CANopen network successful. FALSE: the device is not in the CANopen network yet.

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1.4 Test the Demo Projects

Introduction of Demo Projects:

faq145_1	Use SDO message to write/read the setting of CANopen device.
faq145_2	Use PDO message to write/read the status of CANopen device.
faq145_3	Composite exercise: use I-8123 to control multi CANopen Slave devices.

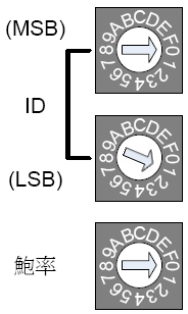
1.4.1 Test Demo faq145_1

Hardware:

1. ISaGRAF PAC(CE based) X 1 (Ex: WP-8447)
2. I-8123W CANopen Master X 1
3. CAN-8423 X 1 (used as a CANopen slave device)
4. I-87057W X1、I-8051W X1、I-8024W X1、I-8017HW X1

Hardware Initialization:

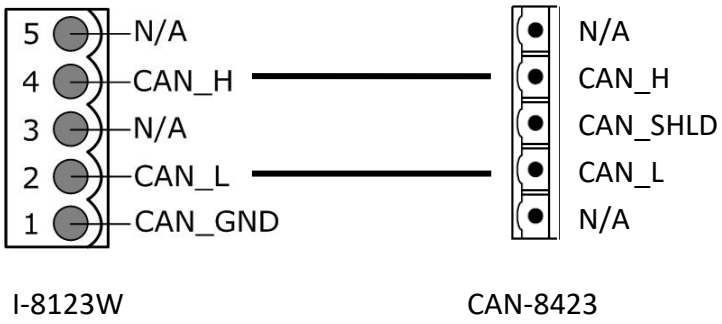
1. Plug I-8123W into slot 1 of ISaGRAF PAC
2. Plug I-8057W, I-8051W, I-8024W, I-8017HW to CAN-8423 sequentially.
3. On the CAN-8423 panel, turn the BAUD switch to 0 (baud rate: 10kbps), the ID MSB switch to 0, and the ID LSB switch to 1 (set ID to 1). As below:



4. Wire every I-8057 DO to I-8051W DI channel on the CAN-8423.
5. Wire every I-8024 AO to I-8017HW AI channel on the CAN-8423.

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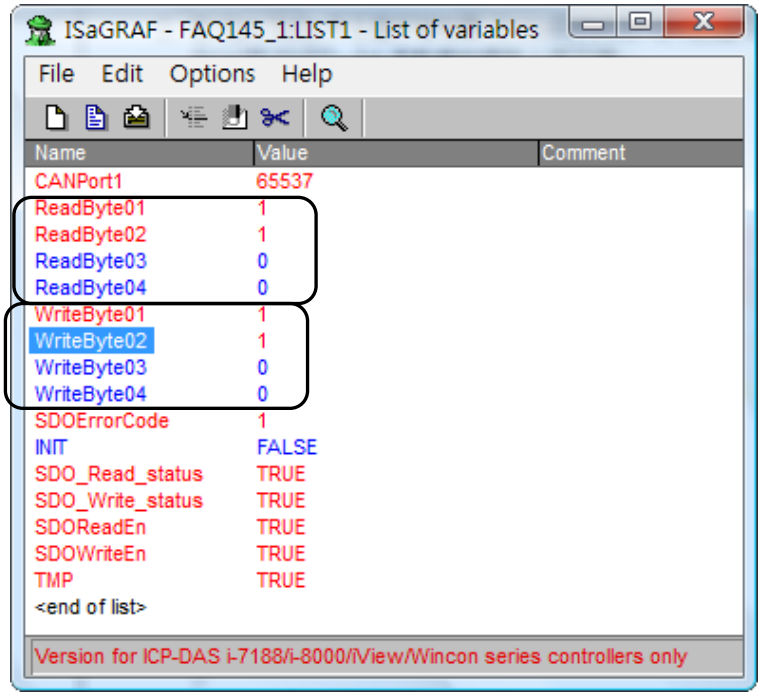
6. CAN Bus Wiring Figure



7. Download the manual from below website for more about CAN-8423.
   http://www.icpdas.com/en/download/show.php?num=1778&model=I-8123W-G

1.4.2 How to operate the CAN-8423 in the demo

1. Recompile the ISaGRAF project and download it into the ISaGRAF PAC. If you are not familiar to the ISaGRAF software, refer to Section 1.1 ~ 1.2 and Chapter 2 of ISaGRAF user manual.
   http://www.icpdas.com/en/download/show.php?num=333&nation=US&kind1=&model=&kw=isagraf
2. Changing the values of variables WriteByte01 ~ 04 in the Spy lists to 0 or 1 can see the values' change of the related variables ReadByte01 ~ 04, as the following picture.



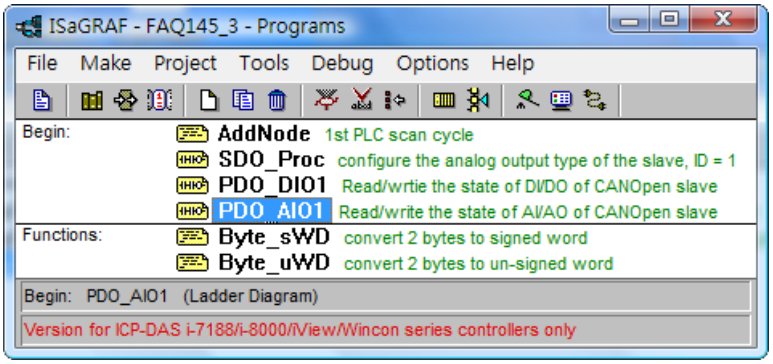
3. Changing those variables is to change the AO output types of the I-8024W on the CAN-8423. Changing the value to 1 is to set the output type to electric current; changing the value to 0 is to set the output type to voltage.

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1.5 Demo Faq145_3 - ISaGRAF PAC Controls Two CAN-8423

● ISaGRAF Project Framework:

Contain 1 ST program (AddNode), 3 LD programs (SDO_Proc, PDO_DIO1, and PDO_AIO1).



● Setting CAN-8423 in This Demo

In this demo, PAC connects two CAN-8423 devices.

1. Set one PAC's ID to 1, Baud rate to 10Kbps, and plug in I-8057W, I-8051W, I-8024W and I-8017HW sequentially. Wire every I-8057 DO to I-8051W DI channels on the CAN-8423. Wire every I-8024 AO to I-8017HW AI channels on the CAN-8423.
2. Set another PAC's ID to 3, Baud rate to 10Kbps, and plug in I-8057W and I-8051W. Wire every I-8057 DO to I-8051W DI channels.

● ISaGRAF Variables List

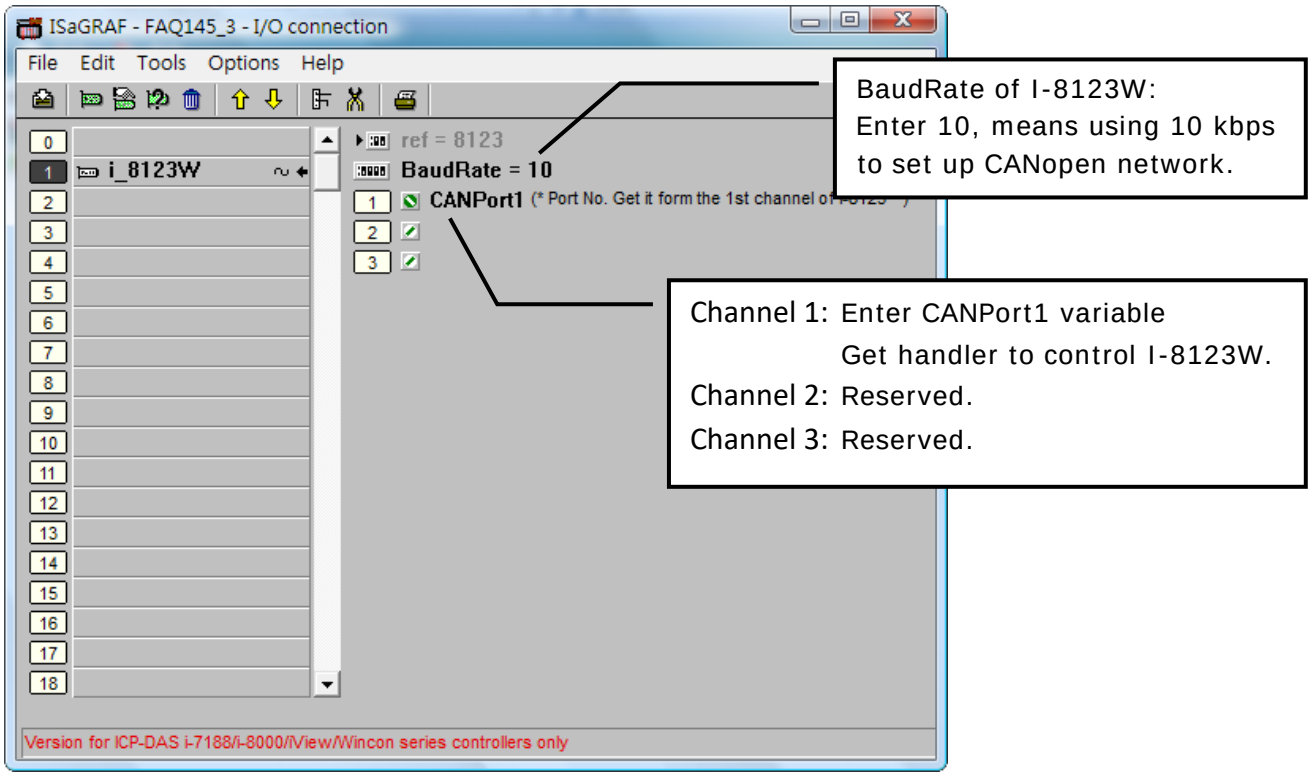
Name	Type	Property	Description
CAN_OPEN2_ID1	Boolean	Internal	Internal use
INIT	Boolean	Internal	A flag for program initialization
TMP	Boolean	Internal	Internal temp storage
DoWriteEn	Boolean	Internal	Trigger the flag to write DO status
DIReadEn	Boolean	Internal	Trigger the flag to read DI status
AOWriteEn	Boolean	Internal	Trigger the flag to write AO status
AIReadEn	Boolean	Internal	Trigger the flag to read AI status
Slave1_status	Boolean	Internal	The online status for Device ID:1
Slave3_status	Boolean	Internal	The online status for Device ID:3
Change_Output_Enable	Boolean	Internal	Trigger the flag to change current DO status
temp	Boolean	Internal	Internal use
CAN_SLave3_DI01~16	Boolean	Internal	The DI status of Device ID:3

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Name	Type	Property	Description
CAN_SLave1_DI01~16	Boolean	Internal	The DI status of Device ID:1
SDO_WRITE_STATUS	Boolean	Internal	The online status for Device ID:1
SDO_READ_STATUS	Boolean	Internal	The online status for Device ID:1
SDOWriteEn	Boolean	Internal	Write the setting of Device ID:1
SDOReadEn	Boolean	Internal	Read the setting of Device ID:1
Slave1NotInit	Boolean	Internal	Check if send the initialization setting for the Device ID:1
Slave3NotInit	Boolean	Internal	Check if send the initialization setting for the Device ID:3
WORD_OUT11	Integer	Internal	Write out the DO status to Device ID:3
CANPort1	Integer	Input	The handler got from the 1st channel of I-8123W
WORD_OUT1	Integer	Internal	Write out the DO status to Device ID:1
WORD1_OUT1~4	Integer	Internal	Write out the AO status to Device ID:1
WORD_IN1	Integer	Internal	The current DI status of Device ID:1
WORD1_IN1~4	Integer	Internal	The current AI status of Device ID:1
Error_Code1~5	Integer	Internal	The error codes for each PDO commend
Data_Len	Integer	Internal	The DO length want to write, default value 2
Data_Len1	Integer	Internal	The AO length want to write, default value 8
WriteByte01~04	Integer	Internal	Write the setting for AO channel type
ReadByte01~04	Integer	Internal	Read the setting of AO channel type
SDOError1~8	Integer	Internal	The error codes for SDO commend
WORD_IN11	Integer	Internal	Current DI status of the Device ID:3
T2	Timer	Internal	Default value T#1s
SDOReadScanTime	Timer	Internal	Default value T#1s
DIReadScanTime	Timer	Internal	Default value T#1s
AIReadScanTime	Timer	Internal	Default value T#1s
PDO_WRITE	Defined words		Set to TRUE
PDO_READ	Defined words		Set to FALSE
SDO_WRITE	Defined words		Set to TRUE
SDO_READ	Defined words		Set to FALSE

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● I/O Connection



● CAN-8423 Object Dictionary

All CANopen devices must have the object dictionary for the device configuration and non-real-time communication. The information that can be found from the device manual is necessary for programming when using the CANopen devices.

The following is the default object dictionary of CAN-8423.

1. CAN-8423 : ID 1

Main Index	Sub-Index	Description	Type	Remark
0x2006	1 to 4	The input/output range number of the 1 to 4 channel on the slot3. Here means the output type for setting I-8024 module.	UNSIGNED 8	The accept range: 0 (Default) : -10 to 10V 1 : 0 to 20mA

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COB-ID	Max. Length (Unit: byte)	Description
0x201	2	Each bit used to control the status of mapping DO channel
0x181	0	Each bit used to display the status of mapping DI channel
0x301	8	Each word used to control the status of mapping AO channel
0x281	0	Each word used to control the status of mapping AI channel

2. CAN-8423 : ID 3

COB-ID	Max. Length (Unit: byte)	Description
0x203	2	Each bit used to control the status of mapping DO channel
0x183	0	Each bit used to display the status of mapping DI channel

- **AddNode Procedure Description:**

```
(*
This demo uses one I-8123W on the slot1 and connects to the CANopen slave devices with 10 Kbps
baud rate. The CANopen devices are two CAN-8423 devices, one's ID is 1 that plugged with 16 DO
(slot 0: I-8057W), 16 DI (slot 1: I-8051W), 4 AO (slot 2: I-8024W) and 4 AI (slot 3: I-8017HW) and the
other device's ID is 3 that plugged with 16 DO (slot 0: I-8057W), 16 DI (slot 1: I-8051W).
*)

(* Add CANopen slave devices into the CANopen master end point list *)
if    INIT    then

  (* Add the CANopen slave device ID: 1 into the end point list, And set the interrupt checking time
     as 6000 ms. *)
   if Slave1NotInit then
      (* The interrupt checking time can be set between 0 ~ 65535 ms. *)
      (* Set "BOO_" to False: means to use the Guarding method to detect the disconnection*)
      TMP := CanOp_st( CANPort1 , False , 1 , 6000 ) ;
```


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```
      (* If TMP is true, it means that the sent commend “add-node” is succeed,
           And set the variable “Slave1NotInit” to false. *)

      if TMP then
         Slave1NotInit := false;
      end_if;
   end_if;

   (* Add the CANopen slave device ID: 3 into the end point list,
        And set the interrupt checking time as 6000 ms. *)
   if Slave3NotInit then
      (* The interrupt checking time can be set between 0 ~ 65535 ms. *)
      TMP := CanOp_st( CANPort1 , CAN_OPEN2_ID1 , 3 , 6000 ) ;
      (* If TMP is true, it means that the sent commend “add-node” is succeed,
           And set the variable “Slave3NotInit” to false. *)

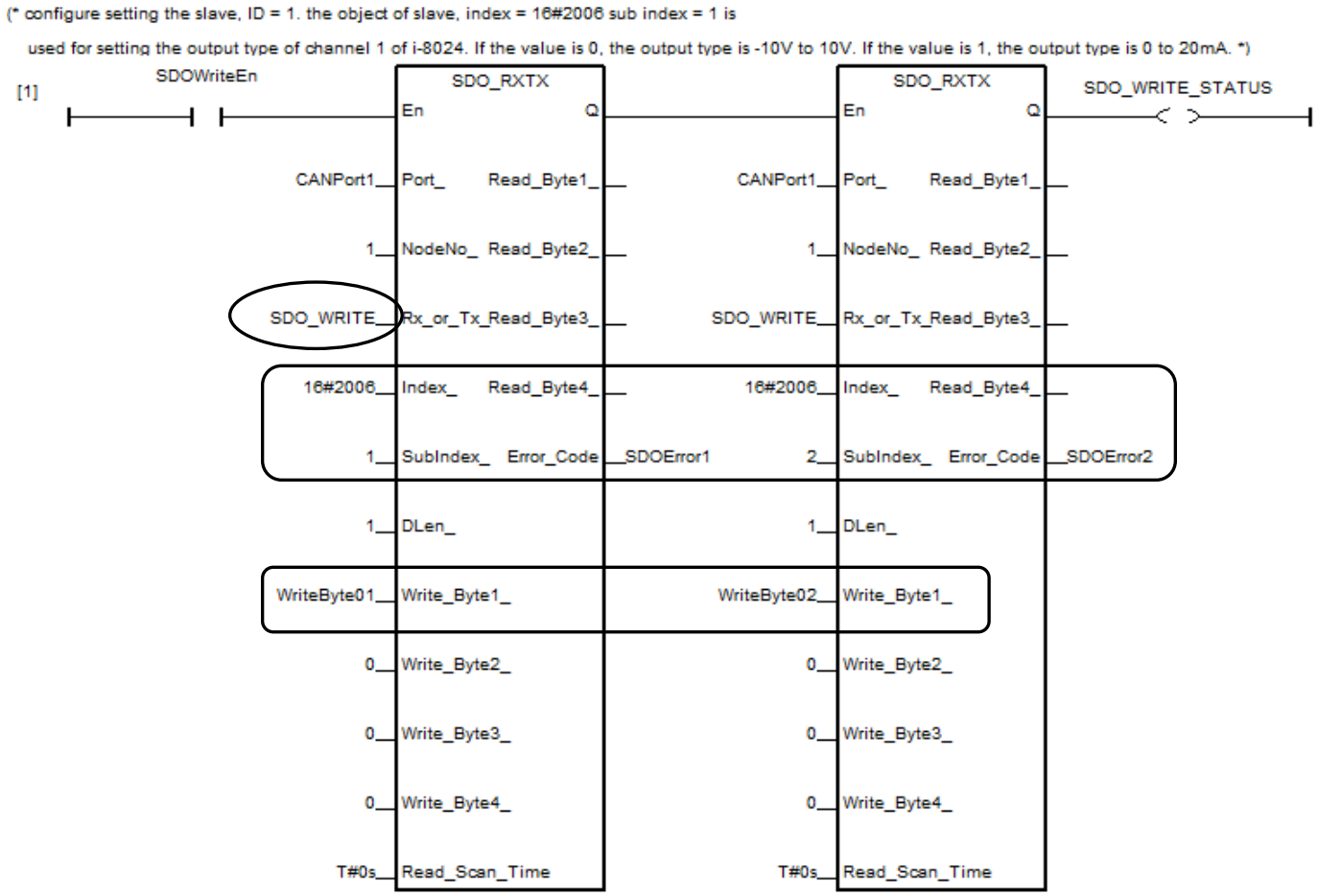
      if TMP then
         Slave3NotInit := false;
      end_if;
   end_if;

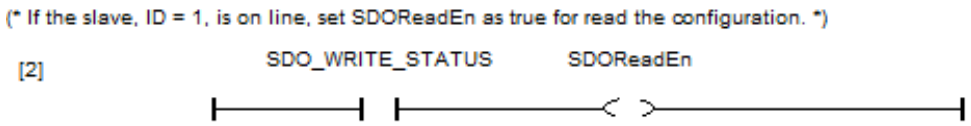
   (* If the variables “Slave1NotInit” & “Slave3NotInit” are all false,
      It means commend is sent and these 2 devices have been added into the end point list. *)
   if Not(Slave1NotInit) and Not(Slave3NotInit) then
      INIT := False;
   end_if;
end_if ;
```


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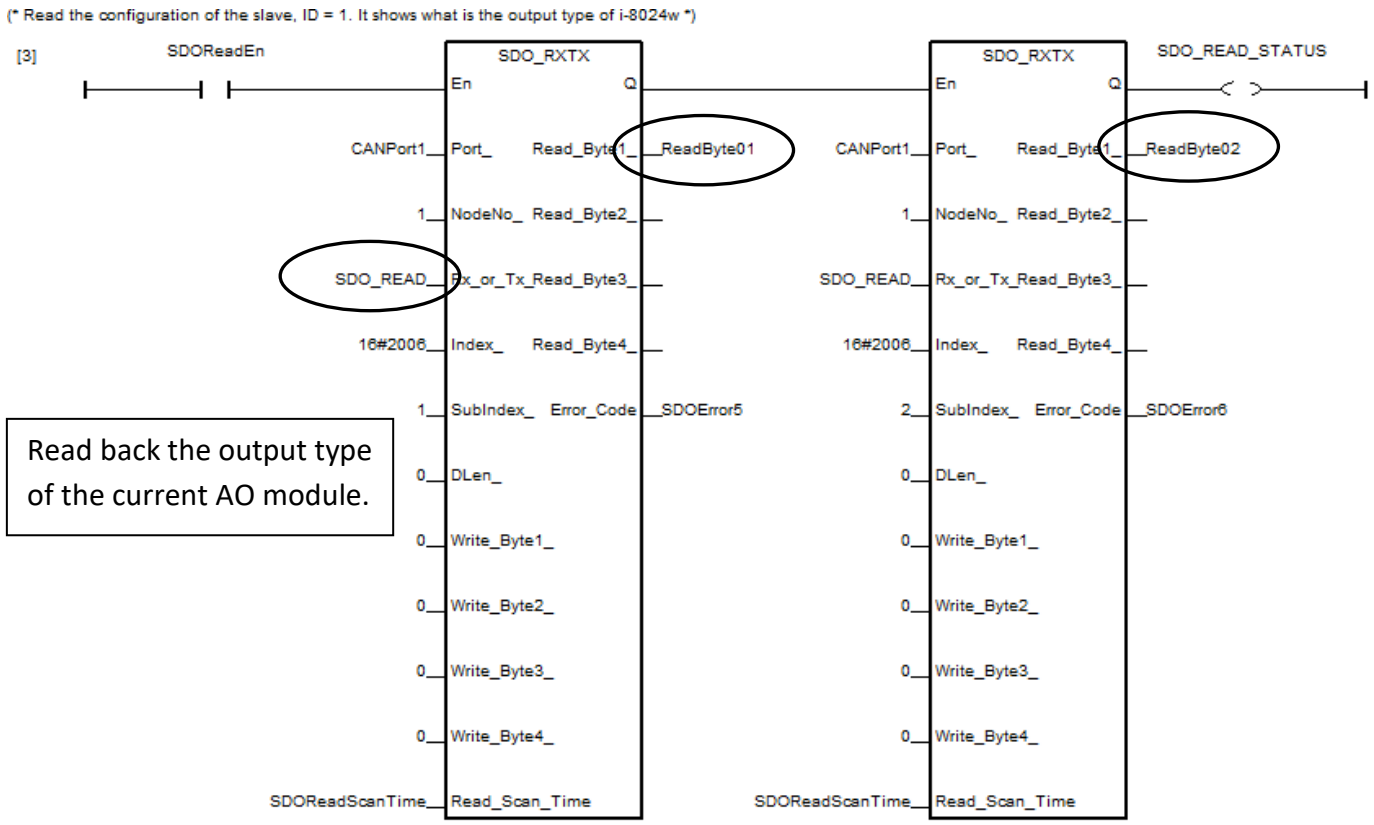
● SDO_Proc Procedure Description:

Set the output type of AO on the CAN-8423 ID: 1. Contrast to the object dictionary, we know, Index: 0x2006, SubIndx: 1 to 2 are mapping to the type of the AO's channel 1 to 2 that output type can be changed via the WriteByte01 to 02. The SDOError1 to 2 can know the current commend statuses.



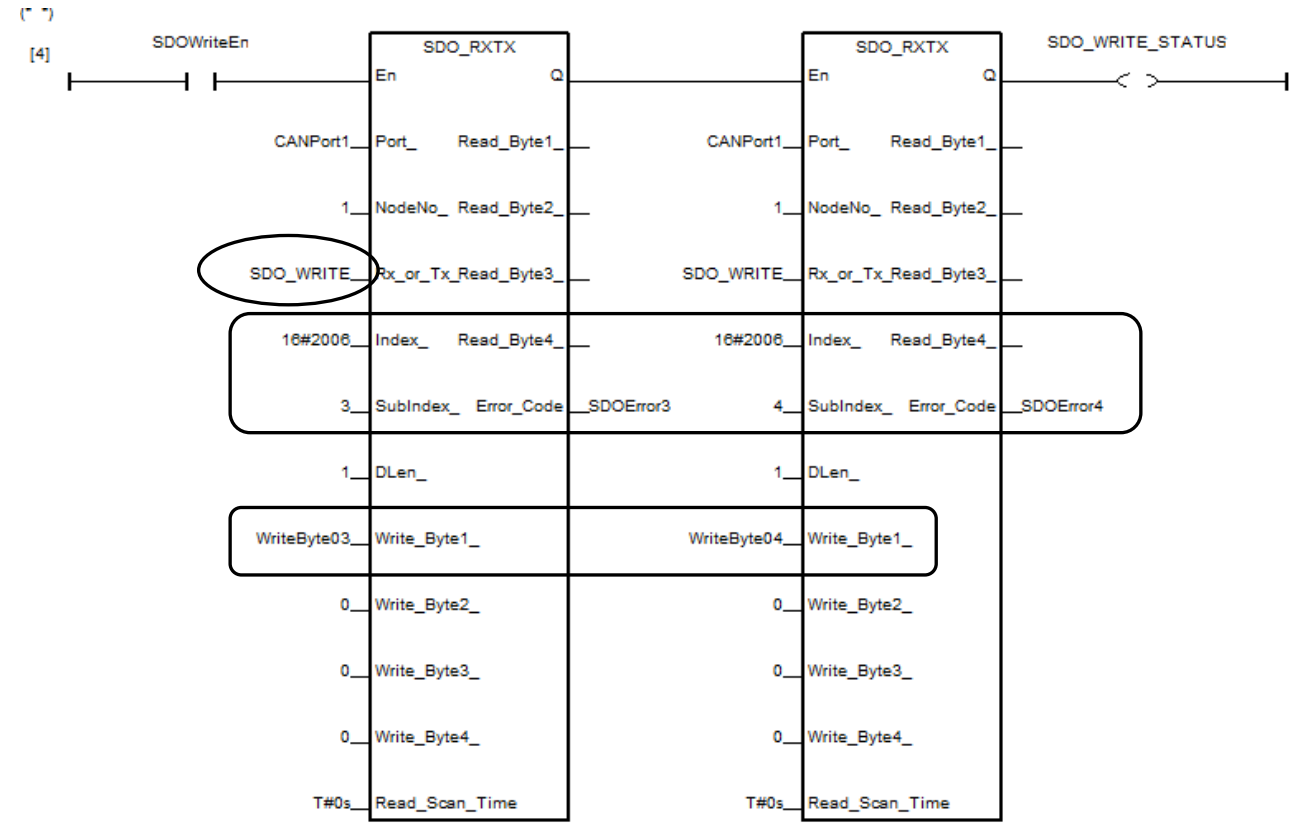


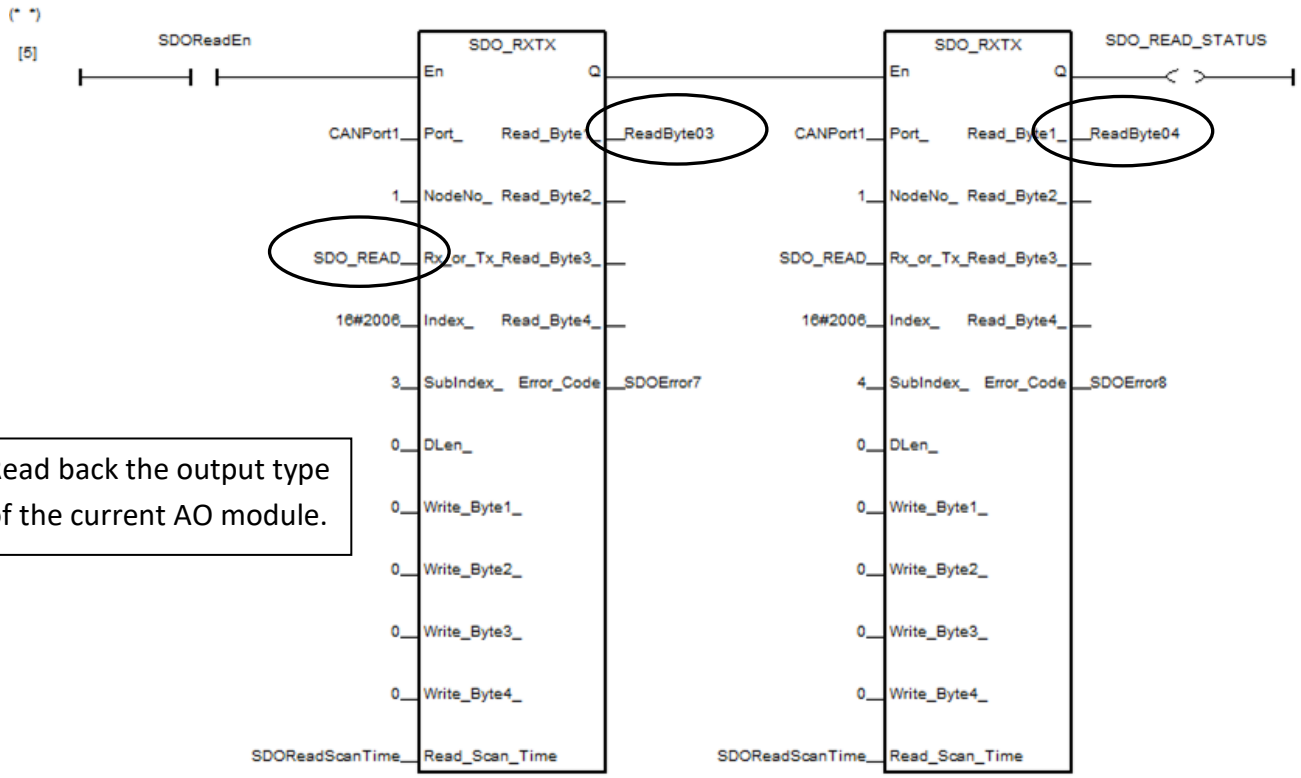
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Set the output type of AO on the CAN-8423 ID: 1. Contrast to the object dictionary, we know, Index: 0x2006, SubIndx: 3 to 4 are mapping to the type of the AO's channel 3 to 4 that output type can be changed via the WriteByte03 to 04. The SDOError3 to 4 can know the current commend statuses.

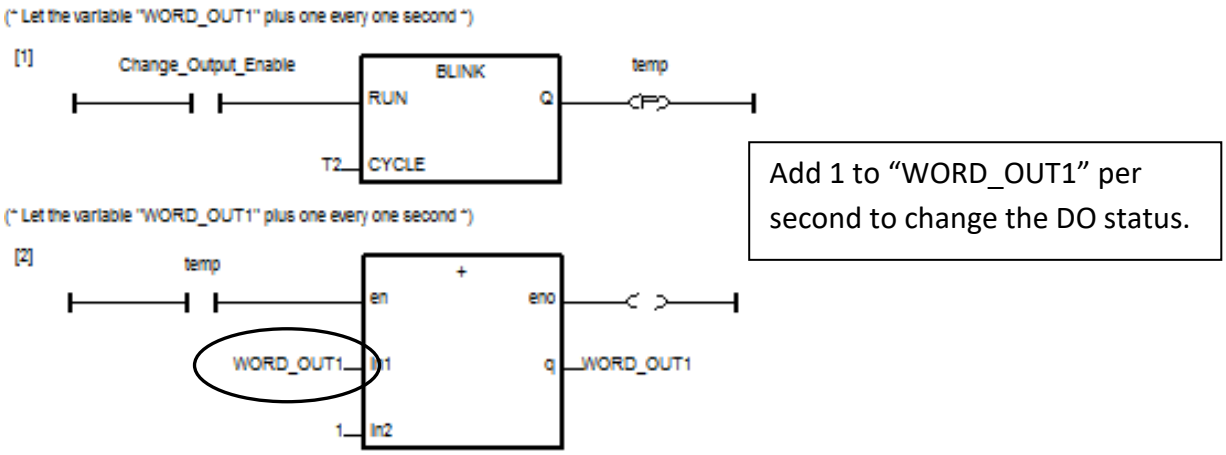




Read back the output type of the current AO module.

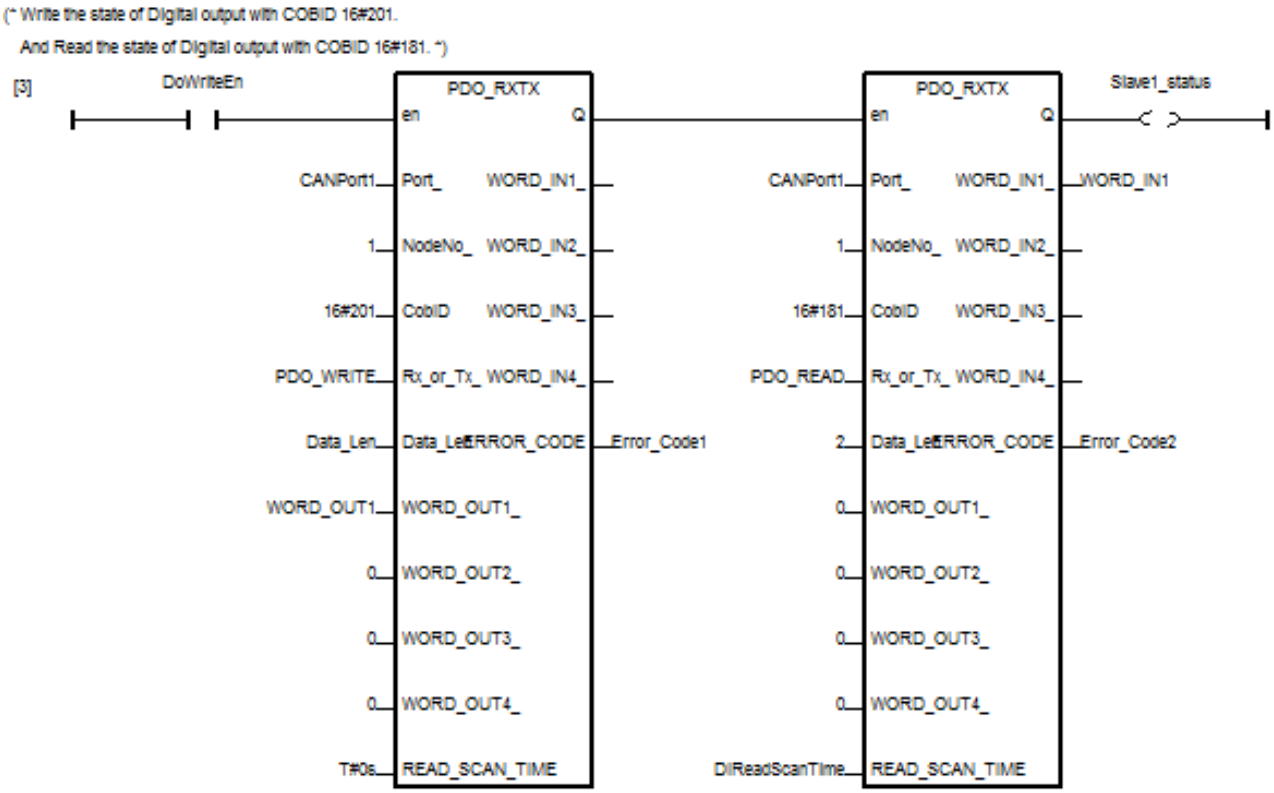
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● PDO_DIO1 Procedure Description

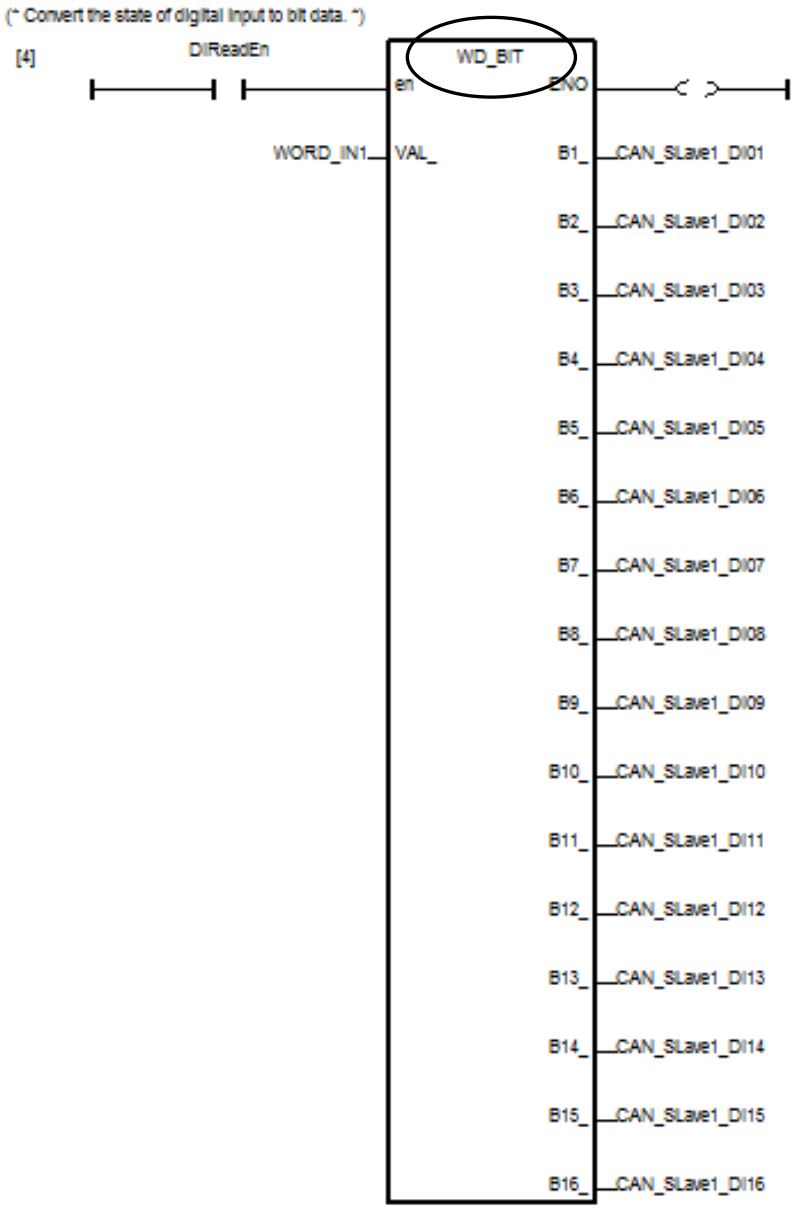


Add 1 to “WORD_OUT1” per second to change the DO status.

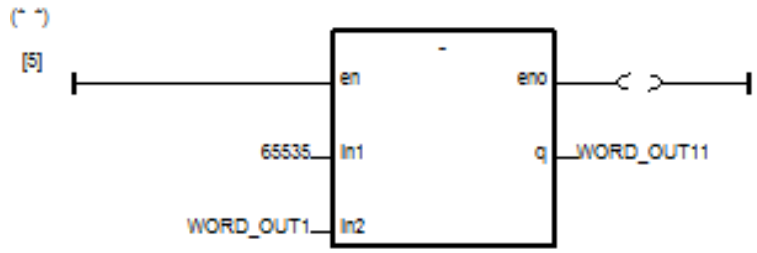
Write the data (length 2) to the object 0x201 to control the DO module of CAN-8423 ID:1. Read the DI status of CAN-8423 ID:1 from the object 0x181.



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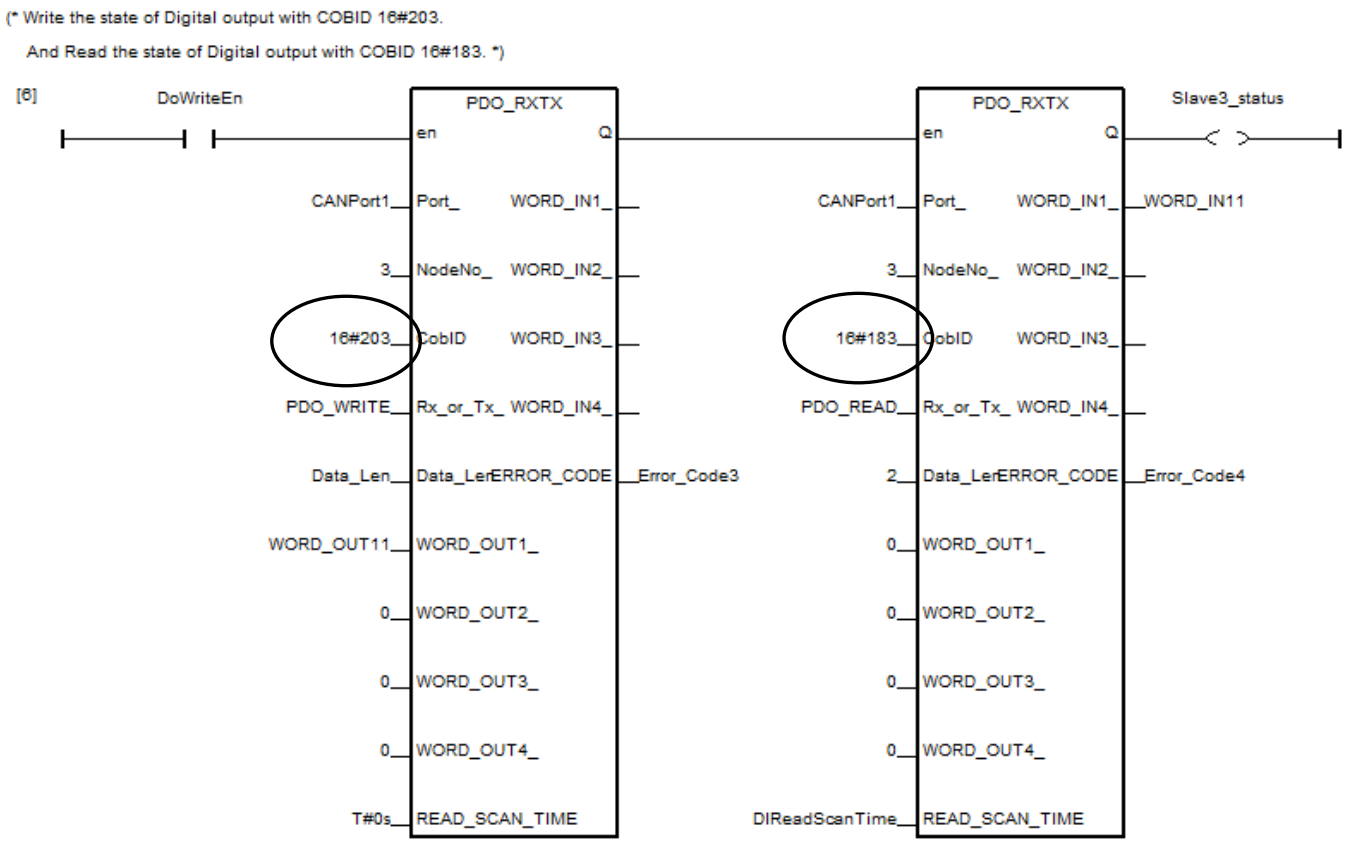


Using the read back DI data to get the DI status via the function block WD_BIT.

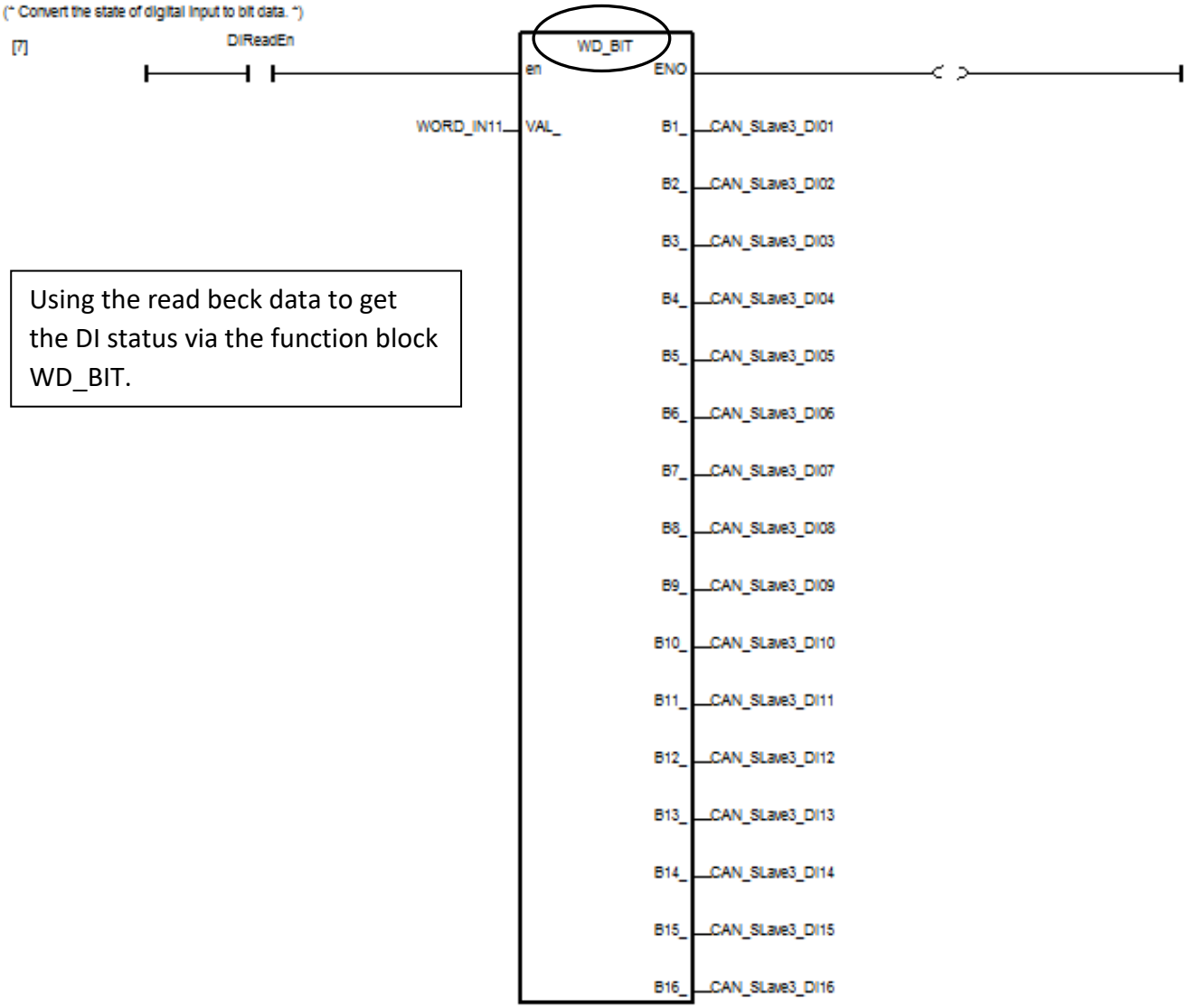


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Write the data (length 2) to the object 0x203 to control the DO module of CAN-8423 ID:3.
Read the DI status of CAN-8423 ID:3 from the object 0x183.

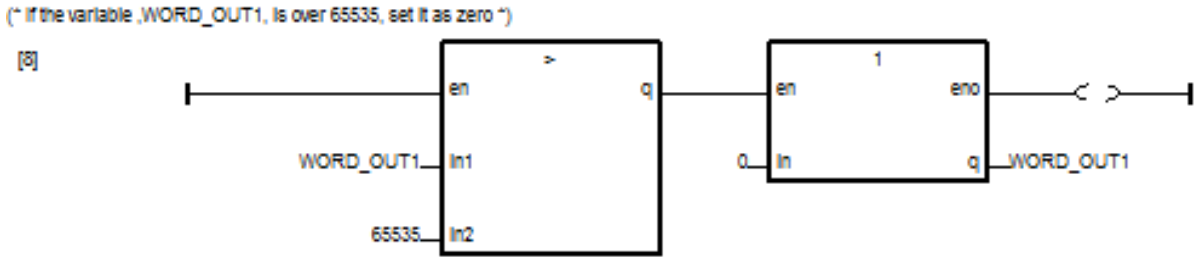


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Using the read beck data to get the DI status via the function block WD_BIT.

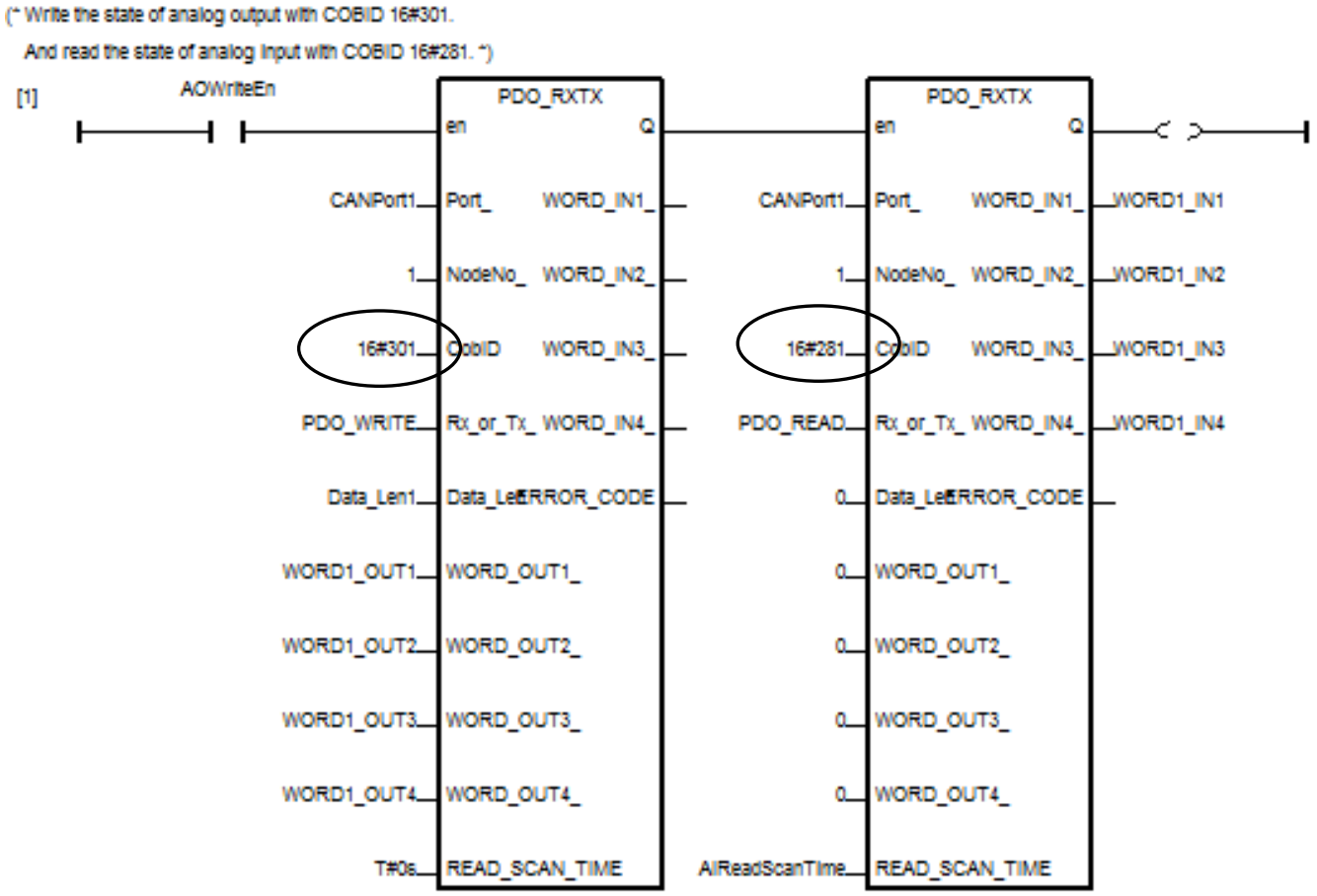
If the value of “WORD_OUT1” is larger than 65535, set the value to 0.



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● PDO_AIO1 Procedure Description

Write the data (length 8) to the object 0x301 to control the AO module of CAN-8423 ID:1.
Read the AI status of CAN-8423 ID:1 from the object 0x281.



Click the link for more ISaGRAF FAQ:
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