Chapter 16 Redundancy

16.1 Features and Architecture

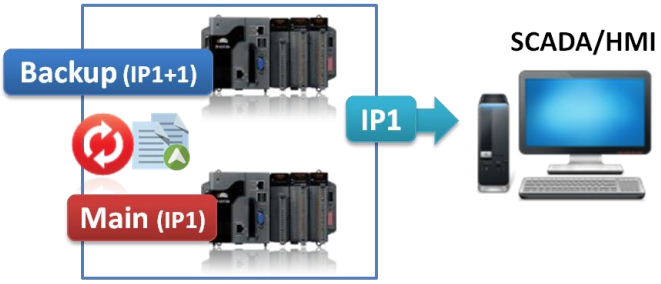
The ICP DAS **Win-GRAF PAC - XP-8xx8-CE6** series support the redundant system:

One redundant system is composed by two Win-GRAF PACs that one is called Main-PAC and the other one is called Backup-PAC. When the PAC that running programs also called Active-PAC is crashed or need to release its control authority by user-defined event, the PAC control authority will automatically switch to the normal one.

Features of the Win-GRAF redundancy

1. **Higher safety:**
   There are three communication cables (LAN1, LAN2 and Alive Port) connected between two PACs. Passive-PAC can backup data when one of LAN cables connects properly. Active-PAC can run Win-GRAF project as long as there is still one cable connecting. In general, if three cables are disconnected (Note: please resume the communication of cables and restart the PAC) or the PAC is crashed, the other PAC will automatically change to Active-PAC.

2. **Unique Public IP:**
   The Win-GRAF redundant system provides a unique public IP address for SCADA/HMI to access it without needing to determine which one is the Active IP address.



3. **Easy maintenance:**
   If one of the redundant PACs is broken during operations, you can remove the broken one. **Note that do not shut down or dismounting the normal PAC, keep it running.** It's no need to download the Win-GRAF project, simply adjust the rotary switch of the same spare Win-GRAF PAC (or a repaired PAC) to the proper position and connect all required communication cables (e.g., LAN1, LAN2, Alive port and I/O), and then re-install this PAC to the redundant system.

   Make sure that the normal PAC is still working properly and then power up the spare PAC. Then, the normal PAC will automatically copy the Win-GRAF project and all the redundant data back to this spaer PAC. It is easier for operators of maintenance and installation. They do not have to re-install all files because the normal PAC will automatically do it for the new one.

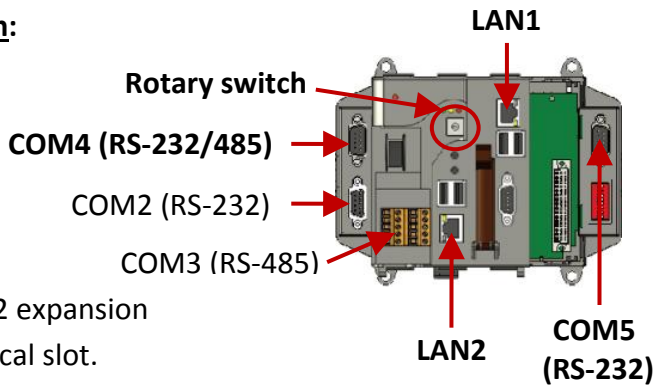
   Exception:
   Except the Win-GRAF project if there are other projects such as C, VB.net, C# and eLogger HMI, running in the redundant system, these files need to pre-installed to the spare Win-GRAF PAC (or a repaired PAC) before re-installing this PAC to the redundant system.

4. **Easy to design the application:**
   Users do not need to specify what files or data should be sent to spare PAC because the Win-GRAF redundant system will automatically handle these tasks.

5. **Users can specify some safety procedures in the program:**
   While the SCADA is unable to connect the Active-PAC due to disconnection on LAN1 or RS-485 ports, users can add these kind of conditions to detect these events and to activate safety procedure to transfer control authority from malfunction PAC to the normal one.

6. **I/O Redundancy:**
   Besides PAC Redundancy, users can choose iDCS-8000 system to achieve I/O redundancy.
   www.icpdas.com/root/product/solutions/remote_io/dcs_redundancy_io/idcs_seleection_guide.html

The architecture of the Win-GRAF redundant system:



Notice:

1. The Win-GRAF redundant system is composed by two PACs. **Do not** use two Main-PACs or two Backup-PACs to form a redundant system.
2. Win-GRAF redundant PACs support RS-485/RS-422 expansion boards (e.g., I-8142i/ I-8144i) plugged into their local slot. Please don't use other kinds of I/O modules.

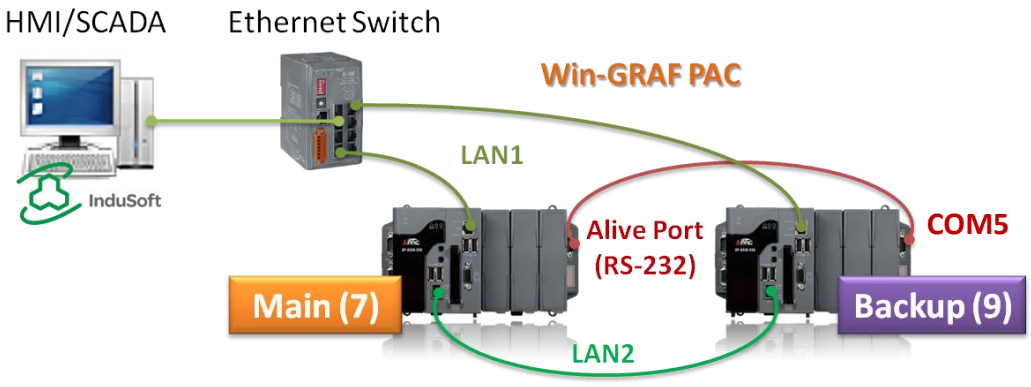
Win-GRAF Redundant System 1 (Rotary switch: 7 & 9)

The rotary switch of PAC is set to "7" called Main-PAC and the other one is set to "9" called Backup-PAC.

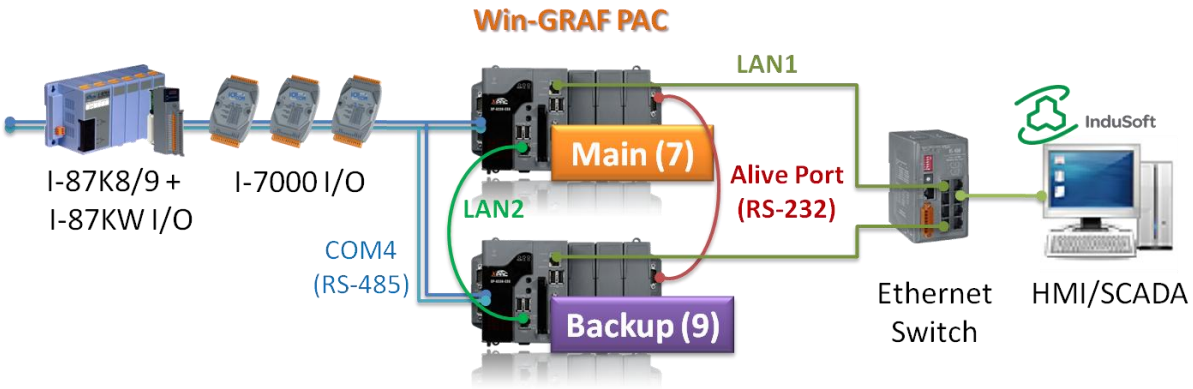
Note:

LAN1: Ethernet Cable, LAN2: Ethernet Crossover Cable, Alive Port (COM5): RS-232 Crossover Cable.

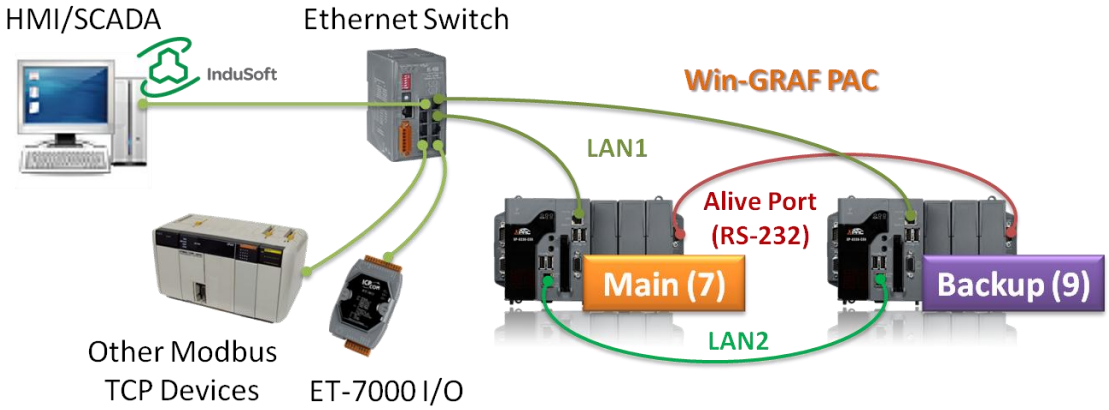
1. **Two PACs without plugged-in I/O modules:**



2. Two PACs with the use of DCON I/O modules:

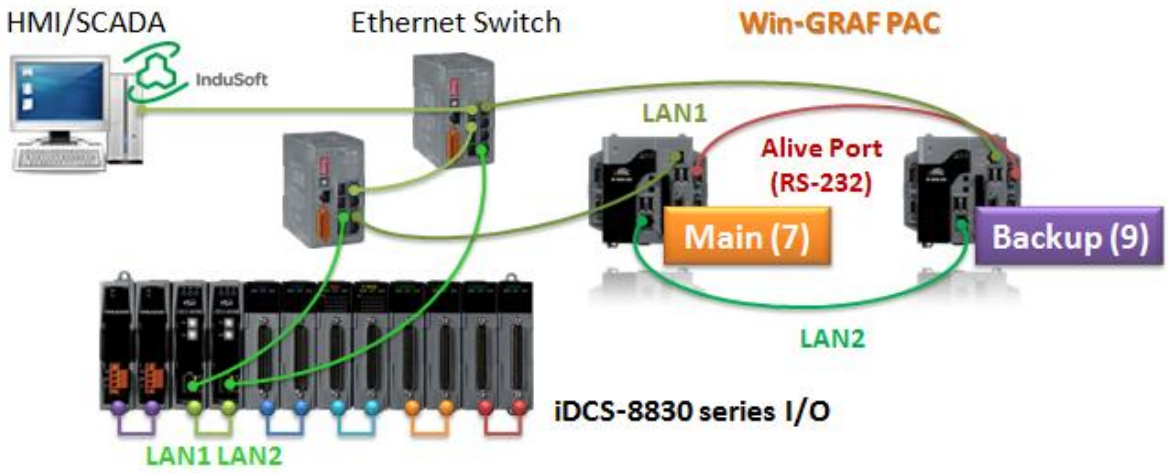


3. Two PACs with the use of Modbus TCP I/O modules:



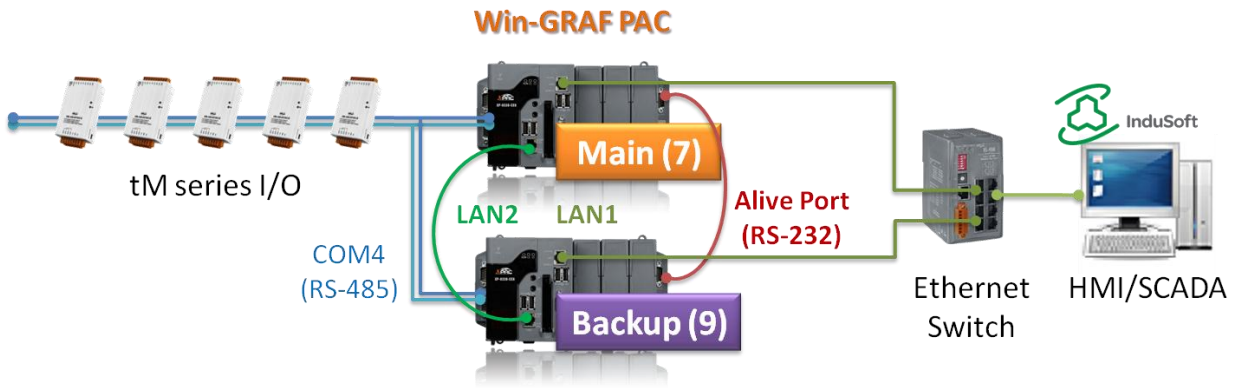
4. Two PACs with the use of iDCS-8830 I/O modules:

This architecture allows to accomplish both PAC and I/O redundancy.



Note: Each pair of plugged-in redundant I/O modules with iDCS-8830 must be the same model numbers.

5. Two PACs are equipped with Modbus RTU/ASCII I/O modules:



6. The I/O connection architecture of the above (2) ~ (5) can also be mixed with 2 (or more) together.

Win-GRAF Redundant System 2 (Rotary switch: 6 & 8)

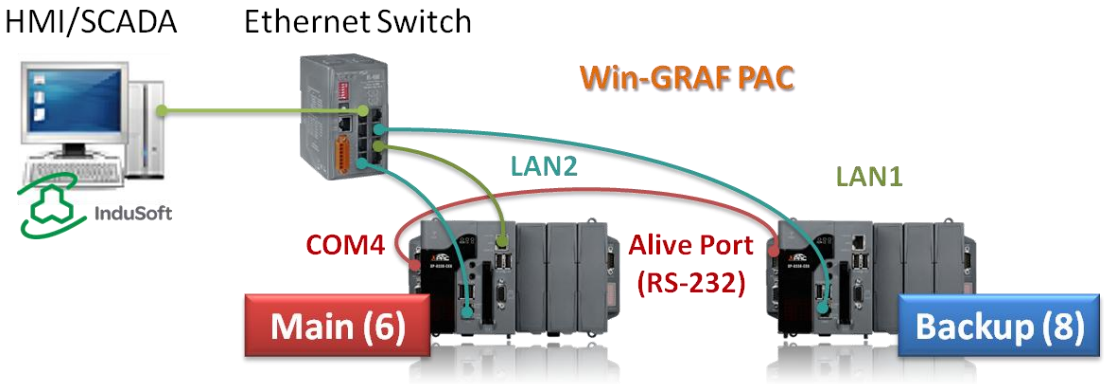
The rotary switch of PAC is set to "6“ called Main-PAC and the other one is set to "8" called Backup-PAC. Win-GRAF redundant system 2 is suitable for multiple sets of redundant PACs whose LAN2 cable is connected to an Ethernet switch/Hub.Users must set their LAN2 IP address.

Note:

LAN1, LAN2: Ethernet Cable, Alive Port (COM4): RS-232 Crossover Cable.

1. Two PACs without plugged-in I/O modules:

The others are similar to the architecture of Win-GRAF redundant system 1.

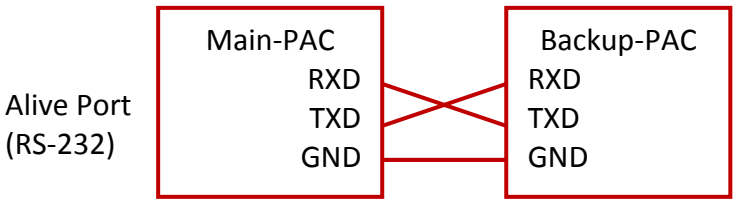


16.2 Important Installation Notes (Ports and LED Indicators)

The Win-GRAF redundant PACs require following three communication ports to communicate with each other.

1. **Alive Port:**

   The Win-GRAF redundant PACs use **RS-232 port as the alive port** (also called Heart-beat port). Both RS-232 ports must be connected together with one RS-232 cross cable. The wire connection for RXD, TXD, and GND pins of RS-232 ports is illustrated in the figure below.

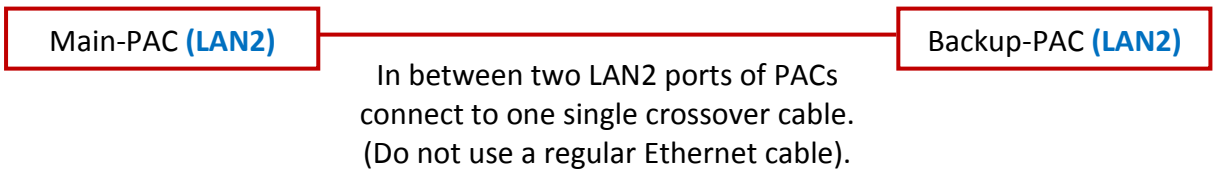


   Win-GRAF Redundant System 1: using COM5 as the Alive Port.
   Win-GRAF Redundant System 2: using COM4 as the Alive Port.

2. **Replication Port:**

   Win-GRAF Redundant System 1

   The Win-GRAF redundant PACs use **LAN2 port as the replication port**. **In between two LAN2 ports of PACs must connect to one single crossover cable.** LAN2 can only be used to transfer redundant data between two PACs in high speed. **Do NOT** connect LAN2 with any external devices such as Switches or Hubs otherwise it might cause an error or get timed-out.



   In between two LAN2 ports of PACs
   connect to one single crossover cable.
   (Do not use a regular Ethernet cable).

   Win-GRAF Redundant System 2

   The Win-GRAF redundant PACs allows to use **LAN1/LAN2 port as the replication port**. **In between two LAN1/LAN2 ports of PACs simply connect to an Ethernet Switch/Hub**.

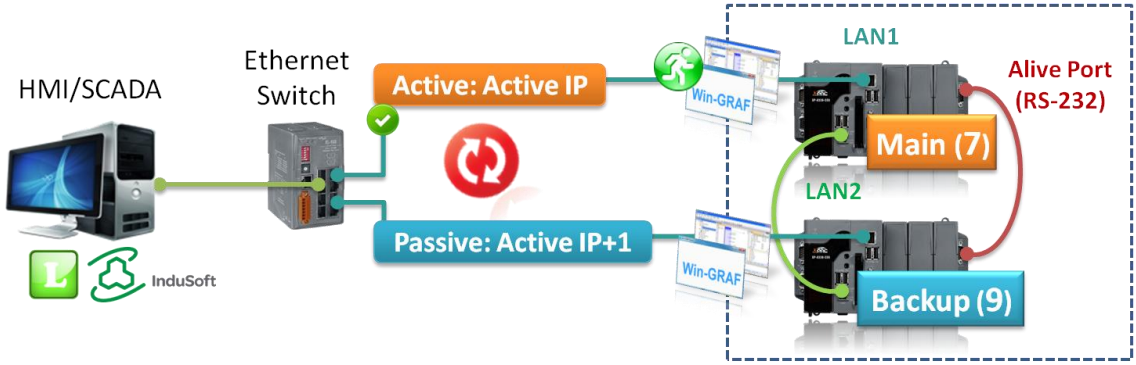
   LAN1 and LAN2 port use an Ethernet cable.

3. **Public IP Port:**

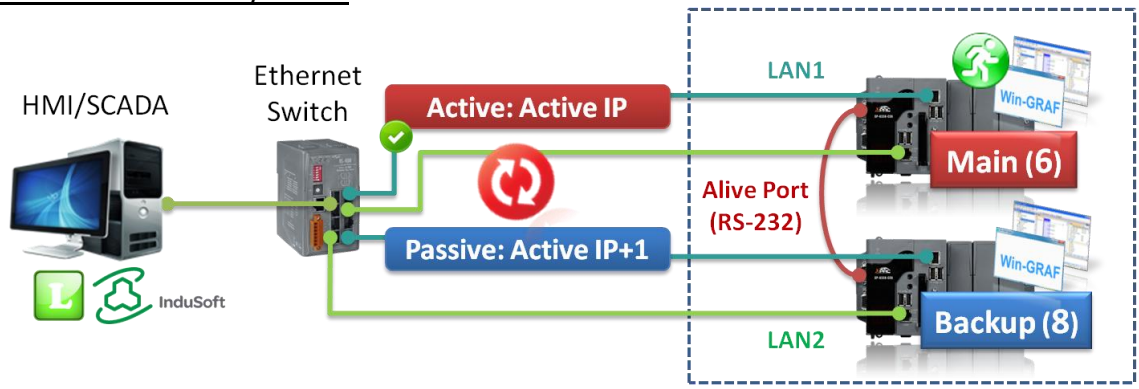
   The LAN1 port of Win-GRAF PAC should be connect to an Ethernet Switch through a normal Ethernet cable. Then PAC can communicate with SCADA or control external Modbus TCP devices such as I/O modules and Ethernet equipment.

   SCADA/HMI could communicate with Win-GRAF redundant system with only one single "Active_IP" address (refer to Section 16.4.1). This means: when Active-PAC takes over the control authority, IP address of LAN1 will automatically switch to "Active_IP"; when this PAC releases out the control authority, IP address of LAN1 will switch to "Active_IP+1".

   Win-GRAF Redundant System 1



   Win-GRAF Redundant System 2



4. **LED Indicators:**

   The L1 and L2 LED indicators on PAC panel can be used to display the running status of Win-GRAF redundant system.

L1: Active/Passive PAC	
ON	This PAC is Active PAC
Blinking	This PAC is Passive PAC
L2: Data Synchronization	
ON	Using LAN2 port to backup data
Blinking	Using LAN1 port to backup data
OFF	No data synchronization

PAC Installation Notes (Very Important):

Note: If two PACs have never been installed the redundancy project, refer to Section 16.5 - Test the Redundant System 1 and Section 16.6 - Test the Redundant System 2 to download the Win-GRAF project to the Main-PAC first.

※ **Set the rotary switch**

Before power on PACs, make sure the rotary switch of PAC is set properly. Wrong settings might cause redundant system unstable.

Win-GRAF Redundant System 1: One is set to 7, the other one is set to 9.

Win-GRAF Redundant System 2: One is set to 6, the other one is set to 8.

※ **Connect the communication cables (LAN1, LAN2, and Alive port)**

Before power on PACs, make sure following three cables and other communication cables such as RS-485 cables are properly connected.

While you power on PACs with cable unconnected, it might be error for redundant system.

A. Connect both Alive ports of PACs by using a RS-232 crossover cable.
B. LAN2 ports on two PACs
   Win-GRAF Redundant System 1: using one Ethernet crossover cable to connect with each other.
   Win-GRAF Redundant System 2: using Ethernet cable to connect to an Ethernet Switch or Hub.
C. Connect both LAN1 ports of PACs to an Ethernet switch by using Ethernet cables.

※ **Replace the spare (or repaired) PAC while needed**

When one PAC is running properly, do not power off or shut down this one. Please follow two instructions above to replace the spare (or repaired) PAC; then power on.

※ **Only the Active-PAC run the project**

When the PAC take over the control authority (called Active-PAC), it will run the Win-GRAF project. The Passive-PAC only receive data and take over the control authority accroding to the logical conditions of the Win-GRAF project or when Active-PAC is crashed.

16.3 What Kinds of Data will Automatically Send to the Passive-PAC?

Win-GRAF redundant system will automatically send a part of data from Active-PAC to Passive-PAC.

What Kinds of Data can Backup Automatically:

1. The user's Win-GRAF applications.
2. The execution step of programs.
3. The value of variables.
4. The private data of function block instance.
5. The PAC's RTC (Real Time Clock) time.
6. Retain memory.
7. The configuration file for Schedule-control (refer to Chapter 17).

The most common data that cannot BackUp to the Passive-PAC Automatically?

1. The status of Timer variable (Ticking or Sleeping).
2. Except for user's Win-GRAF applications and config files of schedule-control, some files in the Active-PAC are unable to send to the Passive-PAC. For example, files that stored in the "\system_disk" or "\Micro_SD" or non-Win-GRAF applications such as C, VB.net, C#, and eLogger applications. These files should be pre-installed in the spare (or repaired) PAC before mounting it to the redundant system.
3. If using the COM_OPEN() function to open the serial port, which will not automatically be opened on the Passive-PAC.
4. The PAC's data that stored in EEPROM memory cannot be backed up automatically.

For some data that unable to send to the Passive-PAC automatically, users can deal with them by programming as follows. Refer to the "Retain_and_timer" program in the "demo_RDN_2" project.

```
if  is_first_cycle_just_after_switch  then

  (* Just in the cycle after switching. *)
  ……

end_if ;
```

16.4 Description of Win-GRAF Demo Projects

The Win-GRAF PAC CD provides four demo projects for the redundant system, i.e., "demo_RDN_1.zip", "demo_RDN_2.zip", "demo_RDN_3.zip" and "demo_RDN_4.zip". Refer to Chapter 12 to restore these files to the Win-GRAF Workbench.

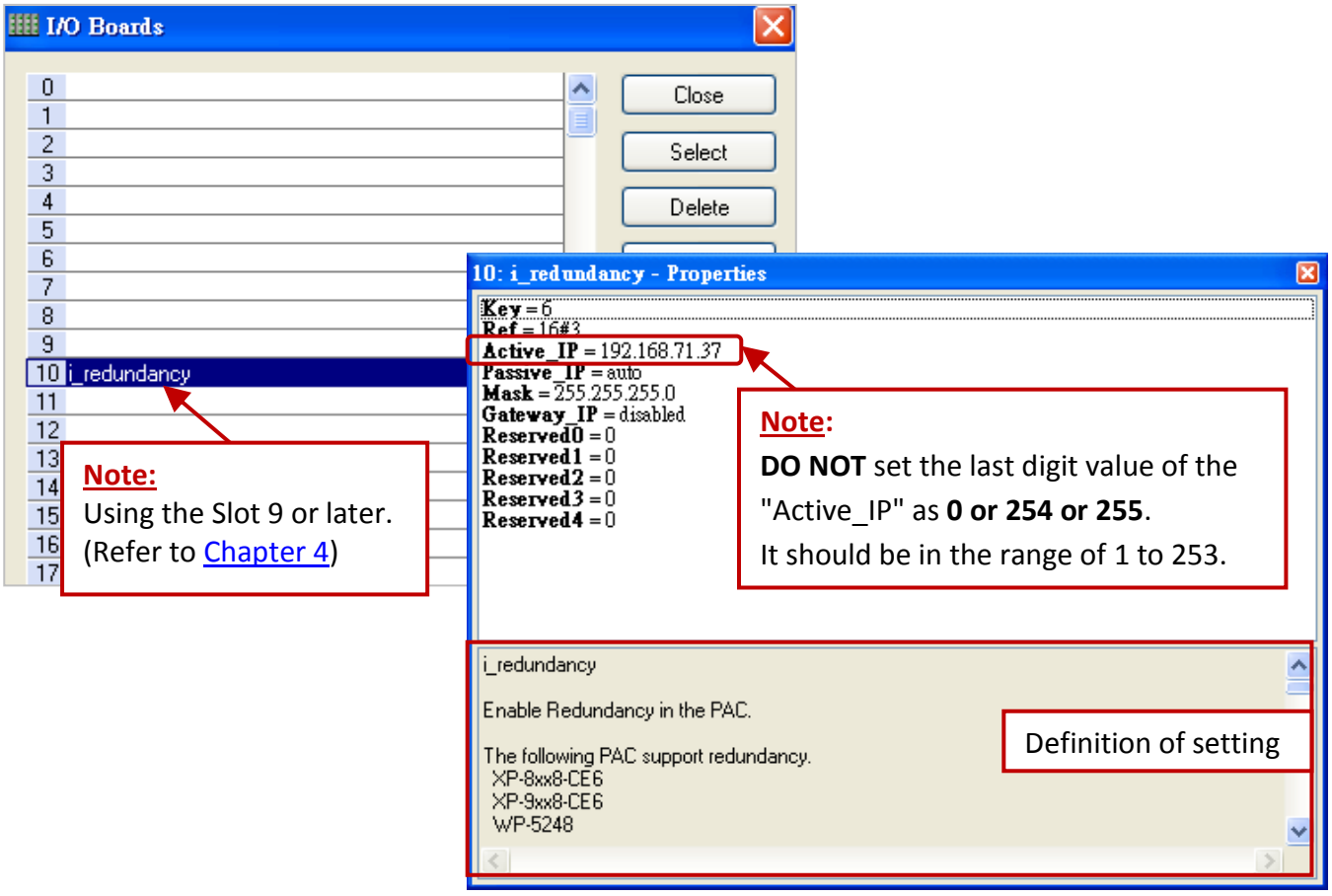
Project Name	Description	
demo_RDN_1	Using both the COM3 of PACs to connect three DCON I/O modules.	Test
demo_RDN_2	Using two PACs without connecting any I/O module.	Test, Program
demo_RDN_3	Using both the LAN1 of PACs to connect a ET-7050 (Modbus TCP I/O module) through one Ethernet switch.	Test
demo_RDN_4	Using both the LAN1 of PACs to connect an iDCS-8830 through one Ethernet switch. iDCS-8830 supports redundant I/O modules.	Test, Program

Note: XP-8xx8-CE6 series support the redundant system.

16.4.1 [Important] "I/O Board" Settings (i_redundancy and i_redundancy_rs485)

✧ **Used for demo_RDN_1, demo_RDN_2, demo_RDN_3, and demo_RDN_4:**

To enable Redundancy function on PAC, users must add the "i_redundancy" function into the "I/O Boards" window.



Description of "i_redundancy" I/O board:

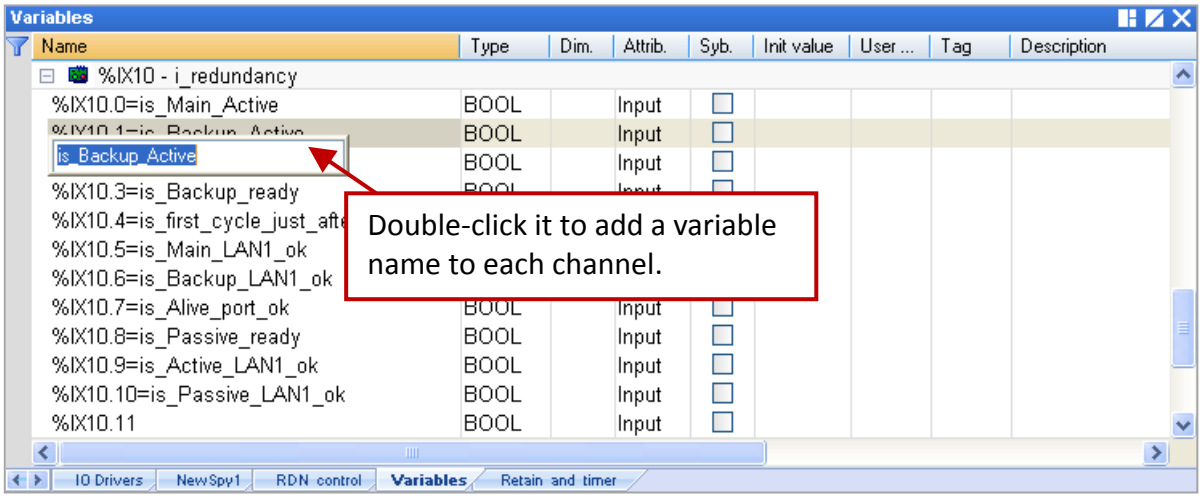
The function is used to display the current status of Win-GRAF redundant system.

Active_IP: This IP address is public for the redundant system to communicate with HMI or SCADA. **DO NOT** set the last digit value of the "Active_IP" IP address as 0 or 254 or 255. It should be from 1 to 253.

Passive_IP: "Auto", the LAN1 IP address of the Passive-PAC will automatically be set as **Active_IP +1**. E.g., if the "Active_IP" is set as "192.168.71.37", the "Passive_IP" will be automatically set as "192.168.71.38".

Mask: The common settings are either 255.255.255.0 or 255.255.0.0 depending on the network environment.

Note: After adding the "i_redundancy" in the "I/O Boards" window, it will auto add 12 "BOOL" input channels in the "Variables" window that can be used to display the current status of the redundant system.



Ch.0 (is_Main_Active): **Is the Main-PAC active now?**

TRUE: Active , FALSE: Passive

Ch.1 (is_Backup_Active): **Is the Backup-PAC active now?**

TRUE: Active , FALSE: Passive

Ch.2 (is_Main_ready): **Is the Main-PAC ready?**

If Ch.2 returns FALSE. The possible reason could be the following.

(1) The Ethernet cable (LAN2) between Main and Backup-PAC is broken.

(2) The Main-PAC is dead or crashed.

(3) The rotary switch of the Main-PAC is not set at 7 (or 6).

Ch.3 (is_Backup_ready): **Is the Backup-PAC ready?**

If Ch.3 returns FALSE. The possible reason could be the following.

(1) The Ethernet cable (LAN2) between Main and Backup-PAC is broken.

(2) The Main-PAC is dead or crashed.

(3) The rotary switch of the Main-PAC is not set at 9 (or 8).

Ch.4 (is_first_cycle_just_after_switch): For Active-PAC only.

True: Now is in the first cycle just after switching.
False: Now is not in the first cycle after switching.

Ch.5 (is_Main_LAN1_ok): Is the LAN1 port of the Main-PAC ok?

TRUE: OK.
FALSE: Fail or Ethernet cable is disconnected.

Ch.6 (is_Backup_LAN1_ok): Is the LAN1 port of the Backup-PAC ok?

TRUE: OK.
FALSE: Fail or Ethernet cable is disconnected.

Ch.7 (is_Alive_port_ok): Is the communication status of Alive Port ok?

TRUE: OK.
FALSE: Fail or the Passive-PAC is dead or crashed.

Ch.8 (is_Passive_ready): Is the Passive-PAC ready now?

If Ch.8 returns FALSE. The possible reason could be the following.
(1) The Ethernet cable (LAN2) between Main and Backup-PAC is broken.
(2) The Passive-PAC is dead or crashed.
(3) The rotary switch setting of the Passive-PAC is incorrect.

Ch.9 (is_Active_LAN1_ok): Is the LAN1 port of the Active-PAC ok?

TRUE: OK.
FALSE: Fail or Ethernet cable is disconnected.

Ch.10 (is_Passive_LAN1_ok): Is the LAN1 port of the Passive-PAC ok?

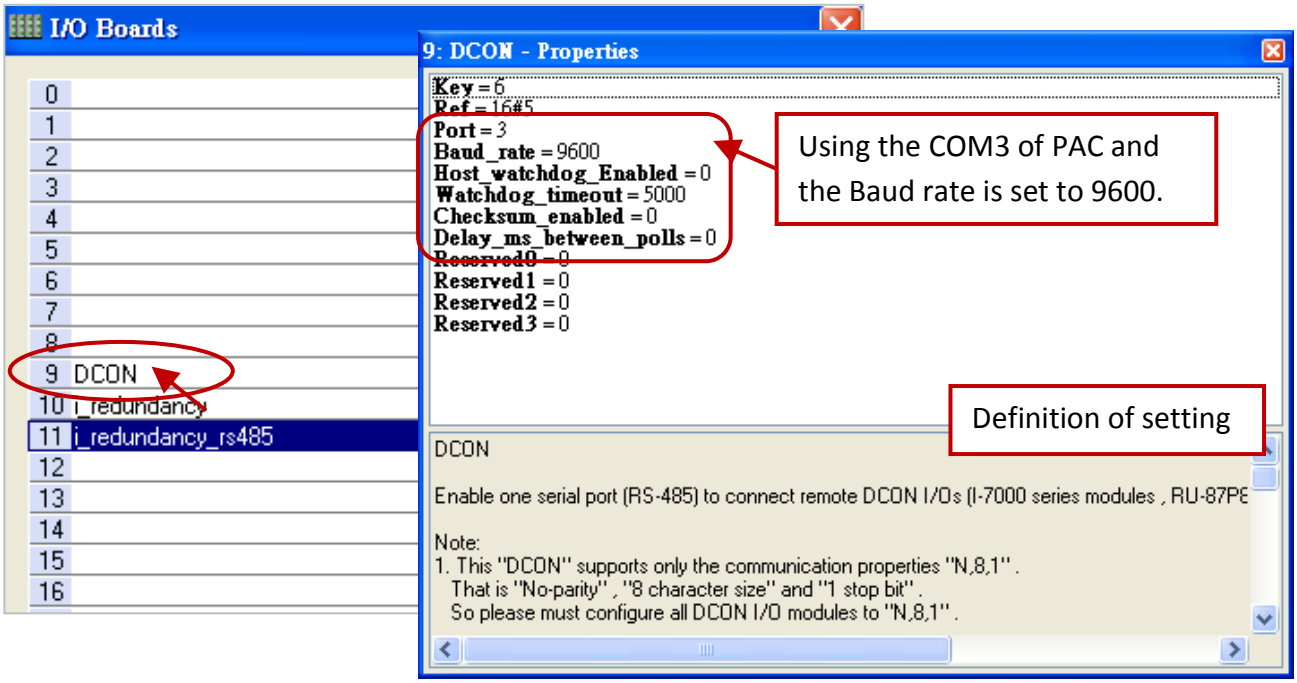
TRUE: OK.
FALSE: Fail or Ethernet cable is disconnected.

Ch.11 (is_Backup_data_ok): Is the data synchronization of two PAC ok?

0: No data synchronization
1: Using LAN1 port to backup data
2: Using LAN2 port to backup data

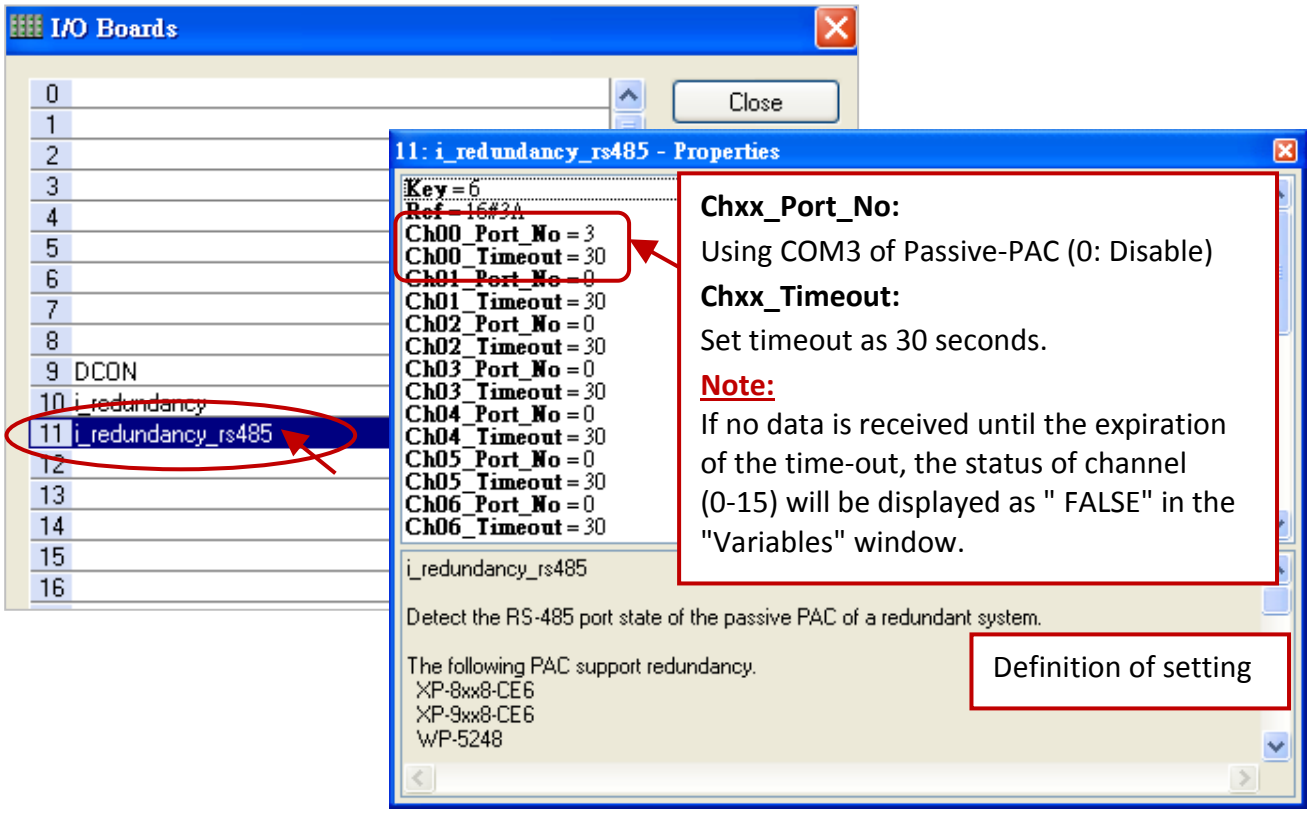
✧ **Used for demo_RDN_1:**

In this case, using the COM3 (RS-485) of PAC to connect DCON I/O modules. Besides "i_redundancy", also "DCON" must be added in the I/O Boards window. Moreover, the "i_redundancy_rs485" function is used to check if the RS-485 port of Passive-PAC can receive data normally.



Important Notice:

1. The "i_redundancy_rs485" must use with the "i_redundancy" or it doesn't work.
2. The "i_redundancy_rs485" only enable RS-485 ports of Passive-PAC to receive data but not to send data.



16.4.2 Declaring Variables (demo_RDN_2)

Users can view or add variables in the "Variable" window (refer to Section 2.3).

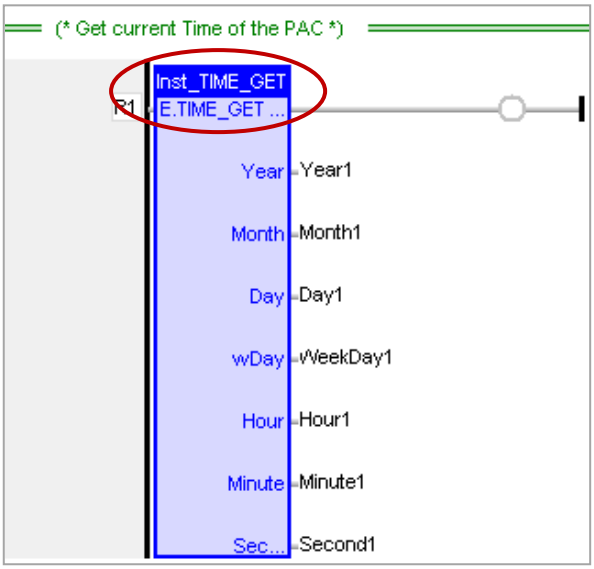
Name	Data Type	Description
Used in the "PAC_Time" program		
Year1	DINT	Used in the "PAC_Time" program: They are used to get the PAC's system time.
Month1		
Day1		
WeekDay1		
Hour1		
Minute1		
Second1		
Set_new_time	BOOL	Set it as "TRUE" to set up new system time.
Year_to_set	DINT	Used in the "PAC_Time" program: They are used to set the PAC's system time.
Month_to_set		
Day_to_set		
Hour_to_set		
Minute_to_set		
Second_to_set		
Used in the "Retain_and_timer" program		
DINT_1	DINT	Used in the "Retain_and_timer" program: Set them as retain variables.
DINT_2		
REAL_1	REAL	
REAL_2		
TMR_1	TIME	Timer
TMR_2		
retain_done	BOOL	TRUE: Retain variables are well set up; FALSE: Not set up yet.
on_line_change_cycle	DINT	Non-zero, means this is the first cycle just after On-Line change.
tmp_bool	BOOL	It used to return the Retain status.
TMR_1_last_state		TRUE: Ticking ; FALSE: Sleeping.
TMR_2_last_state		TRUE: Ticking ; FALSE: Sleeping.
To_tick_TMR_1		Set it as TRUE to start TIMER1.
To_tick_TMR_2		Set it as TRUE to start TIMER2.
To_stop_TMR_1		Set it as TRUE to stop TIMER1.
To_stop_TMR_2		Set it as TRUE to stop TIMER2.

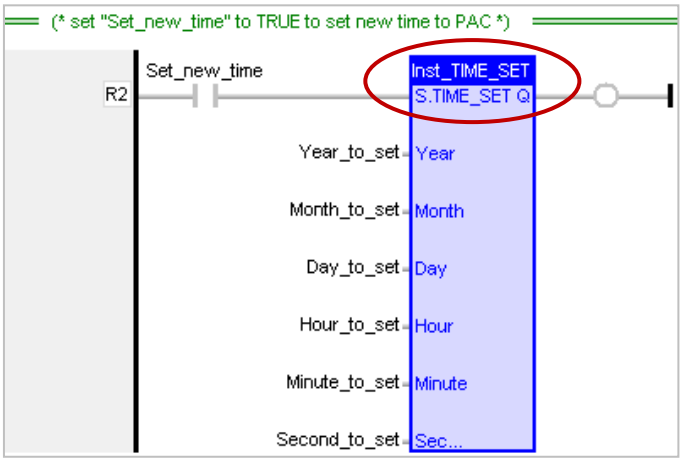
16.4.3 Introduction of the "demo_RDN_2" Project

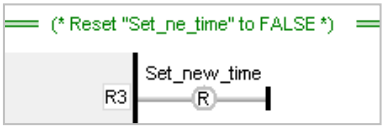
This project includes one LD program and one ST program.

LD Program – "PAC_Time"

It used to get/set the system time of PAC.







LD Program – "RDN_control"

When an error occurs on the LAN1 of the Active-PAC, also the Passive-PAC is ready and its LAN1 is function normally, the Active-PAC will reboot after 10 seconds, and change the control authority to the Passive-PAC.

ST Program – "Retain_and_timer"

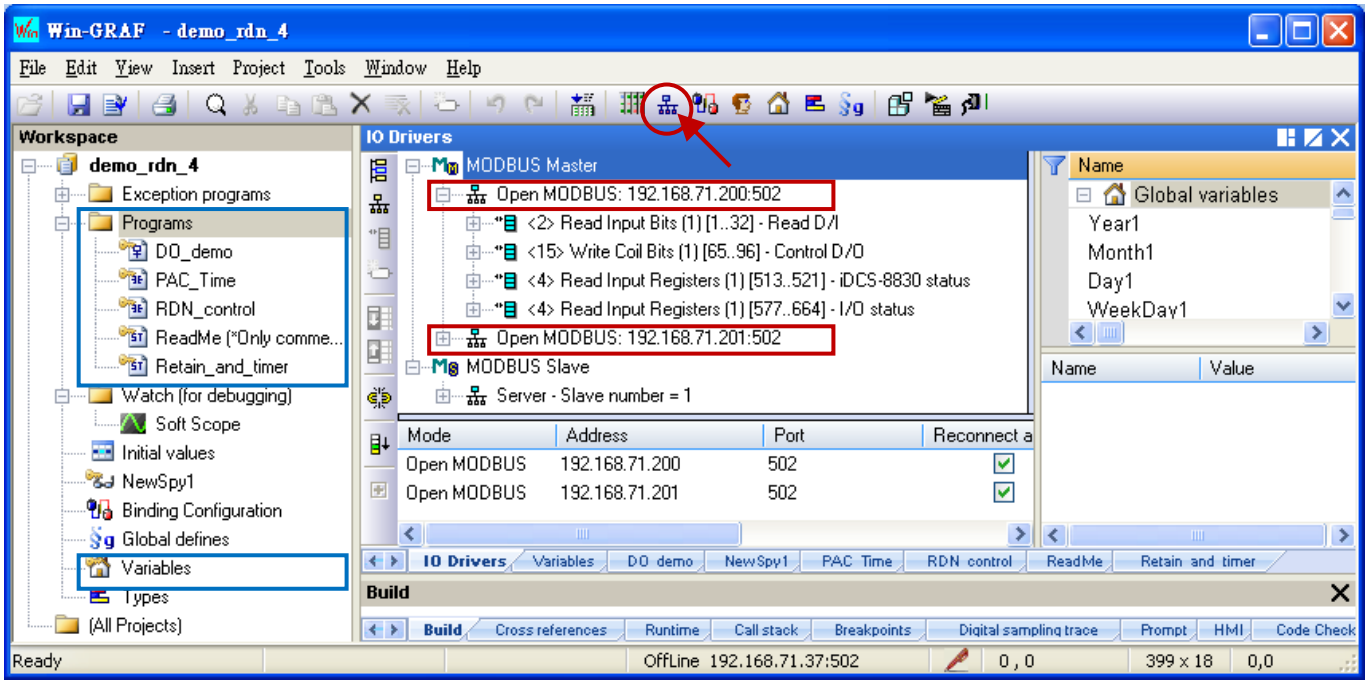
```
(*   "on_line_change_cycle" is declared as DINT (nonezero means  it is in the cycle jsut
     after doing on line change) .
     "retain_done" is declared as BOOL and inited as FALSE .
     "tmp_bool" is declared as BOOL.  *)

on_line_change_cycle := GetSysInfo (_SYSINFO_CHANGE_CYCLE) ;
if (retain_done = FALSE) or
  (is_first_cycle_just_after_switch = TRUE) or
  (on_line_change_cycle <> 0) then
    retain_done := TRUE ;  (*just do it one time *)
    tmp_bool := Retain_Var( DINT_1 , 1) ; (* retain a DINT variable *)
    tmp_bool := Retain_Var( DINT_2 , 2) ;
    tmp_bool := Retain_Var( REAL_1 , 3) ; (* retain a REAL variable *)
    tmp_bool := Retain_Var( REAL_2 , 4) ;
```

```
        (* if Retain variables havn't been inited yet, use default value *)
    if  (DINT_1 < -1000000) or (DINT_1 > 1000000) or
        (DINT_2 < -2000000) or (DINT_2 > 2000000) or
         (REAL_1 < -9.9E10) or (REAL_1 > 9.9E10) or
        (REAL_2 < -9.9E10) or (REAL_2 > 9.9E10)  then
       DINT_1 := 0 ;
       DINT_2 := 0 ;
       REAL_1 := 0.0 ;
       REAL_2 := 0.0 ;
    end_if ;
end_if ;

(*  is_first_cycle_just_after_switch :
     TRUE  : just in the cycle after switching.
     FALSE : other cycle   *)
if  is_first_cycle_just_after_switch  then

  (*  The Timer ticking state is not auto-redundant. So we have to process them here.
      Ticking timer in the cycle just after switching if its last state is "ticking"   *)
  if  TMR_1_last_state  then
    tStart(TMR_1) ;
  end_if ;
  if  TMR_2_last_state  then
    tStart(TMR_2) ;
  end_if ;
end_if ;

(* Timer operation *)
if  To_tick_TMR_1  then
  To_tick_TMR_1 := FALSE ;
  tStart(TMR_1) ;
  TMR_1_last_state := TRUE ;
end_if ;
if  To_tick_TMR_2  then
  To_tick_TMR_2 := FALSE ;
  tStart(TMR_2) ;
  TMR_2_last_state := TRUE ;
end_if ;
if  To_stop_TMR_1  then
  To_stop_TMR_1 := FALSE ;
  tStop(TMR_1) ;
  TMR_1_last_state := FALSE ;
end_if ;
if  To_stop_TMR_2  then
  To_stop_TMR_2 := FALSE ;
  tStop(TMR_2) ;
  TMR_2_last_state := FALSE ;
end_if ;
```

16.4.4 Introduction of the "demo_RDN_4" Project

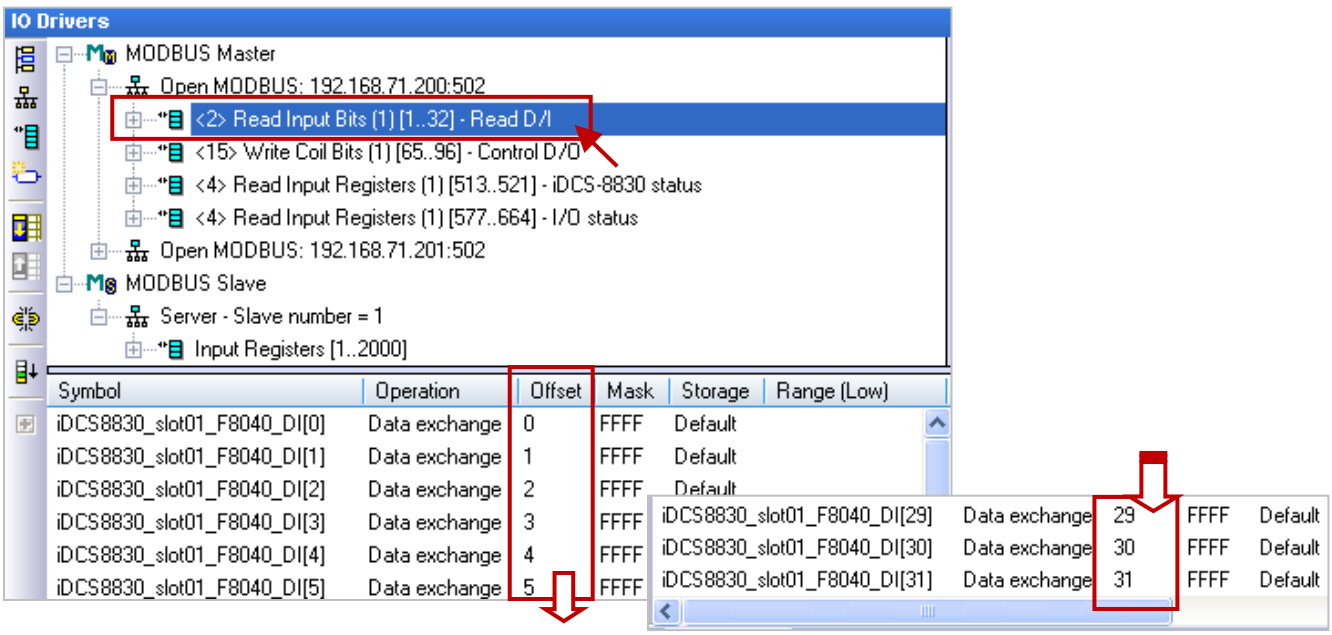
In the "demo_rdn_4" project, you can click on the program name to view its content, click "Variables" to see all used variables, or refer to Section 16.4.1 to view the I/O Board settings ("i_redundancy").
This section will introduce you the "Modbus Master" function (refer to Chapter 5 for more details about operations and the way to set up continuous Offset value for multiple variables).

In this example, we use one redundant I/O expansion unit (iDCS-8830), two redundant DI module (F-8040) plugged in its I/O Solt0, 1, and two redundant DO module (F-8041) plugged in its I/O Solt2, 3. Before testing the project, refer to Section 16.5.4 to configure the iDCS-8830 to function properly.
Click the “Open Fieldbus Configuration” button to open the “I/O Drivers” setting window.

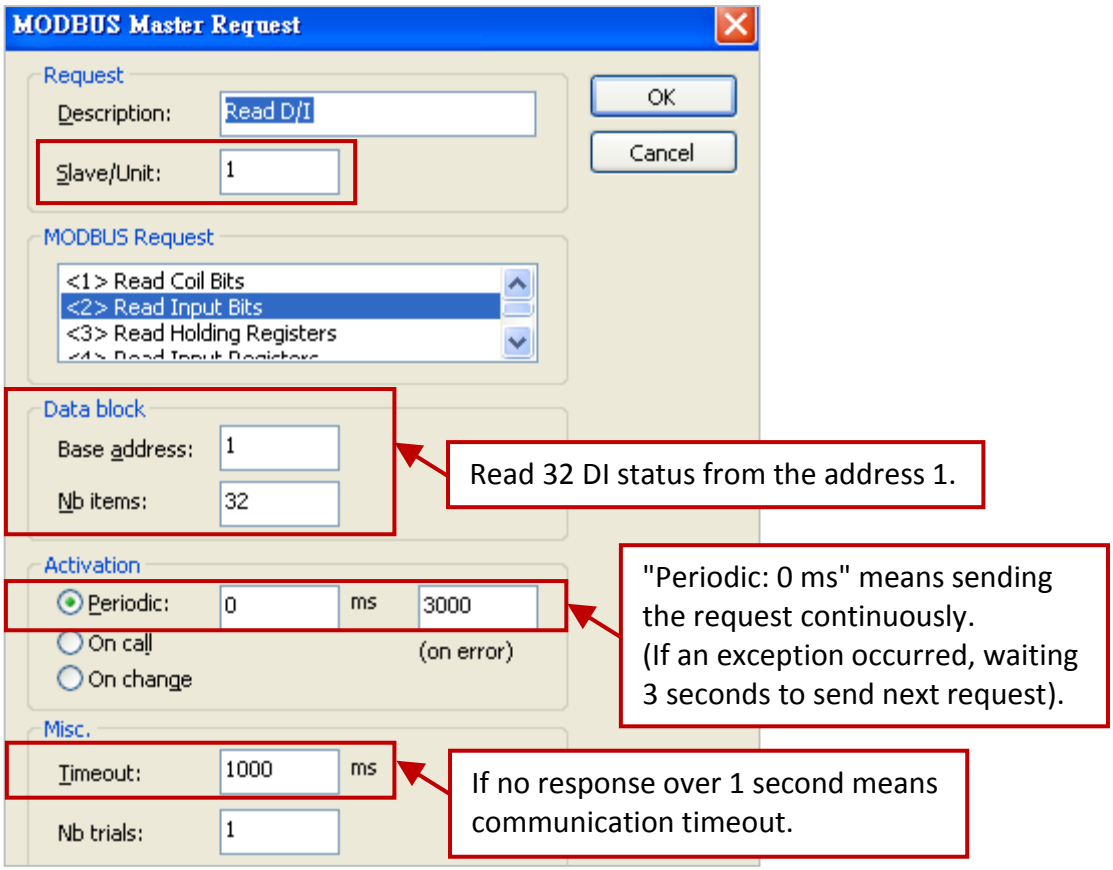


Next, enable the Modbus Master function to connect two Modbus TCP Slave devices. Each iDCS-8830 redundant I/O unit has two IP addresses, e.g., "192.168.71.**200**" and "192.168.71.**201**" (Port: 502) that can be used to read/write the I/O data and status.

Read Digital Inputs (Using two redundant DI module - F-8040 in the slot0, 1)

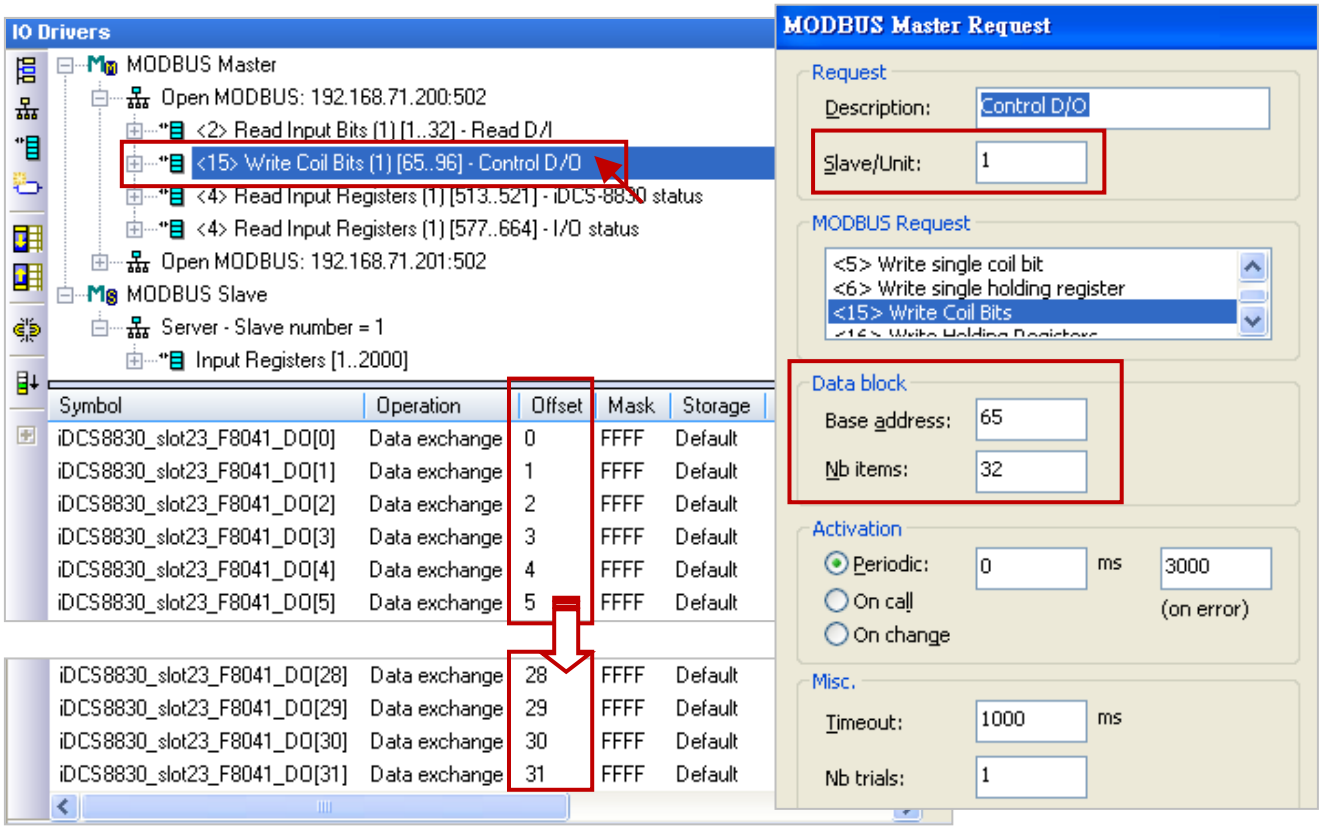


Note: We use an iDCS-8830 redundant I/O unit in this example, refer to iDCS-8000 user manual (CH4 Modbus Addresses Mapping) to know how to input a proper "Base address".
http://ftp.icpdas.com/pub/cd/idcs-8000/usersmanual/fcm-mtcp_software_usermanual_en.pdf



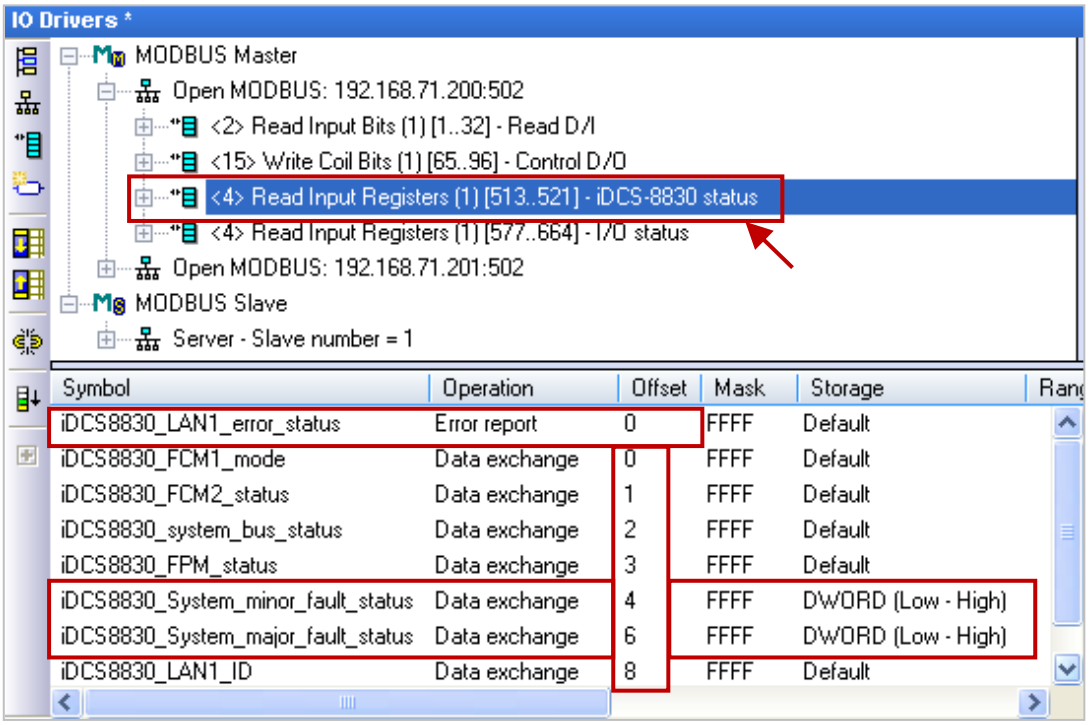
Write to Digital Outputs (Using two redundant DO module - F-8041 in the slot2, 3)

In this example, to write 32 DO status from the address "65" (other settings like the figure above).

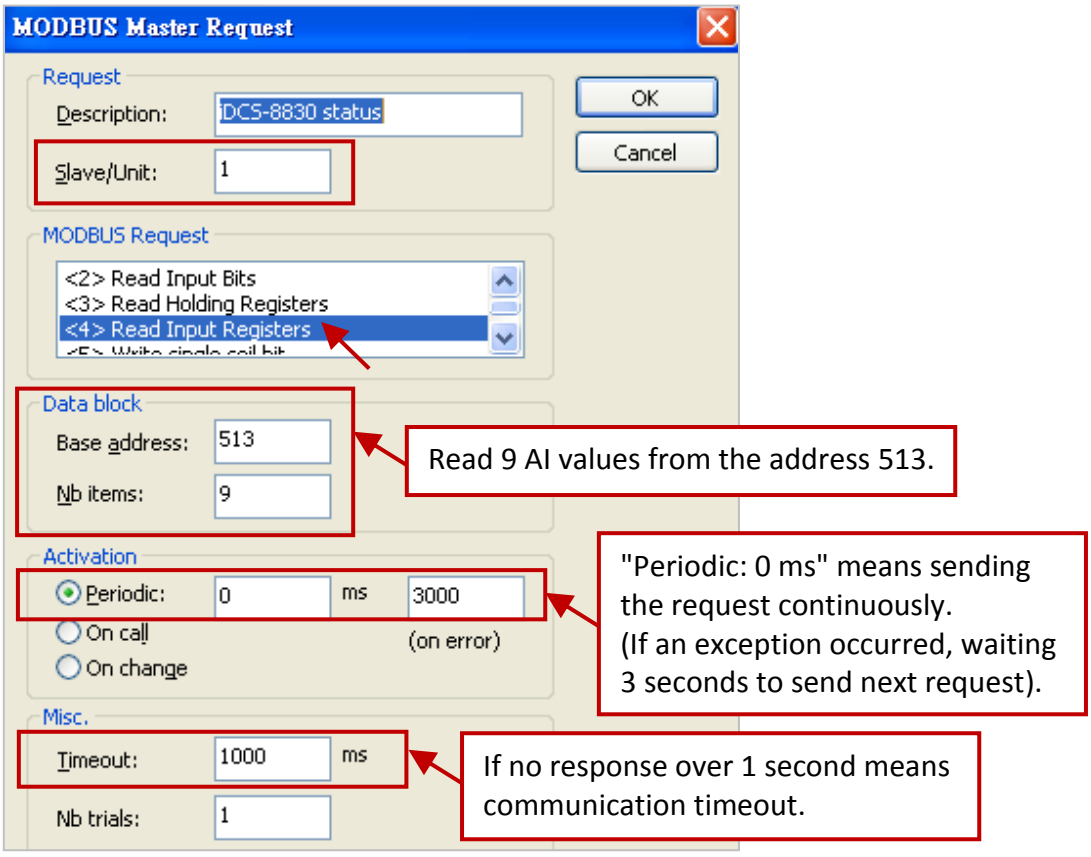


Read the status of the iDCS-8830

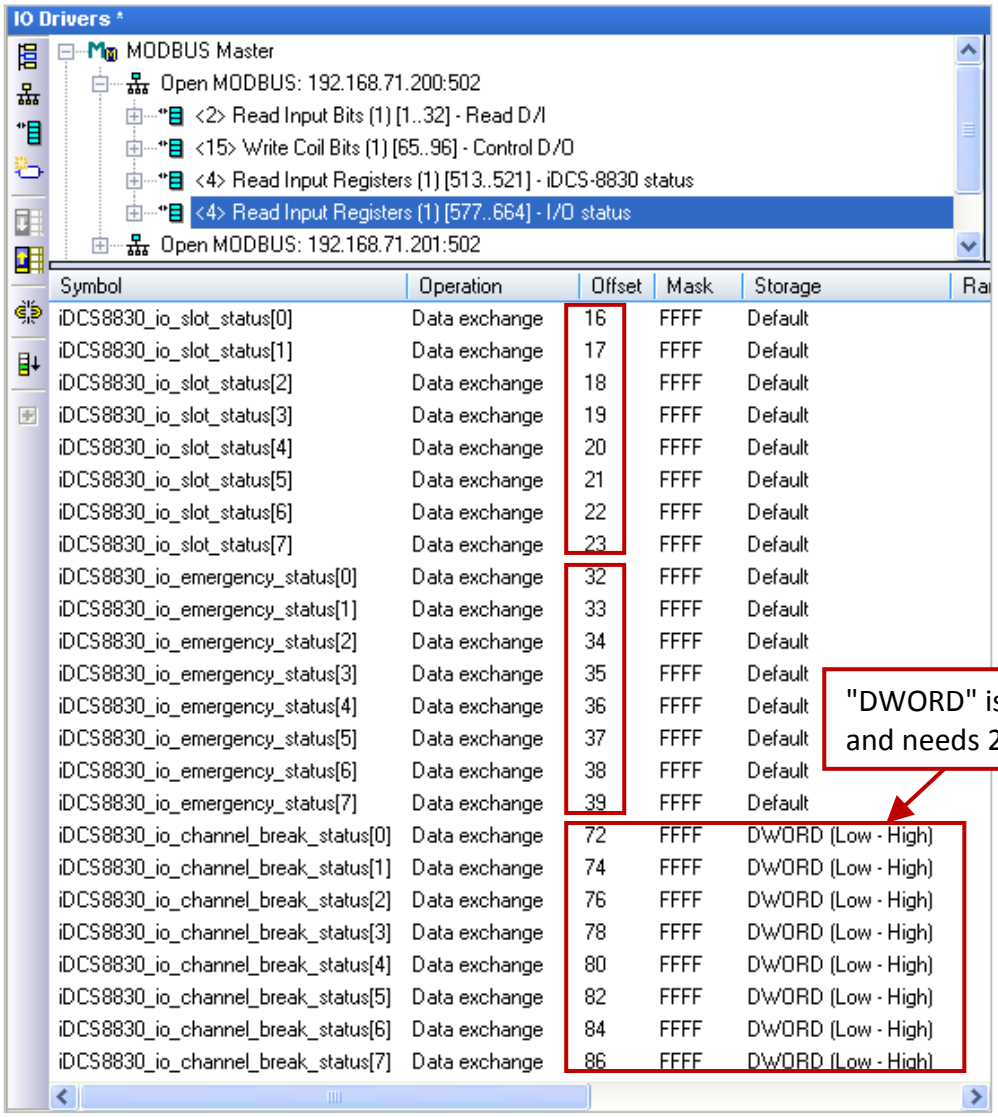
- The “Operation” field of the "iDCS8830_LAN1_error_status" variable is set as “Error report” in order to show an error code when reading failed. The error code will be reset to “0” when reading success. Moreover, its “Offset” field must set as “0”.
- Due to the data type of "iDCS8830_System_minor_fault_status" and "iDCS8830_System_major_fault _status" is "DWORD" (32 bit), the "Offset" must use two Modbus address and the "Storage" must set as "DWORD (Low-High)".



Note: Refer to iDCS-8000 user manual (CH4 Modbus Addresses Mapping) to enter the "Base address".
http://ftp.icpdas.com/pub/cd/idcs-8000/usersmanual/fcm-mtcp_software_usermanual_en.pdf



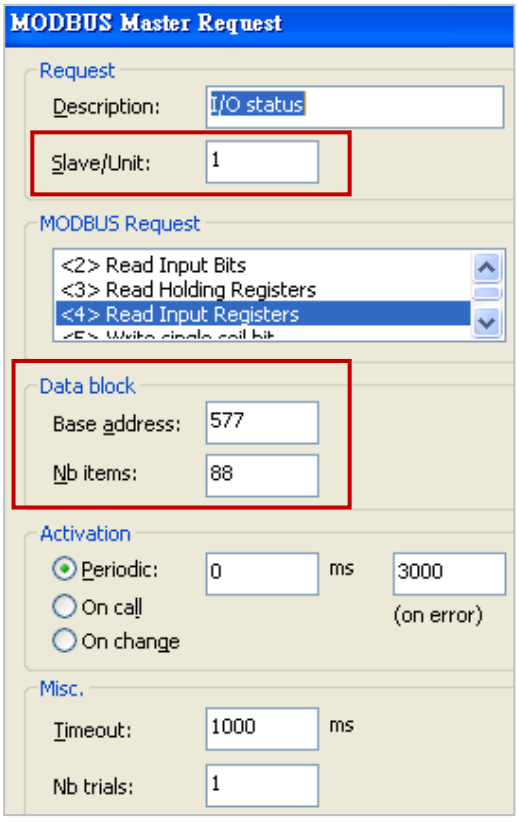
Read the I/O status of the iDCS-8830



Note:

Refer to iDCS-8000 user manual (CH4 Modbus Addresses Mapping) to enter the "Base address".
http://ftp.icpdas.com/pub/cd/idcs-8000/usersmanual/fcm-mtcp_software_usermanual_en.pdf
In this example, to read 88 AI values from the address 577.

Refer to Chapter 5 for more details on Modbus Master settings and refer to Chapter 3 for Modbus Slave settings.

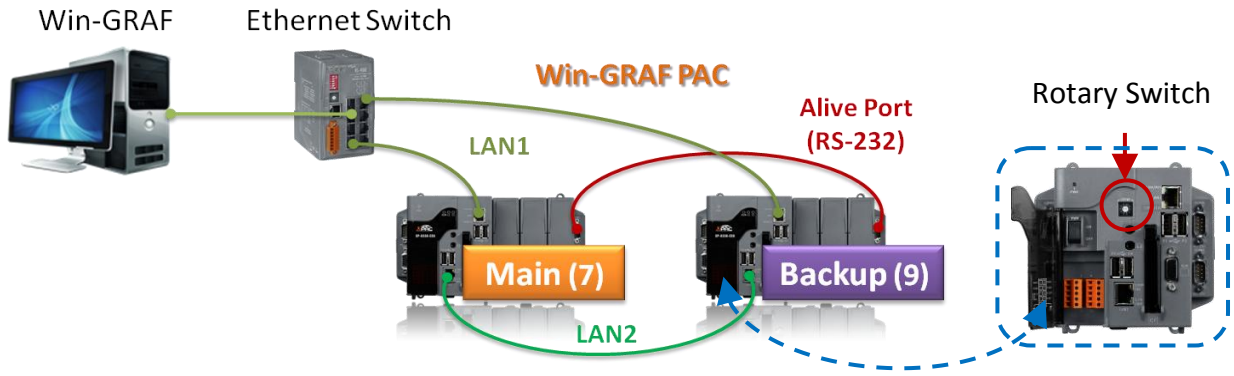


16.5 Test the Redudant System 1 (Rotation switch: 7 & 9)

Important Notes:

- Set the rotation switch properly (Redudant System1: 7 and 9). Make sure that the **LAN1, LAN2 and Alive Port** are connected properly, and then power on. (Redudant System2: Section 16.6)
- The factory default setting of LAN1 and LAN2 is DHCP that must be set as static IP by using XPAC_Utility. Download the project to Main-PAC (7) first, and then it will be automatically copied to Backup-PAC (9) through LAN2 port.

16.5.1 Download the Redundant Project

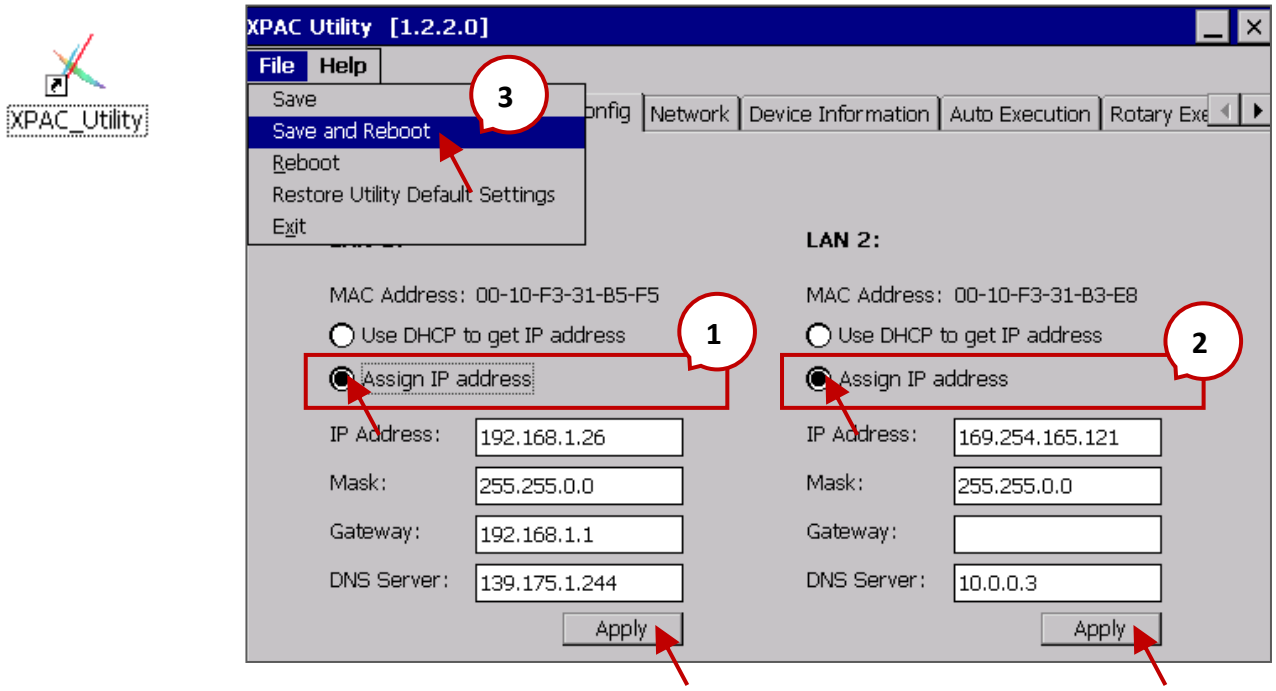


1) Device Requirement:

Win-GRAF PAC	Cable		
XPAC * 2	LAN1: Ethernet cable * 2	LAN2: Ethernet crossover cable * 1	Alive Port: RS-232 crossover cable * 1

2) Set IP addresses:

For the first time to download redundant project, run XPAC_Utility and set LAN1 and LAN2 of two PACs as static IP addresses and click the "Apply" button, and then click the File menu and "Save & Reboot" to apply the IP settings.



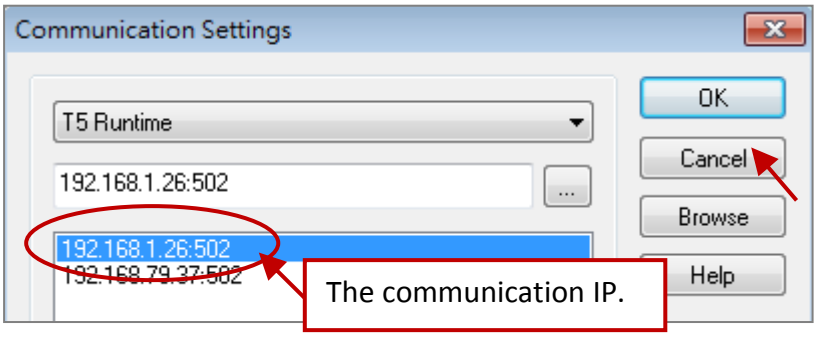
After rebooting, the IP Address and Mask will automatically be set as following:

Main-PAC (7): 199.193.195.**17** / 255.255.255.0 ;

Backup-PAC (9): 199.193.195.**9** / 255.255.255.0

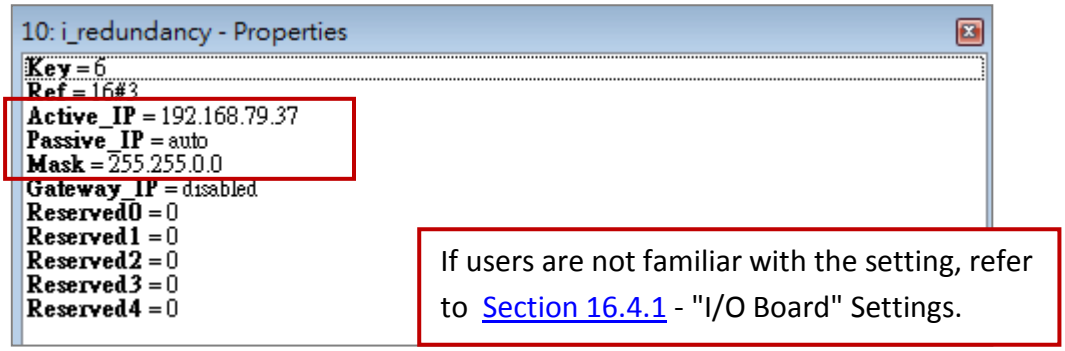
3) Set the Win-GRAF communication IP address

For the first time to download the redundant project, e.g., demo_rdn_2, enter the LAN1 IP address of the Main-PAC (7). Refer to Section 2.3.5 - “Communication Parameters".



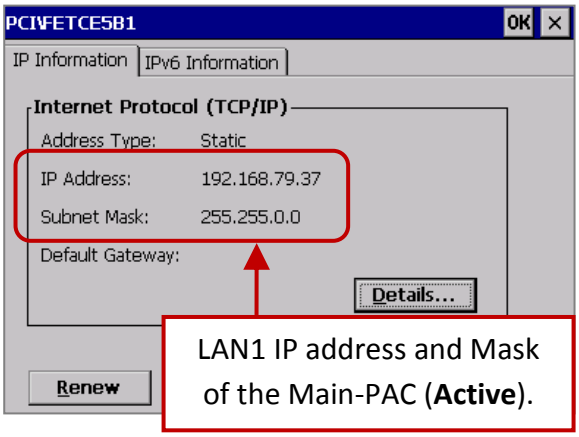
4) Set the Active_IP address

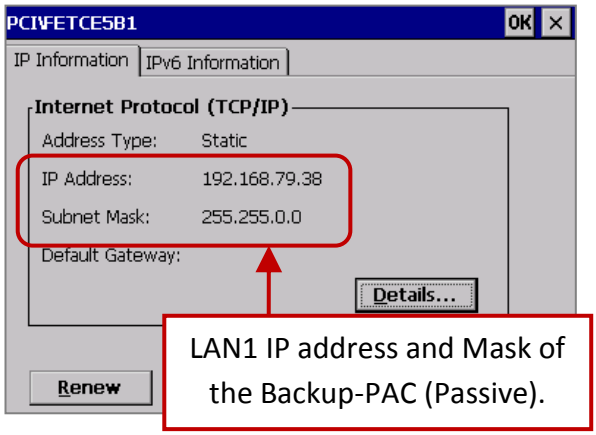
Set the Active_IP and Mask address for the " i_redundancy" function depends on the network environment.



5) Download the Win-GRAF project

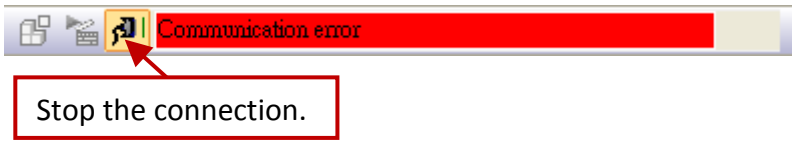
Click the “On Line” button () to download the redundant project to the Main-PAC, refer to Section 2.3.4 and Section 2.3.5. After it’s downloaded, LAN1 IP address of the Main-PAC(7) will automatically set to the Active_IP address and LAN1 IP address of the Backup-PAC(9) will set to Active IP + 1.



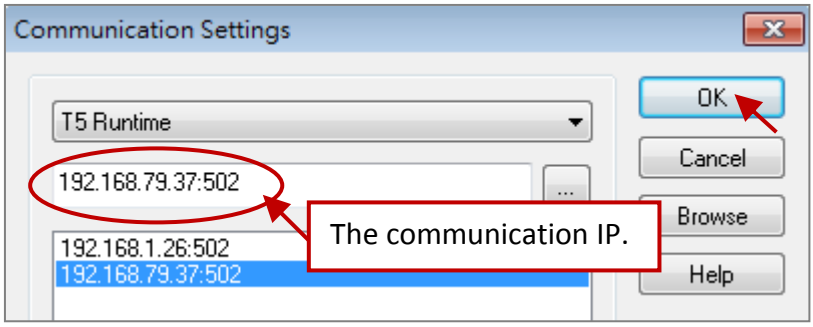


6) Change the Win-GRAF communication IP address to the Active_IP address

Right now, Win-GRAF will show "Communication error" because the current IP address of the Active-PAC is automatically set to the Active_IP address. Click the “On Line” button again to stop the connection between the Win-GARF and the PAC.



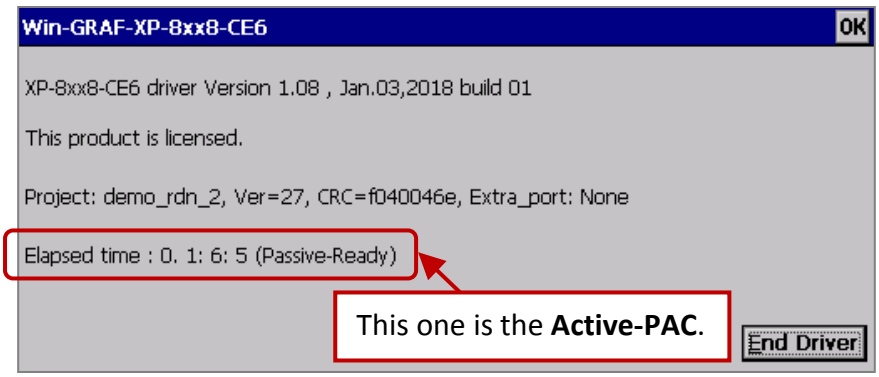
Next, change the Win-GRAF communication IP to the Active_IP address so that this project will always download to the Active-PAC whenever the user wants to debug or change it.



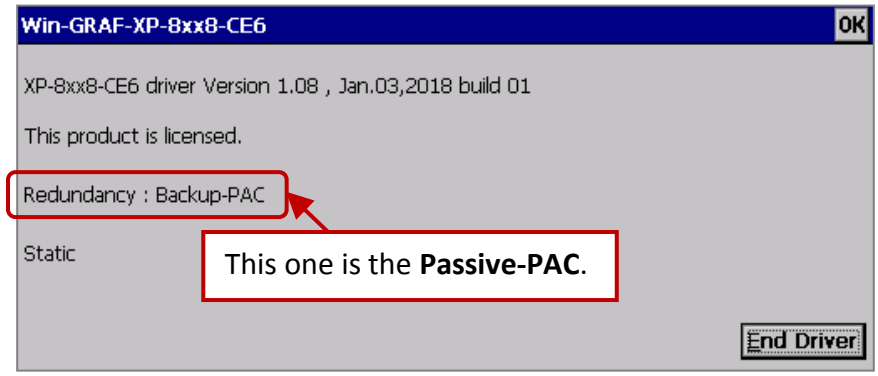
Note:

1. For Win-GRAF and the PAC can communicate properly, both the IP addresses of them must on the same network segment.
2. If users need to set the communication timeout (default 3 seconds, refer to Section 2.3.5.
   E.g., set the IP address to “192.168.71.37:502**(10)**” means that the timeout is set to **10** seconds.
3. Open Win-GRAF driver on the XPAC to check which one is the Active-PAC.

PAC side - Win-GRAF Driver:



Note:
Since Win-GRAF Driver v1.10, simply check the L1 LED indicator on the PAC.
ON: Active PAC ;
OFF: Passive PAC.

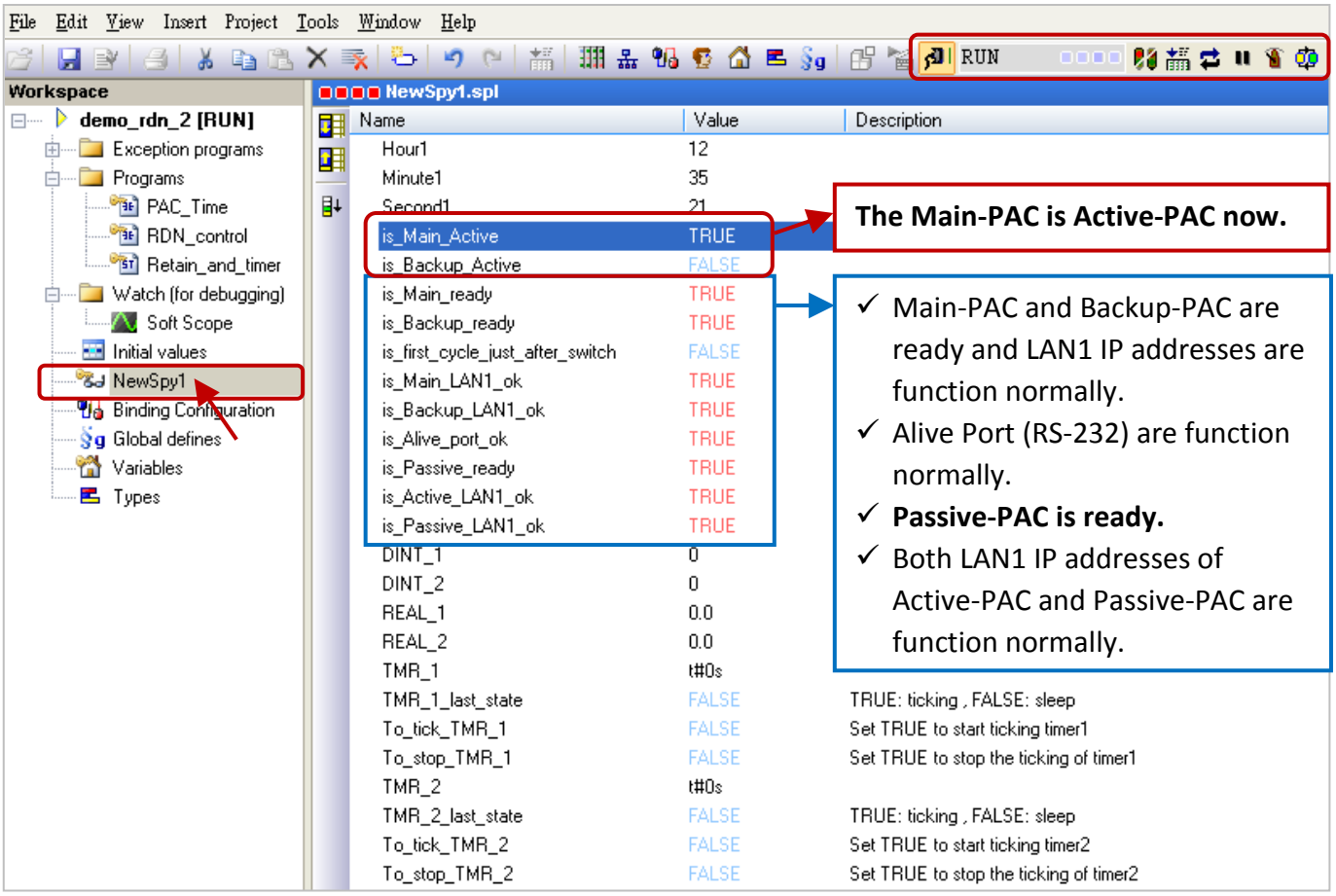


16.5.2 Test the Redundant Project (demo_rdn_2)

Refer to Section 16.4 for the description of demo projects and Section 16.5.1 to download the project.

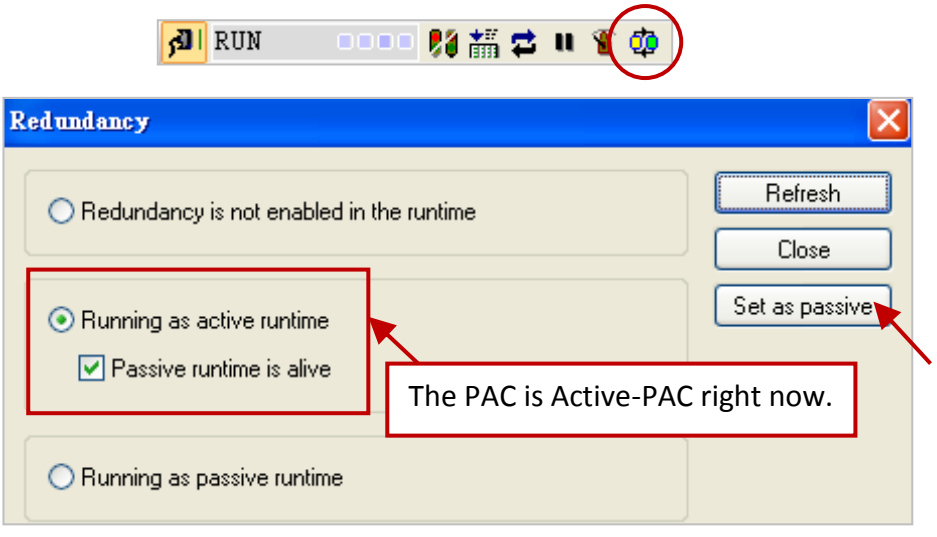
1. View the status of redundant PACs

After Win-GRAF connects to the PAC, click "NewSpy1" to open the spy list window and check the current status of the redundant system.



Note:

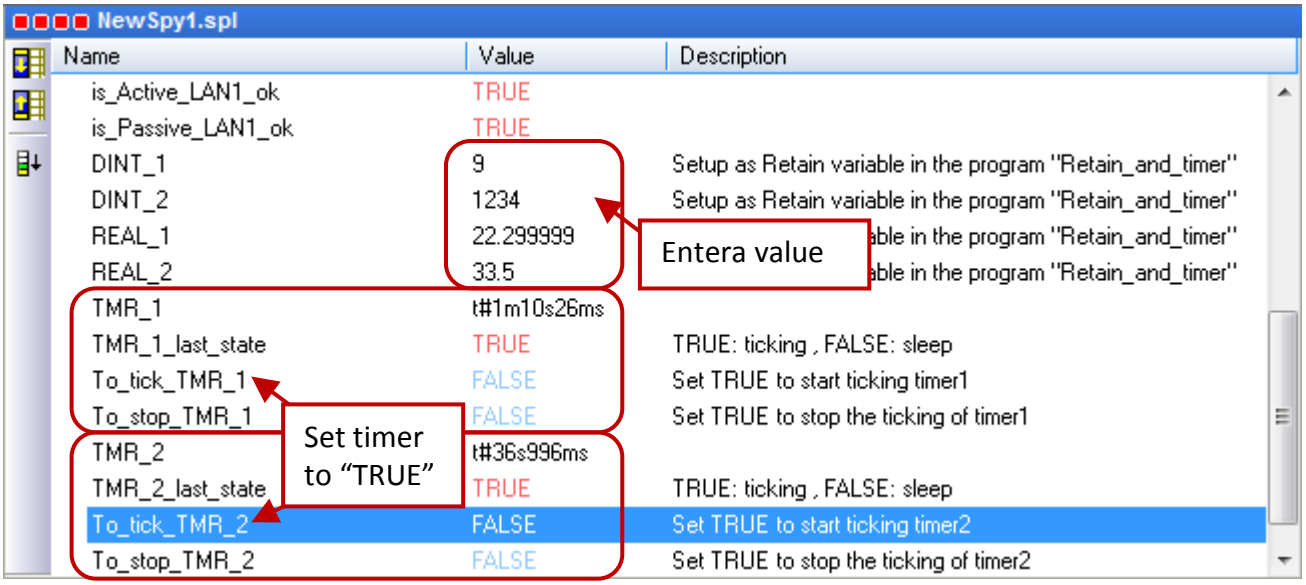
1. **Before switching the control authority, make sure the Passive-PAC is ready** (i.e., "is_Passive_ready" = TRUE).
2. Users can also click the "Redundancy" button ( ) to manually switch the control authority.



2. Set the value of variables

1) Assign a value to DINT_1, DINT_2, REAL_1 and REAL _2 variables.

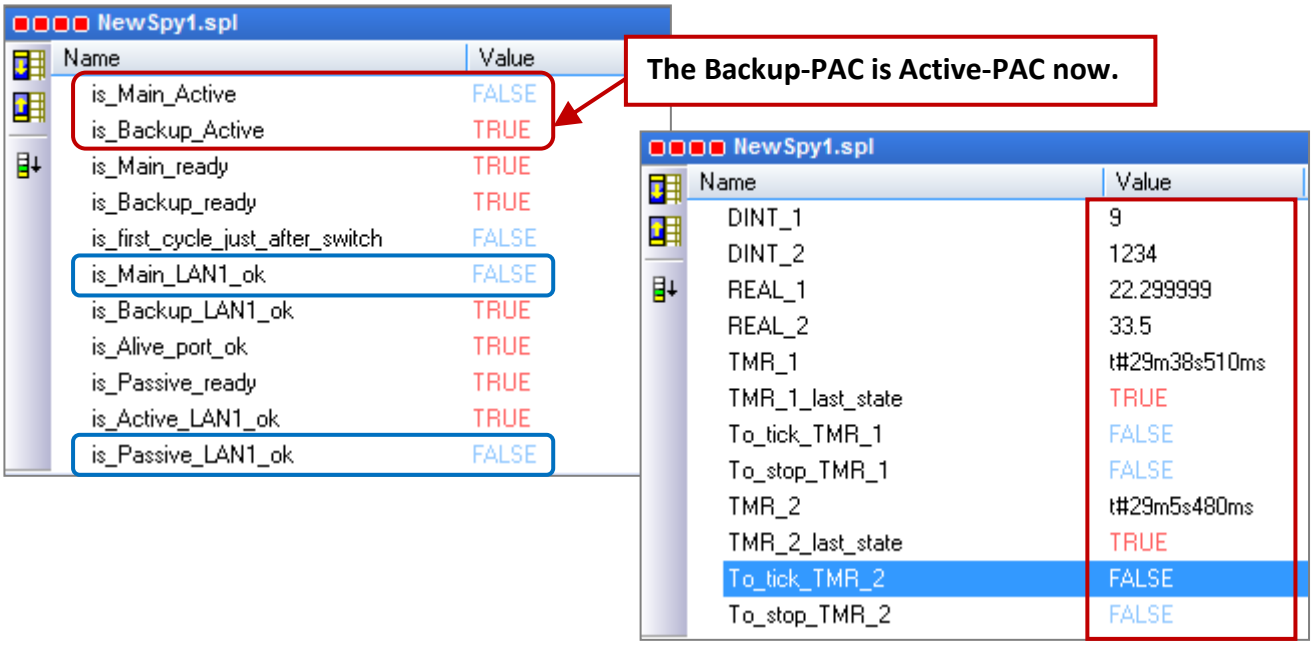
2) Set the To_tick_TMR_1 and To_tick_TMR_2 to "TRUE“ (this status will automatically reset to FALSE) to start the "TMR_1" and "TMR_2" ticking, and the statuses of TIMER will be changed from FALSE to TRUE.



3. Test the redundant system

1) Make sure the Passive-PAC is ready (i.e., is_Passive_Ready is TRUE).

2) Remove the LAN1 cable of the Active-PAC (or power the PAC off and on). In this example, the Active-PAC will automatically reboot after a specific time and give control authority to the other PAC (refer to the “RDN_control” program). Then, users can check if all the values still exist and timer1 and timer2 are still ticking.



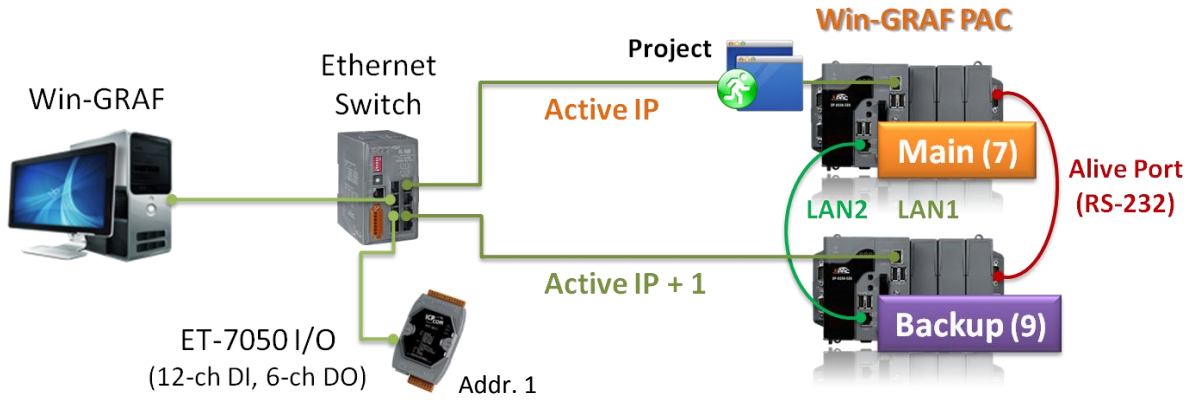
Note:

Plug in the LAN1 cable on the Main-PAC (Passive), the statuses of "is_Main_LAN1_ok" and "is_Passive_LAN1_ok" will become "TRUE“.

16.5.3 Test the Redundant Project (demo_rdn_3, demo_rdn_1)

demo_RDN_3:

Using both the LAN1 of PACs to connect a ET-7050 (Modbus TCP I/O module) through one Ethernet switch.



1. **Configure the ET-7000 module**

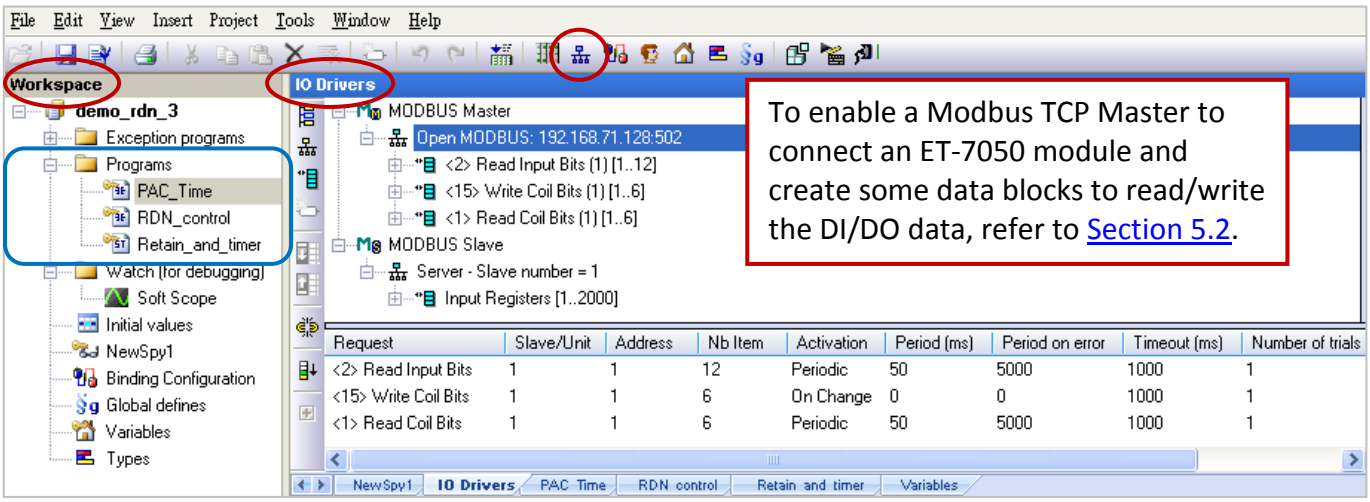
   Refer to the ET-7000 manual to set the IP address and I/O settings (refer to Section 5.2.1).
   Manual: http://ftp.icpdas.com/pub/cd/6000cd/napdos/et7000_et7200/document/
   Users can also use VxComm Utility to search and modify the IP, mask, and gateway addresses of the ET-7000.

2. **Download the Win-GRAF project ("demo_rdn_3")**

   Refer to Section 16.5.1 to download the "demo_RDN_3" project. If users have ever downloaded the redundant project before, only modify the Active_IP, Mask, and Win-GRAF communication IP addresses properly, and then download the project to the Active-PAC.

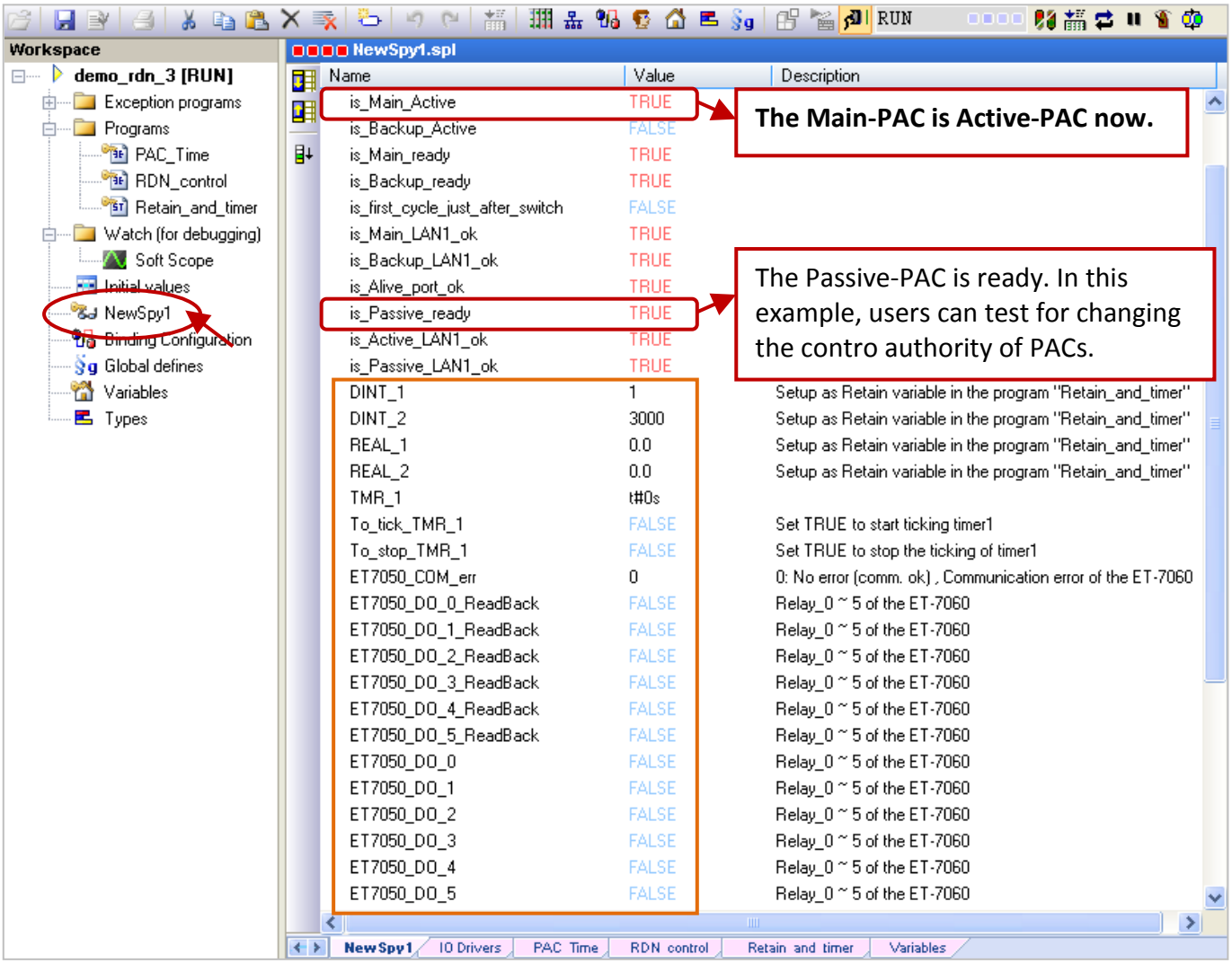
3. **View settings of the Win-GRAF project**

   In the "I/O Drivers" window, enabled the PAC as Modbus TCP Master to connect an ET-7050 module (Modbus TCP Slave, Addr. = 1) and create some data blocks to read/write the DI and DO data (refer to Section 5.2). Next, double-click on the program name which is shown in the Workspace window to view program codes.



4. View the status of redundant PACs

Click "NewSpy1" to open the spy list, now the Main-PAC is the Active-PAC.

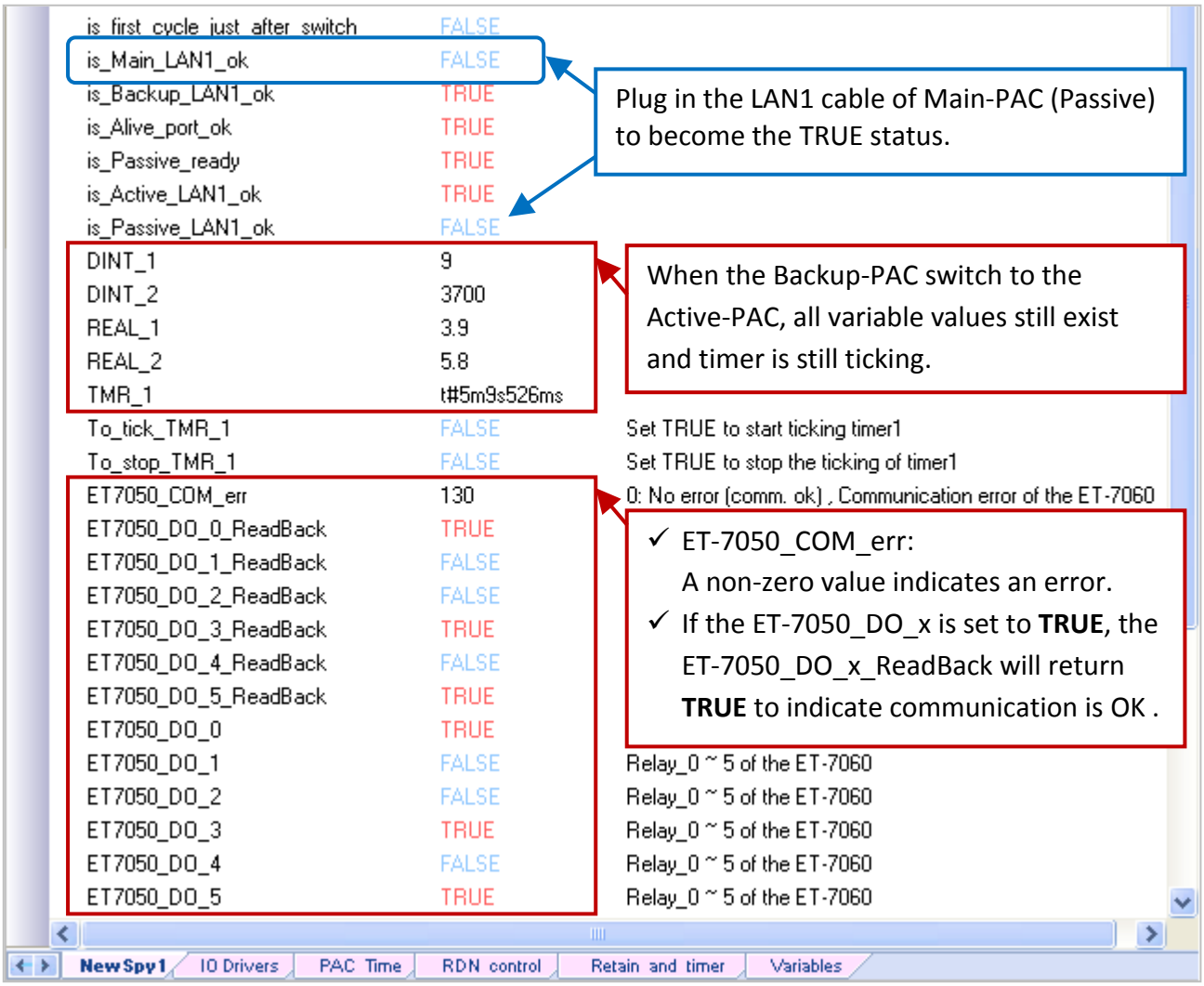


5. Set the value of variables

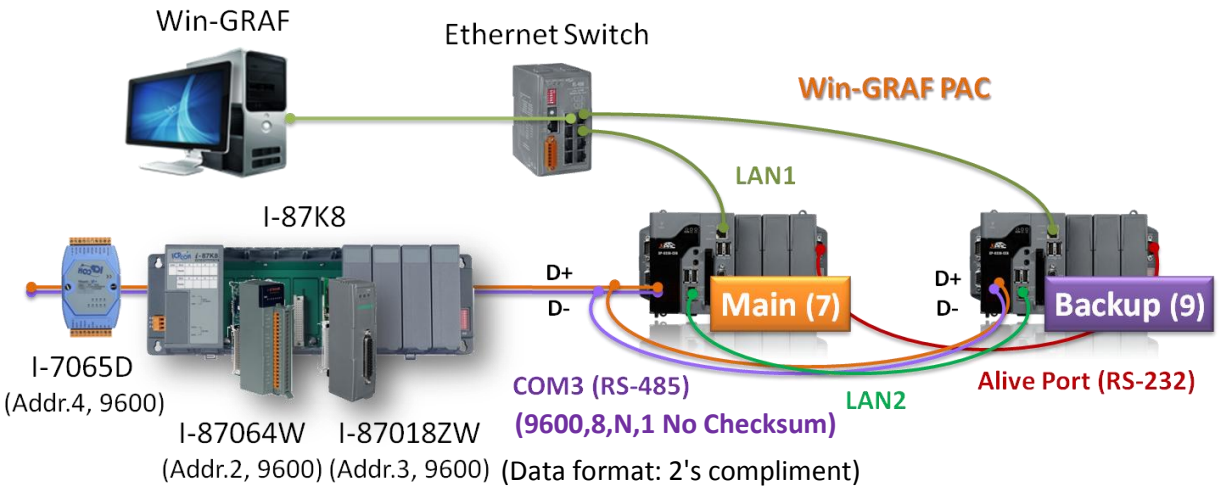
1) Assign a value to DINT_1, DINT_2, REAL_1 and REAL _2 variables.
2) Set the To_tick_TMR_1 to "TRUE" to start the "TMR_1" ticking.
3) Set the ET-7050_Do_x to "TRUE" and the ET-7050_DO_x_ReadBack will return "TRUE".
   If the Ethernet cable of ET-7050 is removed, the "ET-7050_COM_err" will return a non-zero value to indicate the communication error.

6. Test the redundant system

1) Make sure the Passive-PAC is ready (i.e., is_Passive_Ready is TRUE).
2) Remove the LAN1 cable of the Active-PAC (or power the PAC off and on). In this example, the Active-PAC will automatically reboot after a specific time and pass control authority to another PAC (refer to the “RDN_control” program).



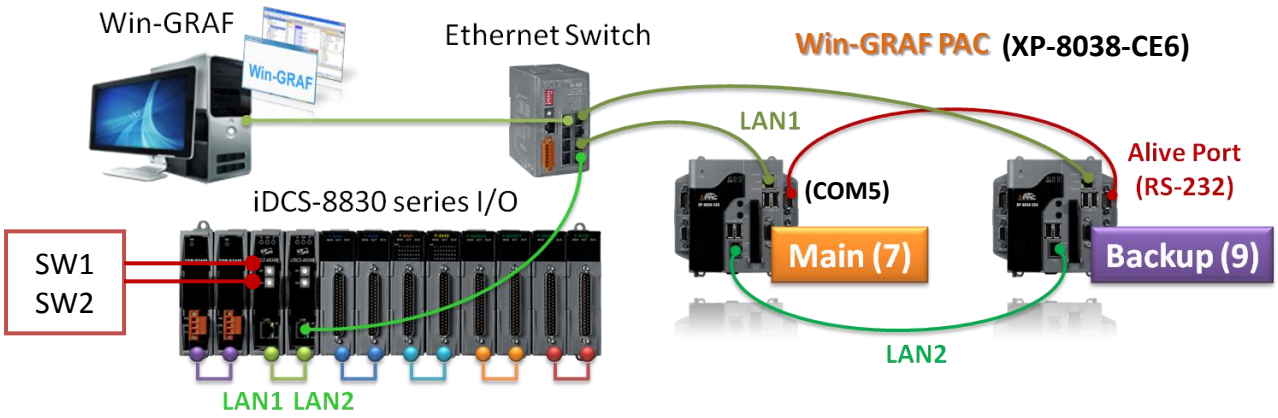
demo_RDN_1:
Using both the COM3 of PACs to connect three DCON I/O modules.



Refer to the test methods of “demo_RDN_3" noted above. Before two PACs connect to remote DCON I/O modules, refer to Chapter 8 to configure each module by using DCON Utility.Visit "DCON Utility" web page to download the software and user manual www.icpdas.com/products/dcon/introduction.htm. Also, users can review Win-GRAF programs and the "i_redundancy“ setting (refer to Section 16.4.1 I/O Boards Settings).

16.5.4 Test the Redundant Project (demo_rdn_4)

Use both LAN1 of two PACs and one iDCS-8830 to connect with an Ethernet switch. iDCS-8830 supports redundant I/O modules.



Refer to Section 16.2 to know the important communication ports and installation notes for the redundant system. Following table lists all used devices in this project:

Products	Quantity	Products	Quantity
XP-8048-CE6	2	DN-DI-32DW	1
RS-408	1	DN-DO-16DR-A	1
iDCS-8830	1	DN-DO-16DR-B	1
F-8040	2	CA-37**10**AM (1M Cable) or CA-37**20**AM/**30**AM/**50**AM/**100**AM	4
F-8041	2		

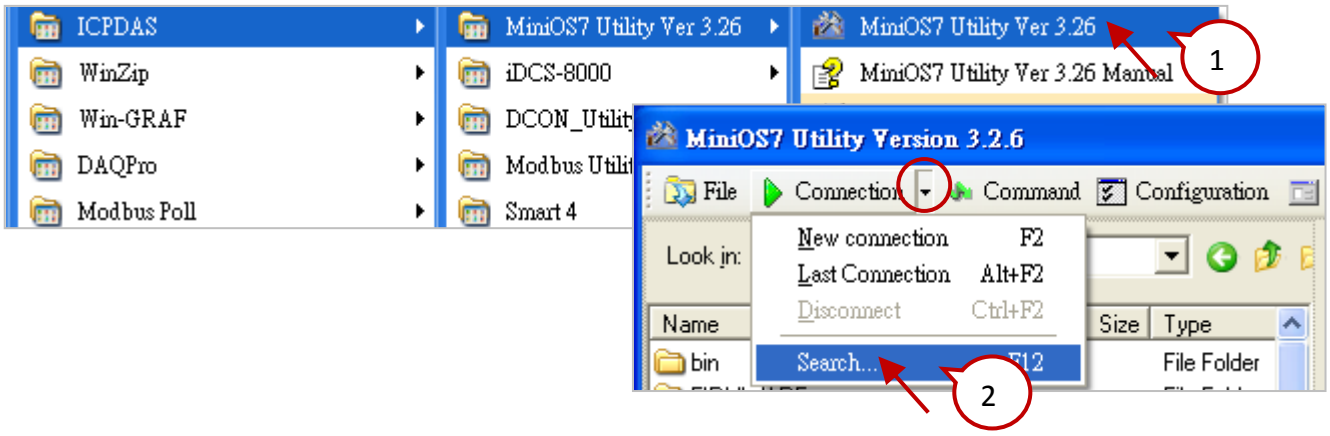
The following describes modules plugged in iDCS-8830 from left to right. Visit the web page to download the software and user manual.
MiniOS7 Utility: http://ftp.icpdas.com/pub/cd/8000cd/napdos/minios7/utility/
iDCS-8000 Utility: http://ftp.icpdas.com/pub/cd/idcs-8000/utility/ (Software Installation: Ch2.2)
iDCS-8000 User Manual/Website:
http://ftp.icpdas.com/pub/cd/idcs-8000/usersmanual/
http://www.icpdas.com/root/product/solutions/remote_io/dcs_redundancy_io/idcs_introduction.html

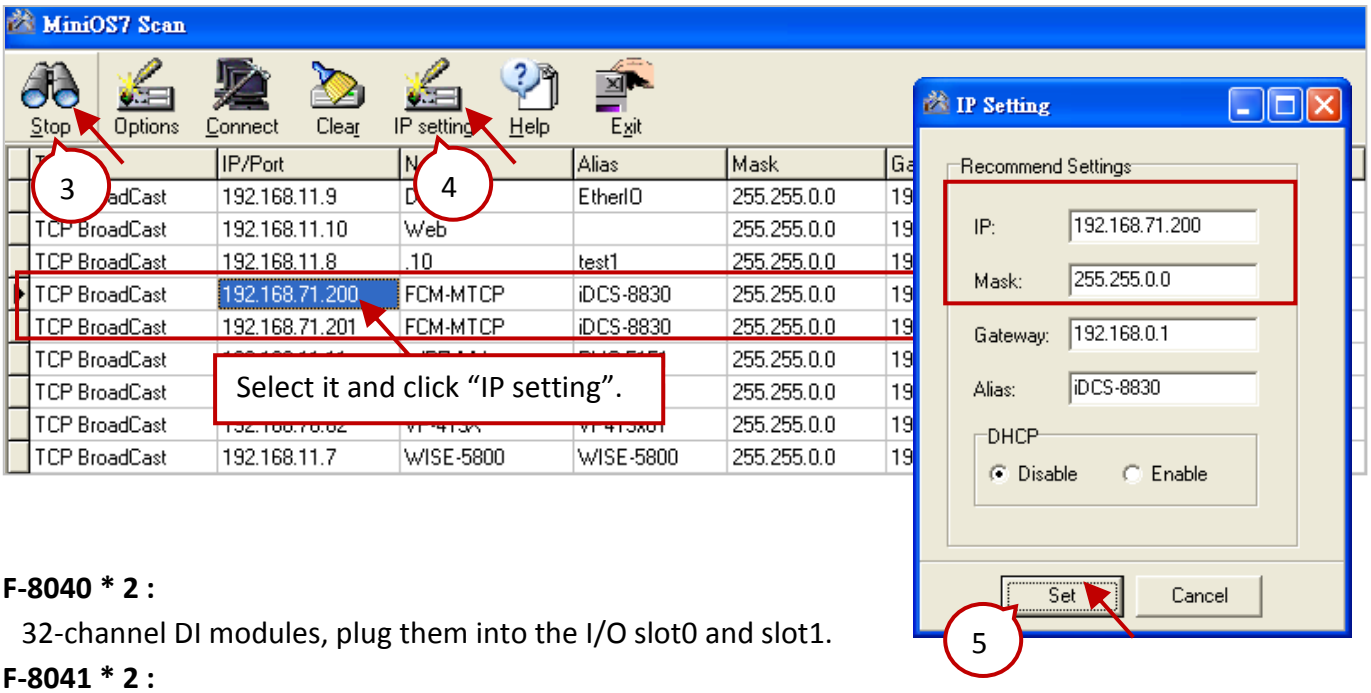
FPM-D2440 * 2: Power module1, Power module2 (for power input, 24V).
FCM-MTCP * 2:

MCU1 (set the SW2 to "C", the SW1 to "8", and the IP address to 192.168.71.**200**).
MCU2 (set the SW2 to “C”, the SW1 to “9”, and the IP address to 192.168.71.**201**).
SW2/SW1 means the fourth IP address of the MCU (Main Control Unit). ($C8_{16}$ = 200; $C9_{16}$ = 201)

Configure IP addresses by using MiniOS7 Utility:

Refer to Section 2.3 of iDCS-8000 user manual for more details. Open “MiniOS7 Utility” and click “Search” to search current IP addresses of iDCS-8830 (i.e., MCU1/2), and click “Stop” to stop searching. In this example, set both IP addresses as “192.168.71.200” and “192.168.71.201” and set the Mask as “255.255.**0.0**”. Next, click the “Set” button and close MiniOS7 Utility.





F-8040 * 2 :

32-channel DI modules, plug them into the I/O slot0 and slot1.

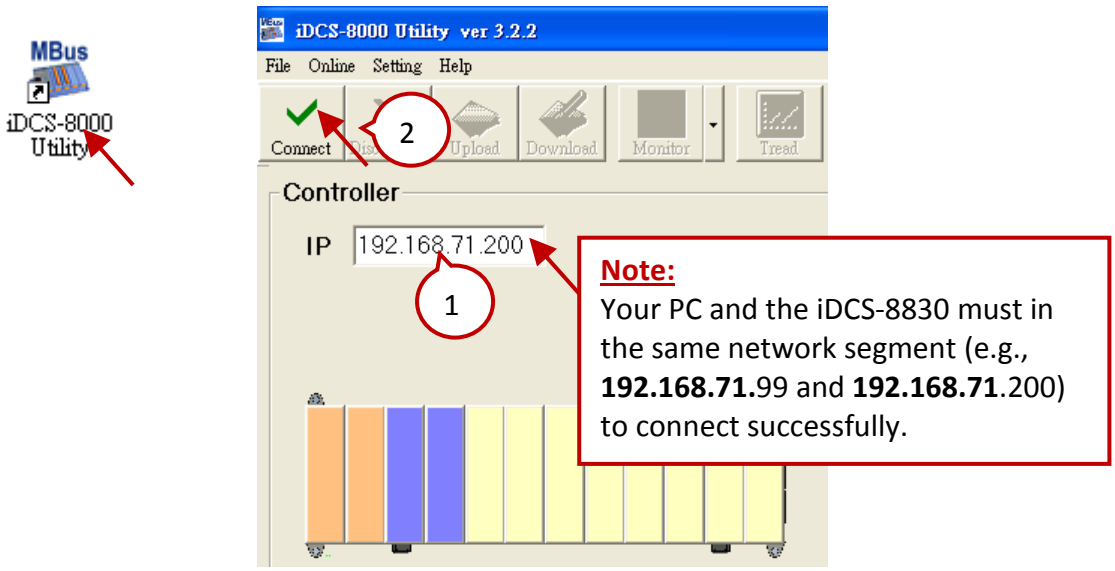
F-8041 * 2 :

32-channel DO modules, plug them into the I/O slot2 and slot3.

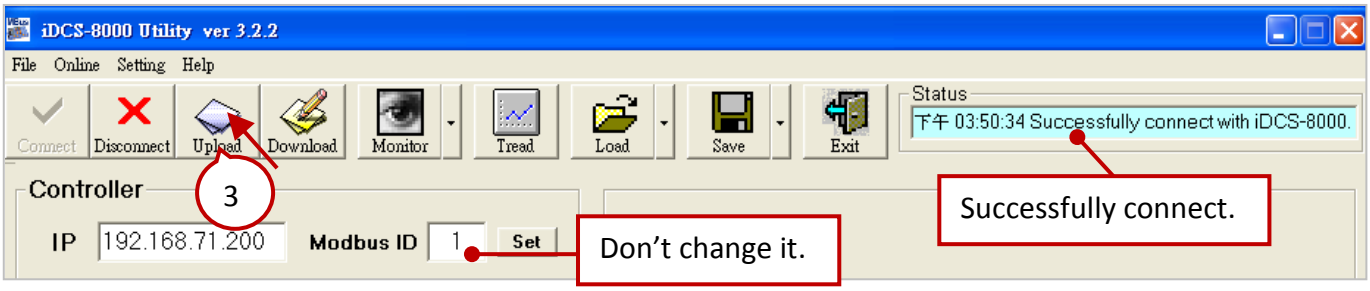
Configure I/O modules by using iDCS-8000

Refer to Section 2.3 of iDCS-8000 user manual for more details.

1) Open iDCS-8000 Utility and enter the IP address of the iDCS-8830 to connect.

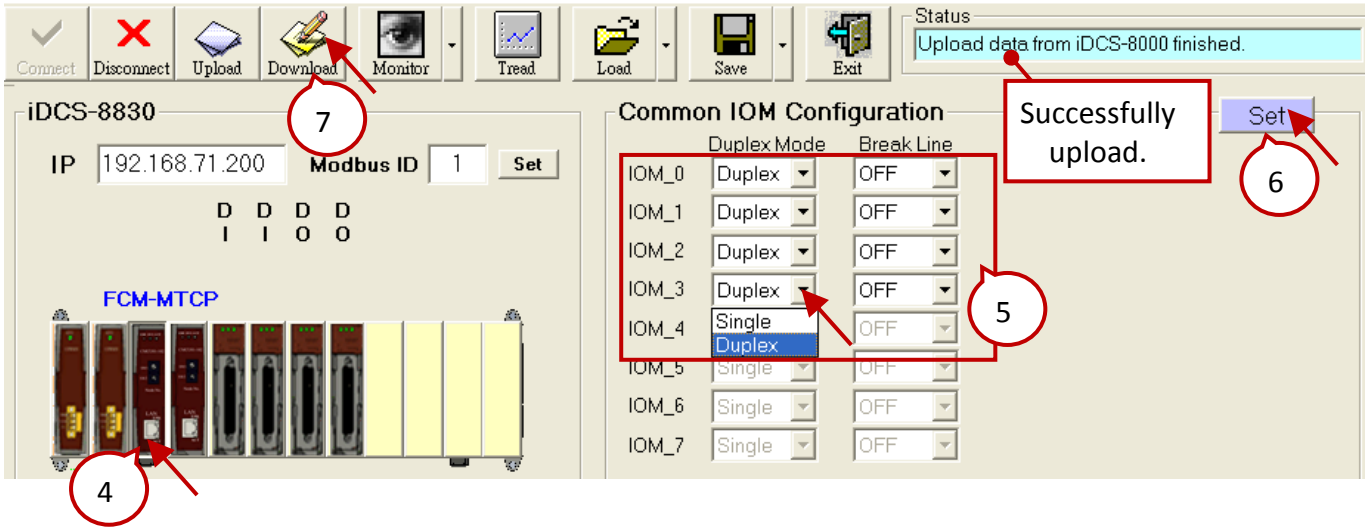


2) Click "Upload" to upload the current I/O settings that used in the iDCS-8830.



3) Click the 1st FCM-MTCP (MCU1) and set "IOM_0 ~ 3" (F-8040/F-8041) as "Duplex" Mode.

4) <u>If the F-8040/F-8041 has not yet connected to termination boards</u>, set the "Break Line" as "OFF".



<u>If the F-8040/F-8041 has connected to the following termination boards</u>, set the "Break Line" as "ON".

DN-DI-32DW * 1 : 32-channel DI termination board. Connect to F-8040 DI modules on slot 0 to 1.

DN-DO-16DR-A * 1 : 16-channel DO termination board that used for channel 0 to 15.

DN-DO-16DR-B * 1 : 16-channel DO termination board that used for channel 16 to 31. Connect DN-DO-16DR-A (CN1, CN2) to F-8041 DO modules (slot2, slot3), and then connect DN-DO-16DR-A (CN3) to DN-DO-16DR-B (CN1).

CA-3710AM * 4 : 1m 37-pin Male-Female D-sub cable, which used to connect to I/O modules and the termination boards.

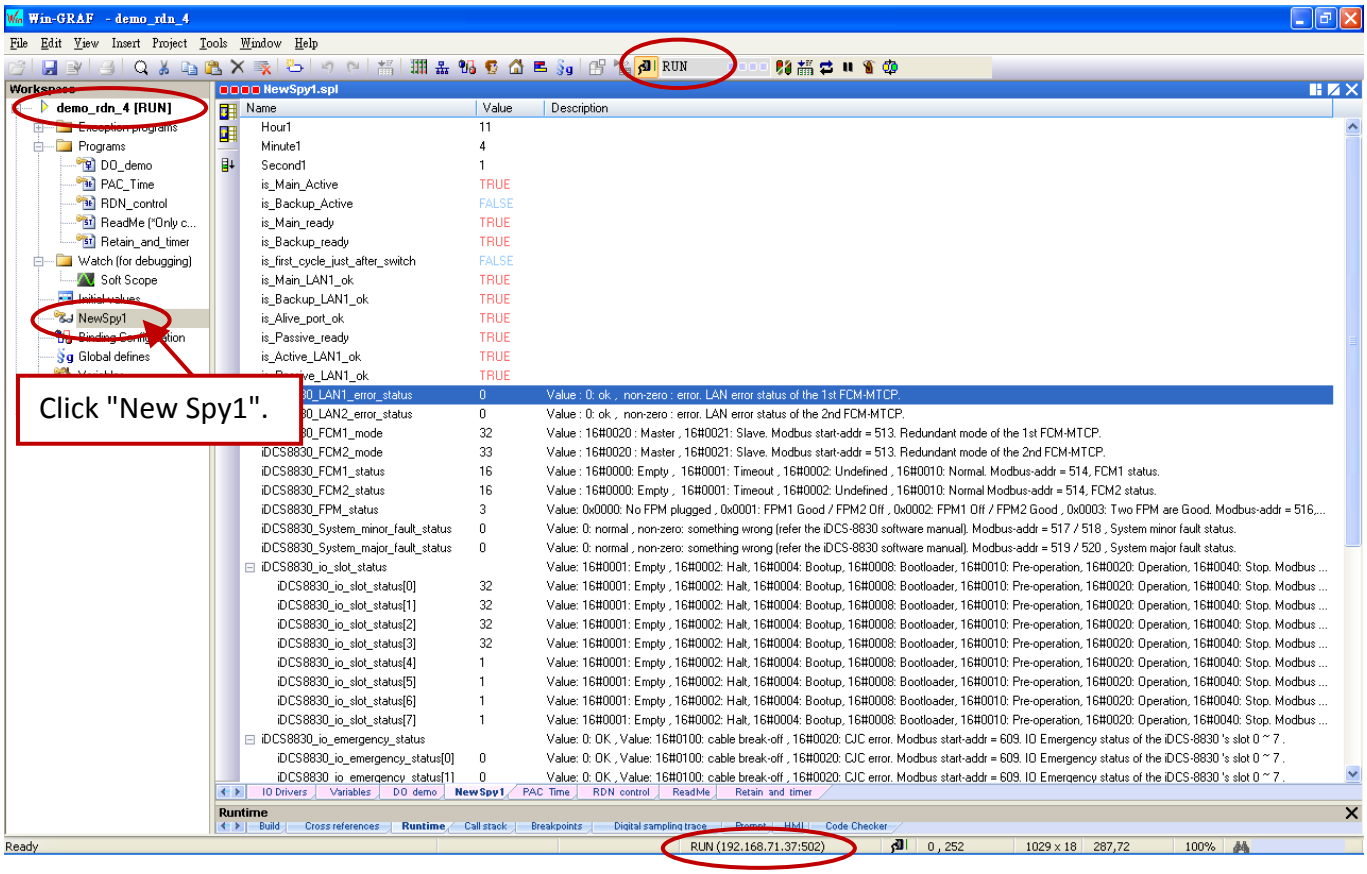
5) Click "Set" and click "Download" to download settings to iDCS-8830, and then close iDCS-8830 utility.

<u>Start testing:</u>

First, users must refer to <u>Section 16.5.1</u> to know how to set Win-GRAF communication IP address and Active_IP address, and download Win-GRAF project ("demo_RDN_4"). The following is a description of testing iDCS-8830. Before testing, make sure all devices are connected properly and then establish the connection between Win-GRAF and the PAC.

<u>Note:</u> Make sure both of IP addresses of the PC and PAC are on the same network segment. For example, if the IP address of PAC is "**192.168.71**.37" and the Mask address is "**255.255.255**.0", set the IP address of PC as "**192.168.71**.x".

After connecting to the PAC, click "New Spy1" to open the spy list.



iDCS-8830's Communication Status:

Name	iDCS8830_LAN1_error_status	iDCS8830_LAN2_error_status
Test Steps	1. Unplug (or plug in) the LAN cable of the 1st FCM-MTCP. Value: Non-0 (or 0). 2. Unplug (or plug in) the LAN cable of the 2nd FCM-MTCP. Value: Non-0 (or 0).	
Return Value	0 : Communication OK ; Non-0 : Communication Error	

iDCS8830_LAN1_error_status	130	Value : 0: ok , non-zero : error. LAN error status of the 1st FCM-MTCP.
iDCS8830_LAN2_error_status	0	Value : 0: ok , non-zero : error. LAN error status of the 2nd FCM-MTCP.

iDCS-8830's Power Status:

Name	iDCS8830_FPM_status
Test Steps	1. Unplug (or plug in) the power cable of the 1st FCM-MTCP. Value: 2 (or 3). 2. Unplug (or plug in) the power cable of the 2nd FCM-MTCP. Value: 1 (or 3).
Return Value	0 : No FPM is plugged. 1 : FPM1 Off ; FPM2 Good. 2 : FPM1 Good ; FPM2 Off. 3 : Both of these FPM are plugged.

iDCS8830_LAN1_error_status	0	Value : 0: ok , non-zero : error. LAN error status of the 1st FCM-MTCP.
iDCS8830_LAN2_error_status	0	Value : 0: ok , non-zero : error. LAN error status of the 2nd FCM-MTCP.
iDCS8830_FCM1_mode	32	Value : 16#0020 : Master , 16#0021: Slave. Modbus start-addr = 513. Redundant mode of the 1st FCM-
iDCS8830_FCM2_mode	33	Value : 16#0020 : Master , 16#0021: Slave. Modbus start-addr = 513. Redundant mode of the 2nd FCM
iDCS8830_FCM1_status	16	Value : 16#0000: Empty , 16#0001: Timeout , 16#0002: Undefined , 16#0010: Normal. Modbus-addr =
iDCS8830_FCM2_status	16	Value : 16#0000: Empty , 16#0001: Timeout , 16#0002: Undefined , 16#0010: Normal Modbus-addr = !
iDCS8830_FPM_status	2	Value: 0x0000: No FPM plugged , 0x0001: FPM1 Good / FPM2 Off , 0x0002: FPM1 Off / FPM2 Good ,

FCM-MTCP's Redundant Mode and Status:

Name	iDCS8830_FCM1_mode iDCS8830_FCM1_status	iDCS8830_FCM2_mode iDCS8830_FCM2_status
Test Step	Unplug the 1st FCM-MTCP module (FCM1).	
Description	iDCS8830_LAN1_error_status = 130 It means the FCM1 communication error. iDCS8830_FCM1_mode = 32 The redundant mode still displayed as "32" (Master) because the FCM1 is unplug. iDCS8830_FCM2_mode = 32 It means the FCM2 is taking over now and its redundant mode is "Master" (32). iDCS8830_FCM1_status = 1 means that the FCM1 is timeout.	
Return Value	iDCS8830_FCM1_mode / iDCS8830_FCM2_mode 32 : Master 33: Slave iDCS8830_FCM1_status / iDCS8830_FCM2_status 0: Empty 1: Timeout 2: Undefined 16: Normal	

iDCS8830_LAN1_error_status	130	Value : 0: ok , non-zero : error. LAN error status of the 1st FCM-MTCP.
iDCS8830_LAN2_error_status	0	Value : 0: ok , non-zero : error. LAN error status of the 2nd FCM-MTCP.
iDCS8830_FCM1_mode	32	Value : 16#0020 : Master , 16#0021: Slave. Modbus start-addr = 513. R
iDCS8830_FCM2_mode	32	Value : 16#0020 : Master , 16#0021: Slave. Modbus start-addr = 513. R
iDCS8830_FCM1_status	1	Value : 16#0000: Empty , 16#0001: Timeout , 16#0002: Undefined , 16
iDCS8830_FCM2_status	16	Value : 16#0000: Empty , 16#0001: Timeout , 16#0002: Undefined , 16

Plug in the FCM1, it will change to "Slave" mode (33), and becomes a normal status (16).

iDCS8830_LAN1_error_status	0	Value : 0: ok , non-zero : error. LAN error status of the 1st FCM-MTCP.
iDCS8830_LAN2_error_status	0	Value : 0: ok , non-zero : error. LAN error status of the 2nd FCM-MTCP.
iDCS8830_FCM1_mode	33	Value : 16#0020 : Master , 16#0021: Slave. Modbus start-addr = 513. R
iDCS8830_FCM2_mode	32	Value : 16#0020 : Master , 16#0021: Slave. Modbus start-addr = 513. R
iDCS8830_FCM1_status	16	Value : 16#0000: Empty , 16#0001: Timeout , 16#0002: Undefined , 16
iDCS8830_FCM2_status	16	Value : 16#0000: Empty , 16#0001: Timeout , 16#0002: Undefined , 16

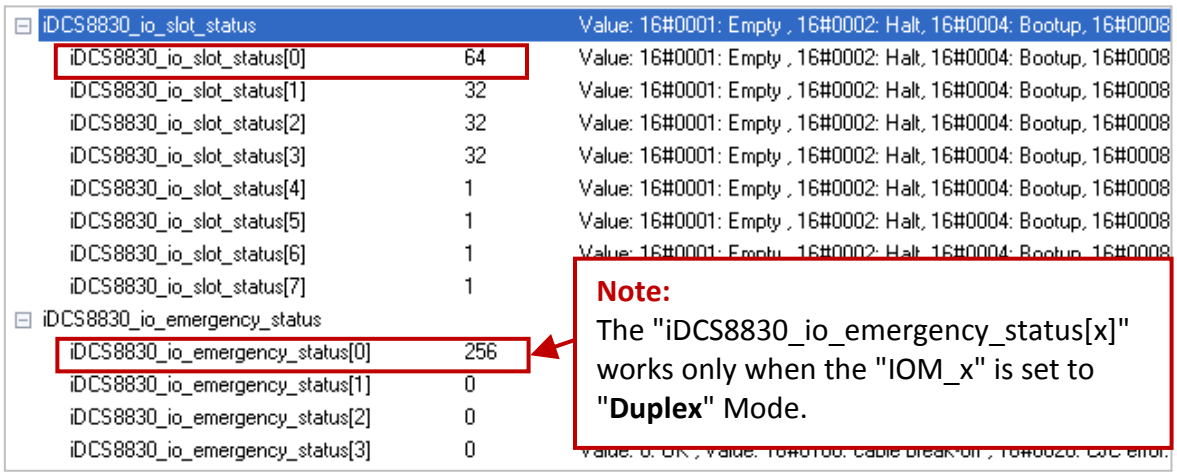
You can try to unplug the FCM2, and then the FCM1 will become the Master (32) and take over.

iDCS8830_LAN1_error_status	0	Value : 0: ok , non-zero : error. LAN error status of the 1st FCM-MTCP.
iDCS8830_LAN2_error_status	130	Value : 0: ok , non-zero : error. LAN error status of the 2nd FCM-MTCP.
iDCS8830_FCM1_mode	32	Value : 16#0020 : Master , 16#0021: Slave. Modbus start-addr = 513. R
iDCS8830_FCM2_mode	33	Value : 16#0020 : Master , 16#0021: Slave. Modbus start-addr = 513. R
iDCS8830_FCM1_status	16	Value : 16#0000: Empty , 16#0001: Timeout , 16#0002: Undefined , 16
iDCS8830_FCM2_status	1	Value : 16#0000: Empty , 16#0001: Timeout , 16#0002: Undefined , 16

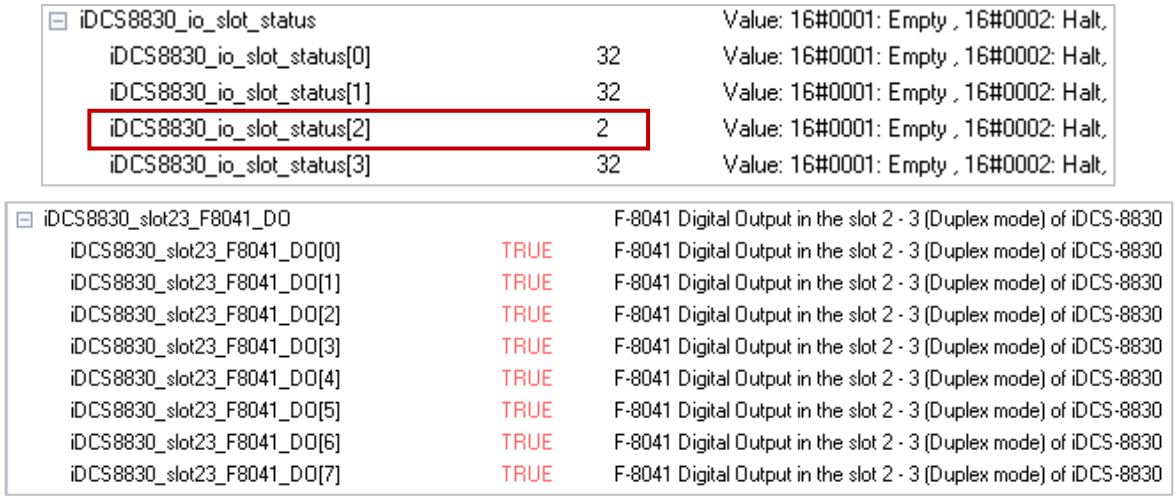
Plug in the FCM2 afterward.

iDCS8830_LAN1_error_status	0	Value : 0: ok , non-zero : error. LAN error status of the 1st FCM-MTCP.
iDCS8830_LAN2_error_status	0	Value : 0: ok , non-zero : error. LAN error status of the 2nd FCM-MTCP.
iDCS8830_FCM1_mode	32	Value : 16#0020 : Master , 16#0021: Slave. Modbus start-addr = 513. R
iDCS8830_FCM2_mode	33	Value : 16#0020 : Master , 16#0021: Slave. Modbus start-addr = 513. R
iDCS8830_FCM1_status	16	Value : 16#0000: Empty , 16#0001: Timeout , 16#0002: Undefined , 16
iDCS8830_FCM2_status	16	Value : 16#0000: Empty , 16#0001: Timeout , 16#0002: Undefined , 16

The Status of I/O Slot and I/O Emergency:

Name	iDCS8830_io_slot_status	iDCS8830_io_emergency_status
Test step	Unplug the cable between the 1st F-804**0** (slot 0) and the terminal board DN-DI-32DW.	
	
Description	iDCS8830_io_slot_status[0] = 64, which means this module (slot0) is stop working. iDCS8830_io_emergency_status[0] = 256 It means the cable which plugged into this module (slot0) is disconnected. Plug in this cable and then you can try to unplug others cable for testing.	
Return Value	iDCS8830_io_slot_status[x] 1: Empty 2: Halt 4: Bootup 8: Bootloader 16: Pre-operation 32: Operation 64: Stop iDCS8830_io_emergency_status[x] 0 : Normal 32: CJC Error 256: Cable Break-off	

Redundant DO module:

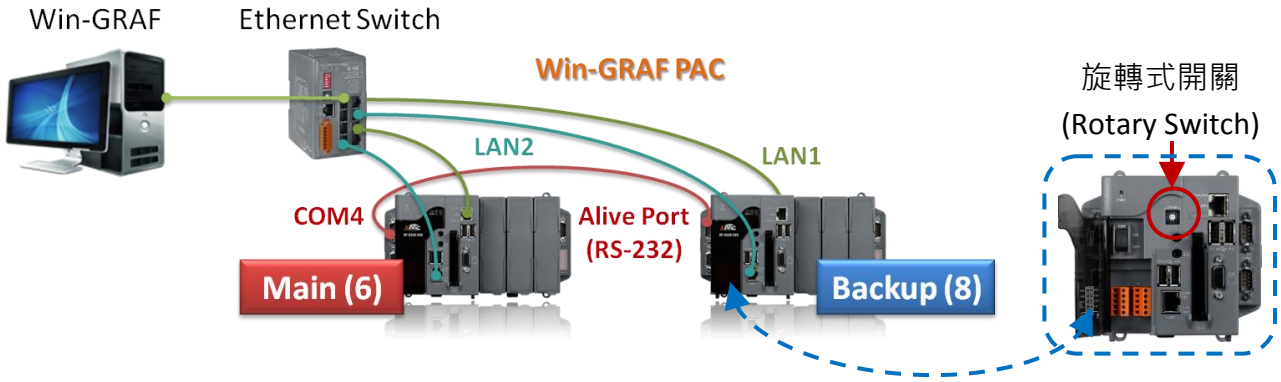
Name	iDCS8830_slot23_F8041_DO
Test step	Plug in the 1st F-804**1** DO module (slot2).
	
Description	At first, the LED indicator (called DO0 ~ 7) of the 1st F-8041 module (slot2) will light up sequentially. When you unplug this module, the 2nd F-8041 module (slot3) will take over and do the same thing. Then, you can view the status value of the iDCS8830_io_slot_ status[2] is "2" which means this module (slot2) is halted. (Plug in this module again.)

16.6 Test the Redudant System 2 (Rotation switch: 6 & 8)

Important Notes:

- Set the rotation switch properly (Redudant System2: 6 and 8). Make sure that the **LAN1, LAN2 and Alive Port** are connected properly, and then power on. (Redudant System1: Section 16.5)
- The factory default setting of LAN1 and LAN2 is DHCP that must be set as static IP by using XPAC_Utility.

16.6.1 Download the Redundant Project

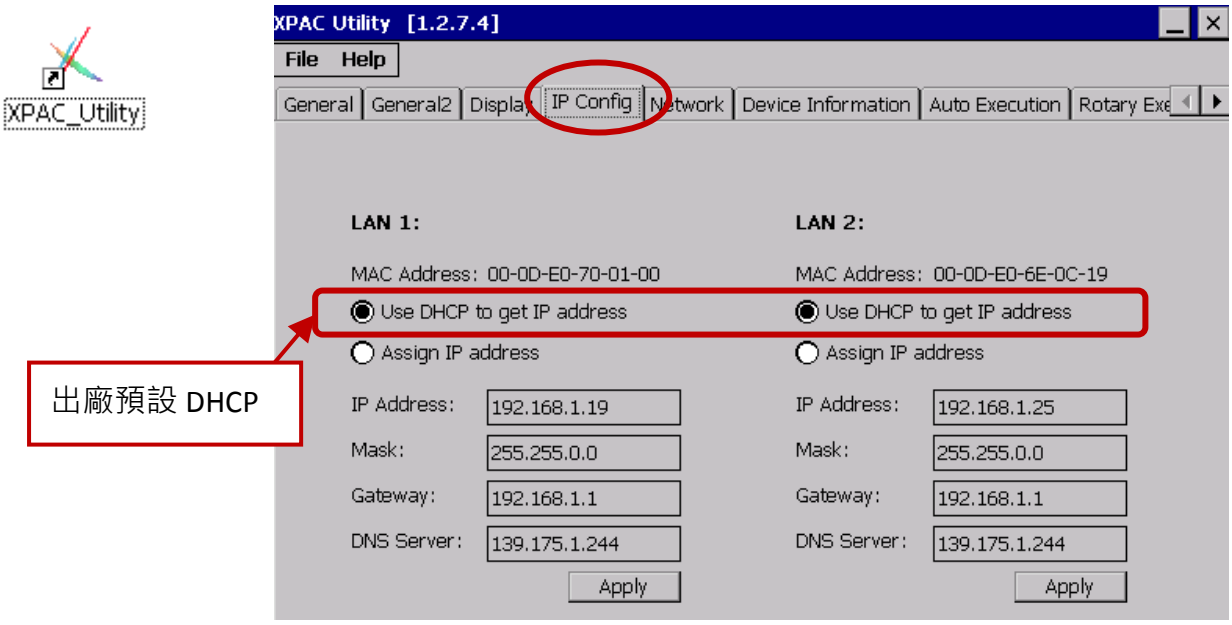


1) Device Requirement:

Win-GRAF PAC	Cable	
XPAC * 2	LAN1 、LAN2: Ethernet cable * 4	Alive Port: RS-232 crossover cable * 1

2) Set IP addresses:

The factory default setting of LAN1 and LAN2 is DHCP, set them as static IP by using XPAC_Utility.



Note:

When using multiple sets of redudant system (i.e., Win-GRAF redudant system 2), it must assign LAN2 IP address for each set.

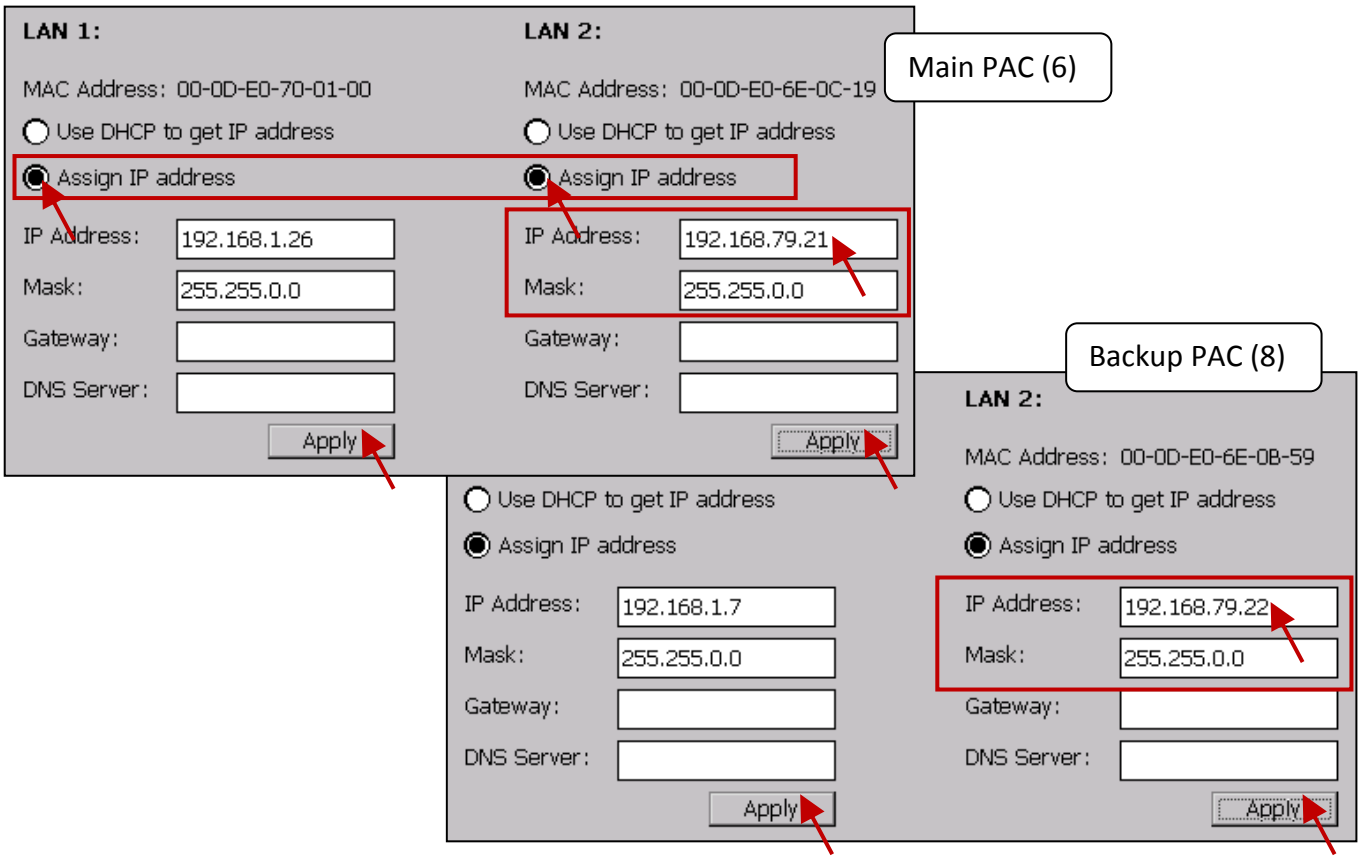
1. If Main PAC = LAN2 IP, the Backup PAC must be LAN2 IP + 1.
2. Both the Mask address of two PACs must be the same.

Rotary Switch (6, 8)	**LAN2**	**Description**
Main PAC (6)	**IP**	The **Active PAC** by default (i.e., L1 LED = ON) Please download the Win-GRAF project to this PAC.
Backup PAC (8)	**IP+1**	The **Passive PAC** by default (i.e., L1 LED = OFF)

For example,

Main-PAC (6): LAN2 IP = 192.168.79.**25** ; Mask = 255.255.0.0

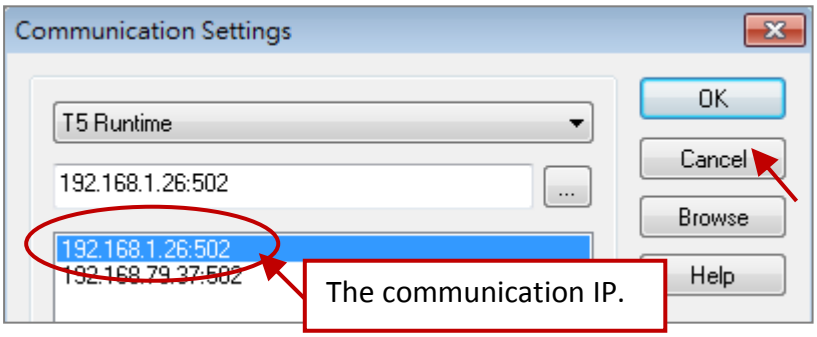
Backup-PAC (8): LAN2 IP = 192.168.79.**26** ; Mask = 255.255.0.0



After completing the settings, click the "Apply“ button and restart two PACs to apply the IP settings. Check to see if IP addresses are correct. In addition, the LAN1 IP of Backup PAC will automatically be set as Active_IP+1 after downloading the project to the Active PAC.

3) Set the Win-GRAF communication IP address

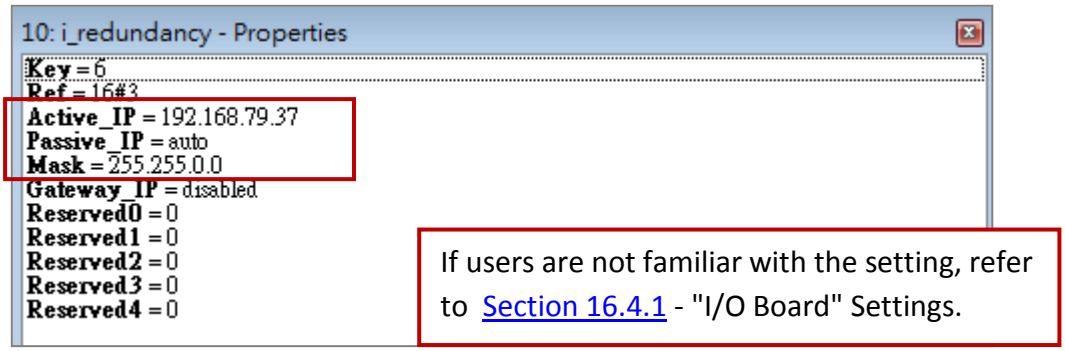
For the first time to download the redundant project, e.g., demo_rdn_2, enter the LAN1 IP address of the Main-PAC (6). Refer to Section 2.3.5 - “Communication Parameters".



4) Set the Active_IP address

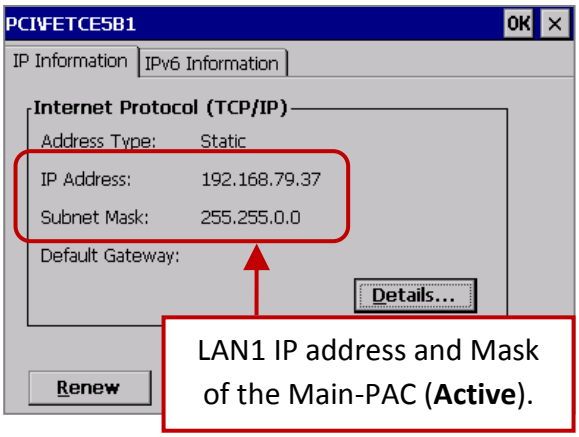
Set the Active_IP and Mask address for the " i_redundancy" function depends on the network environment.

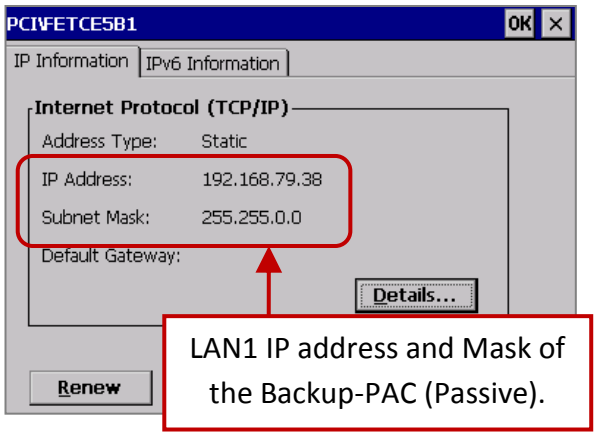
Note: remember to change the Active_IP address when using multiple sets of redundant system.



5) Download the Win-GRAF project

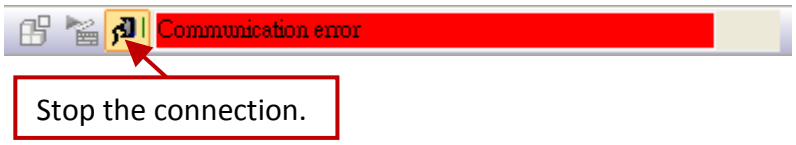
Click the “On Line” button ( ) to download the redundant project to the Main-PAC, refer to Section 2.3.4 and Section 2.3.5. After it’s downloaded, LAN1 IP address of the Main-PAC(6) will automatically be set to the Active_IP address. And then LAN1 IP address of the Backup-PAC(9) will be set to Active IP + 1.



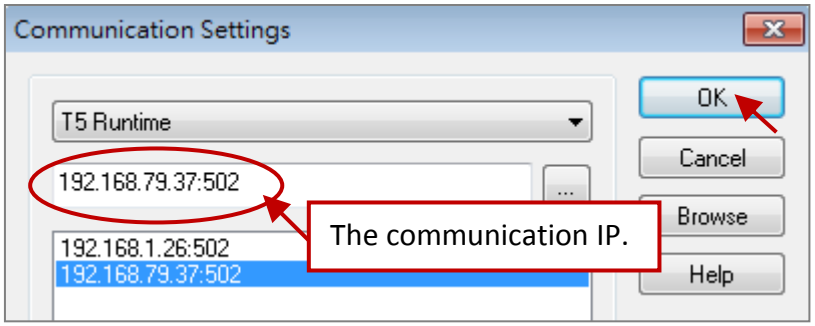


6) Change the Win-GRAF communication IP address to the Active_IP address

Right now, Win-GRAF will show "Communication error" because the current IP address of the Active-PAC is automatically set to the Active_IP address. Click the “On Line” button again to stop the connection between the Win-GARF and the PAC.



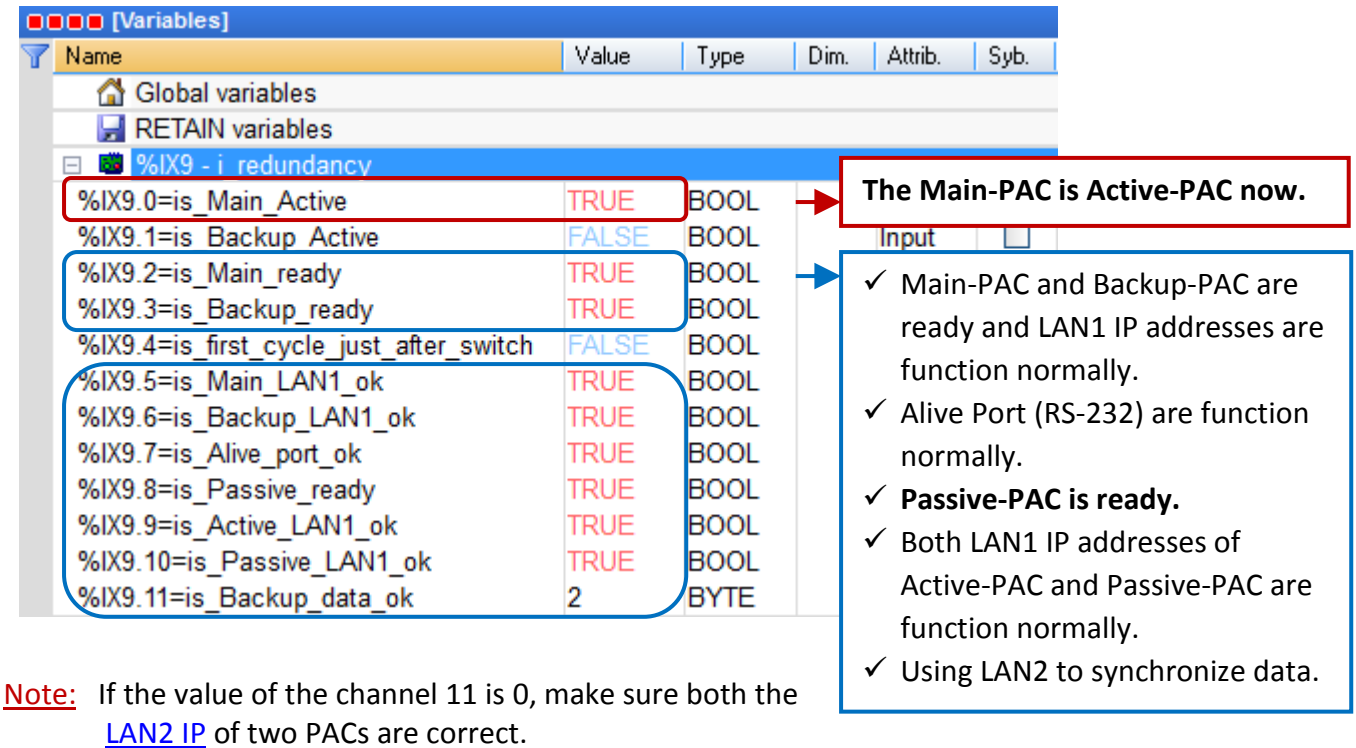
Next, change the Win-GRAF communication IP to the Active_IP address so that this project will always download to the Active-PAC whenever the user wants to debug or change it.



To view the status of Win-GRAF redundant system in the "Variables" window. Refer to Section 16.4.1 I/O Boards Settings to see the description of the “i_redundancy” function.

Test:

1. After unplugging the LAN2 cable of Backup PAC, it will automatically synchronize data through LAN1.
2. After turning off the Main PAC, the Backup PAC will become Active PAC (L1 LED = ON)。



Note: If the value of the channel 11 is 0, make sure both the LAN2 IP of two PACs are correct.