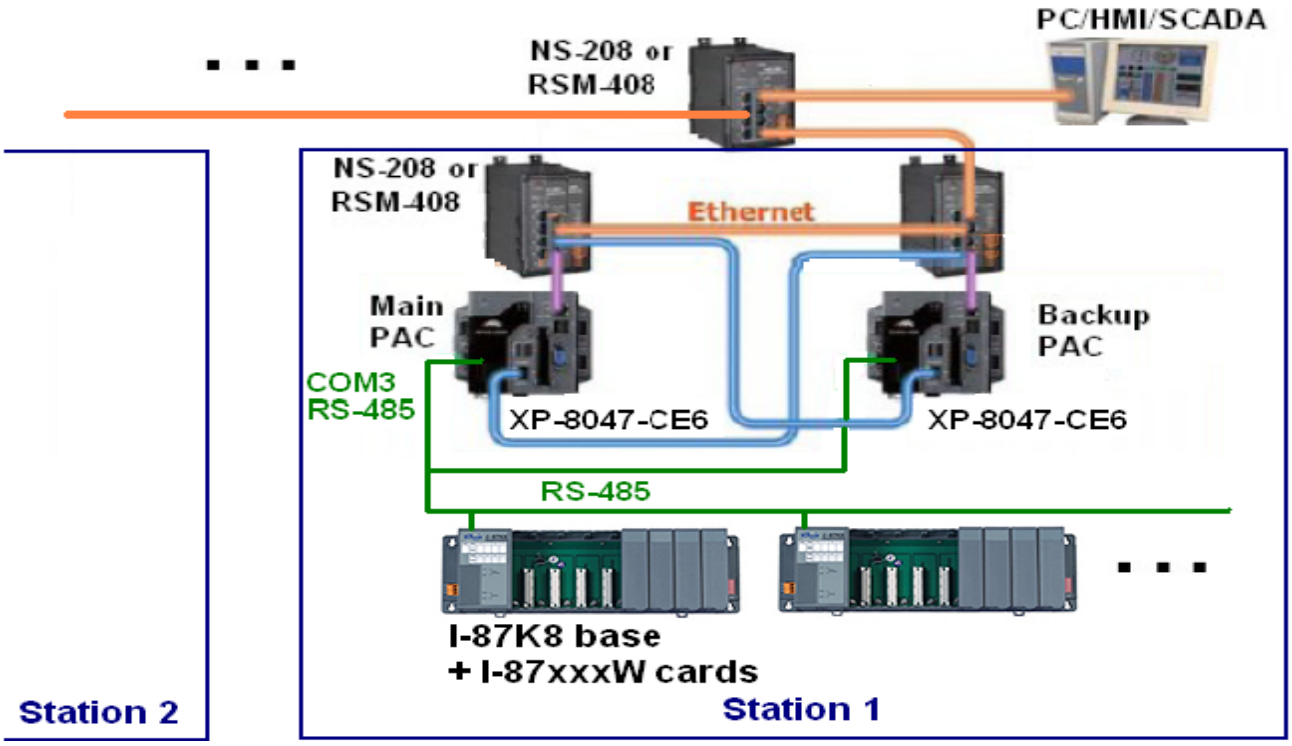
How to program an XP-8xx7-CE6 redundant system (with I-87K8 expansion base or Modbus I/O or other I/O) ?

Advantage more than the WP-8xx7 redundant system:
1. The PC / HMI / SCADA can connect to only one IP address (the “active_IP1” address) to monitor / control the XP-8xx7-CE6 redundant system (The “Active_IP1” address will auto-switch to the active XP-8xx7-CE6 's LAN1 or LAN2 port).
2. The running speed of program in the XP-8xx7-CE6 is faster than the WP-8xx7. The windows behavior is much smooth than the WP-8xx7.

User can download this paper and demo programs at the following web site.
FAQ document and emo programs: https://www.icpdas.com/en/faq/index.php?kind=280#751 > FAQ-138 .
Data Sheet:
http://www.icpdas.com/en/download/index.php?nation=US&kind1=6&kind2=15&model=&kw=isagraf

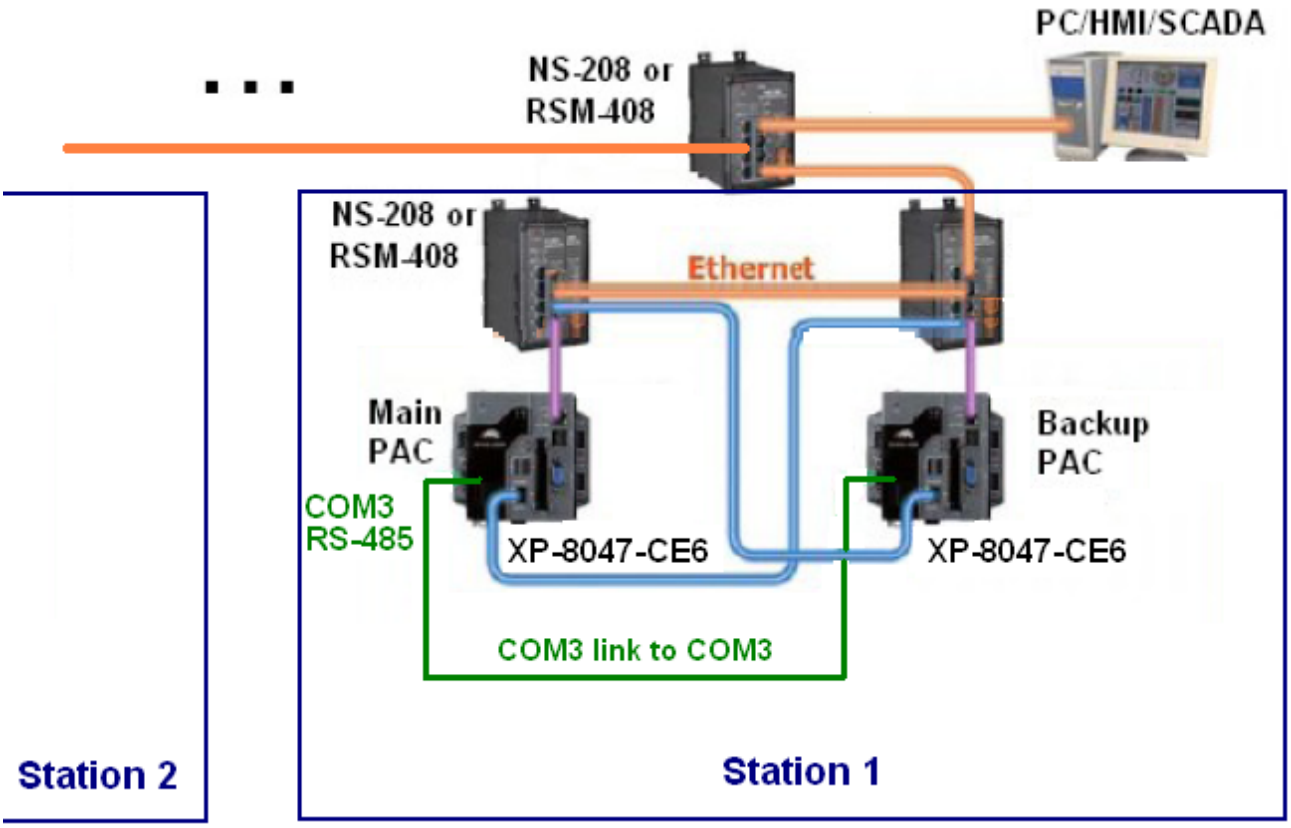
1.1 : Configuration of serval redundant systems

The first configuration is using two XP-8xx7-CE6 PAC to connect one or more I-87K8 expansion base (each I-87K8 base can have max. eight I-87xxxW I/O cards in it). One or more stations can join together as the following figure. Each station contains one or two NS-208 (or RSM-208) and two XP-8xx7-CE6 controllers and one or more I-87K8 base with I-87xxxW I/O cards.



Configuration 1 (demo program : “faq138_1.pia”)
If the application installs non-Modbus devices and non-DCON I/O, please refer to section 1.7.

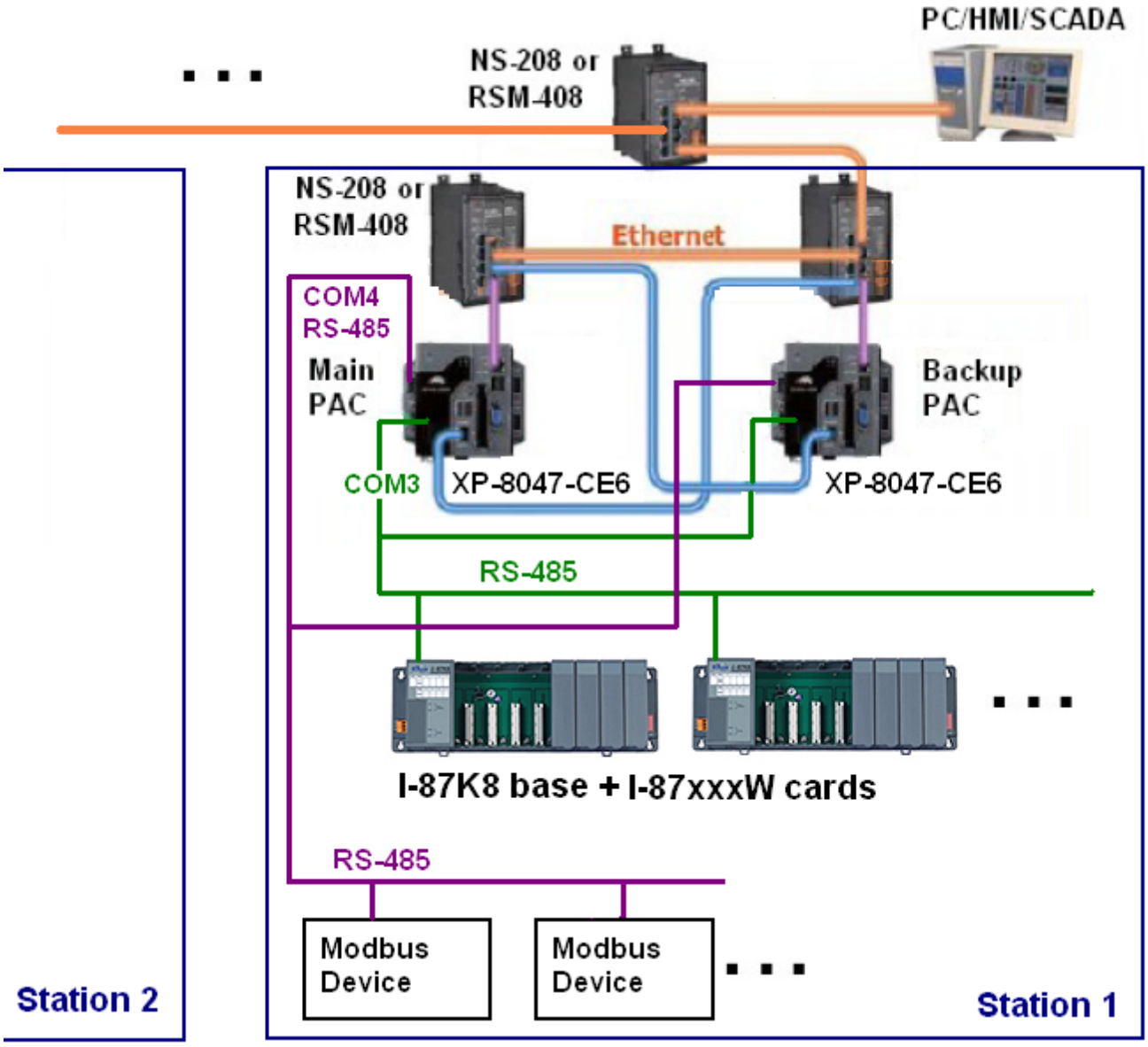
The second configuration is using two XP-8xx7-CE6 PAC without I/O or connect some other devices by serial ports(for example, using both XP-8xx7-CE6 's COM5:RS-232 to link one I-7530 respectively to become CAN signal to connect other CAN/CANopen devices). Both PAC 's COM3: RS-485 should connect to each other in this configuration. Can use only one NS-208 (or RSM-208) or two in each station .



Configuration 2 (demo program : “faq138_2.pia”)

If the application installs non-Modbus devices and non-DCON I/O, please refer to section 1.7.

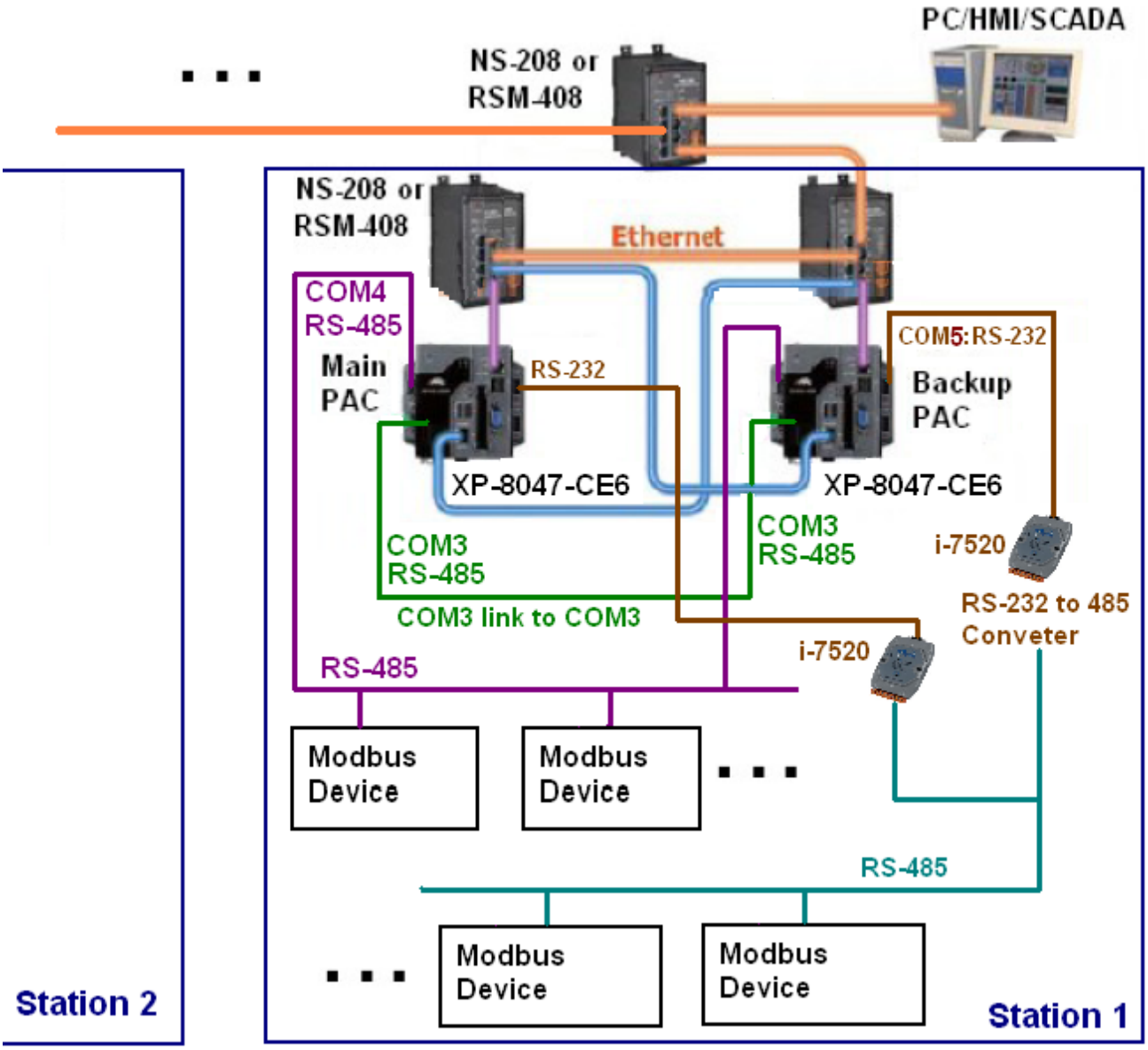
The third configuration is using two XP-8xx7-CE6 PAC to connect one or more I-87K8 expansion bases and connect some Modbus RTU devices (or Modbus ASCII devices) by one or more serial ports . Can use only one NS-208 (or RSM-208) or two in each station.



Configuration 3

If the application installs non-Modbus devices and non-DCON I/O, please refer to section 1.7.

The fourth configuration is using two XP-8xx7-CE6 PAC to connect some Modbus RTU device (or Modbus ASCII devices). Both PAC 's COM3: RS-485 should connect to each other in this configuration. Can use only one NS-208 (or RSM-208) or two in each station.



Configuration 4

If the application installs non-Modbus devices and non-DCON I/O, please refer to section 1.7.

1.2 : Configure both PACs and all I-87xxxW I/O cards in the I-87K8 expansion base

Note: The ISaGRAF driver version of the XP-8xx7-CE6 redundant system should be version 1.14 or later version. If your XP-8xx7-CE6 's ISaGRAF driver version is older, it's better to update it. (visit http://www.icpdas.com/en/download/show.php?num=368&nation=US&kind1=&model=&kw=isagraf for new driver)

Important note : Please must do the settings of the following item 1 to 3 to make the XP-8xx7-CE6 redundant system work properly. If user don't do the below settings (especially item 1 and 2), the XP-8xx7-CE6 redundant system may happen some errors like “IP conflict” and “communication broken” .

1. Set the Hardware IP address of both XP-8xx7-CE6 (at rotary switch position 0) as different address than the IP address assigned in the ”RDN_New2” in the IO connection window. For example, only set the first number as different one and remain the other three numbers as the same and set all Mask as 255.255.255.0

For example, if the “RDN_new2” setting in the IO connection windows are as the following,

Redundant IP: (Rotary switch at 7: Main and 9: Backup)

Active_IP1 = **192** .168.2.100
Active_IP2 = **192** .168.2.101
InActive_IP1 = **192** .168.2.102
InActive_IP2 = **192** .168.2.103.

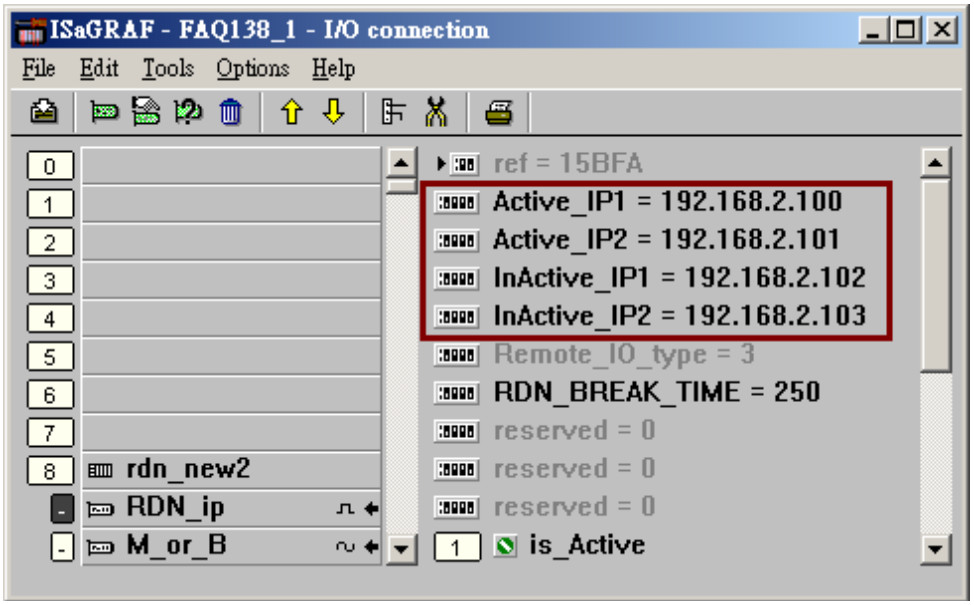
Then we can set the hardware IP address (at Rotary switch 0) as the below.

Hardware IP: (both PAC at rotary switch 0)

Main PAC 's LAN1 = **200** .168.2.100
Main PAC 's LAN2 = **200** .168.2.101
Backup PAC 's LAN1 = **200** .168.2.102
Backup PAC 's LAN2 = **200** .168.2.103

Refer to the next page for an example.

For example, the setting in the “faq138_1.pia” project is as the following figure.



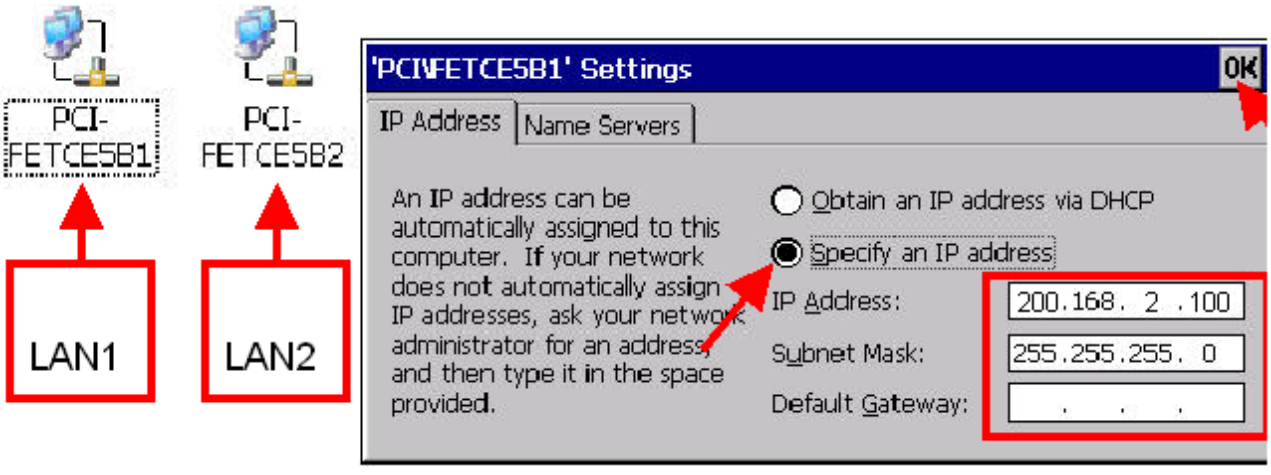
Then turn the rotary switch of both XP-8xx7-CE6 to 0 and then power on them. After booting up, set the Hardware IP(means the IP address at rotary switch 0) as below (set all Mask as 255.255.255.0)

Hardware IP: (rotary switch at 0)

Main PAC 's LAN1 = **200**.168.2.100 , Main PAC 's LAN2 = **200**.168.2.101

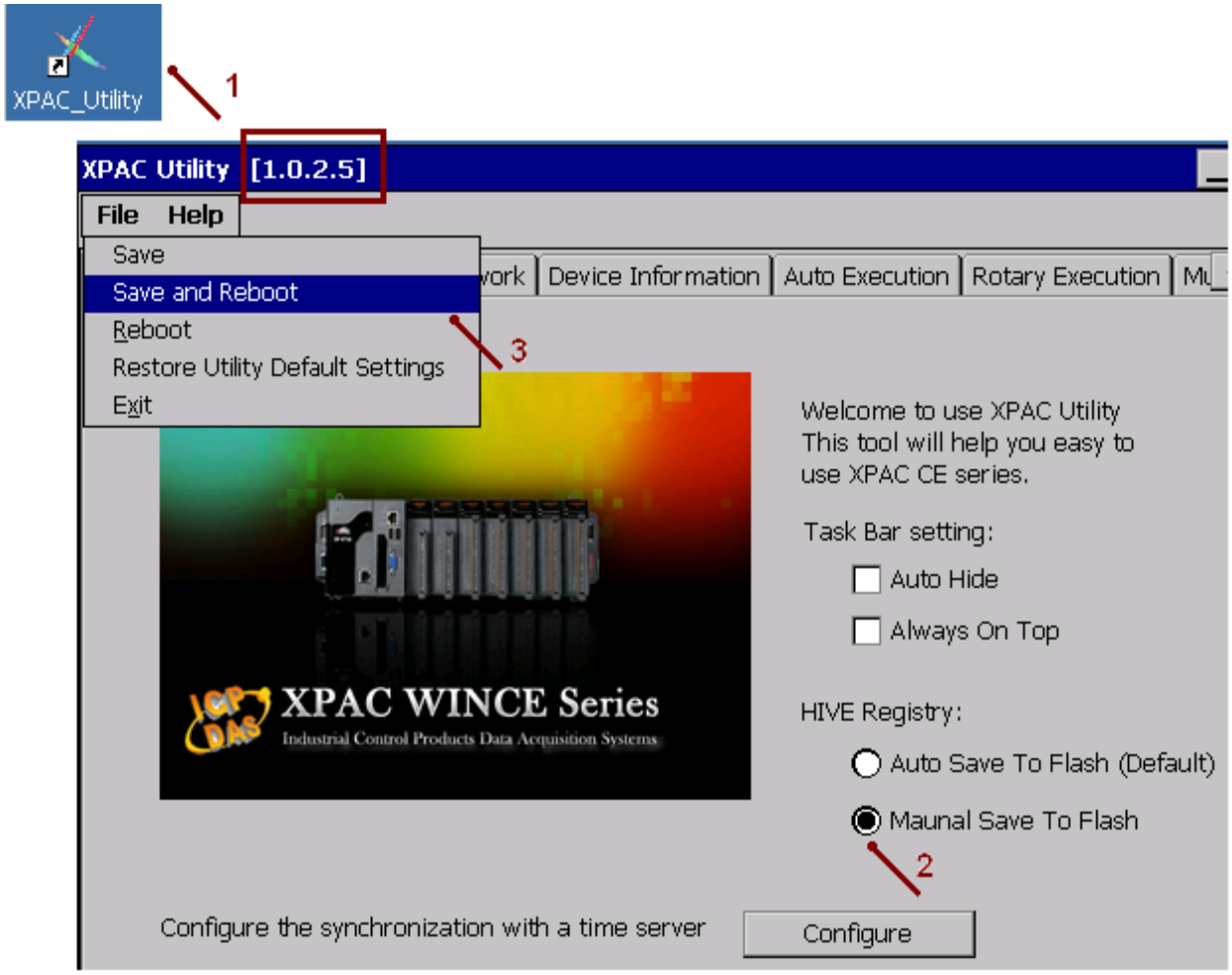
Backup PAC 's LAN1 = **200**.168.2.102, Backup PAC 's LAN2 = **200**.168.2.103

run [Start] > [Setting] > [Control Panel] on the XP-8xx7-CE6 's VGA monitor
run “Network and Dial-up Connections”
Then set “IP address” and “Subnet Mask” of both “LAN1” and “LAN2” .



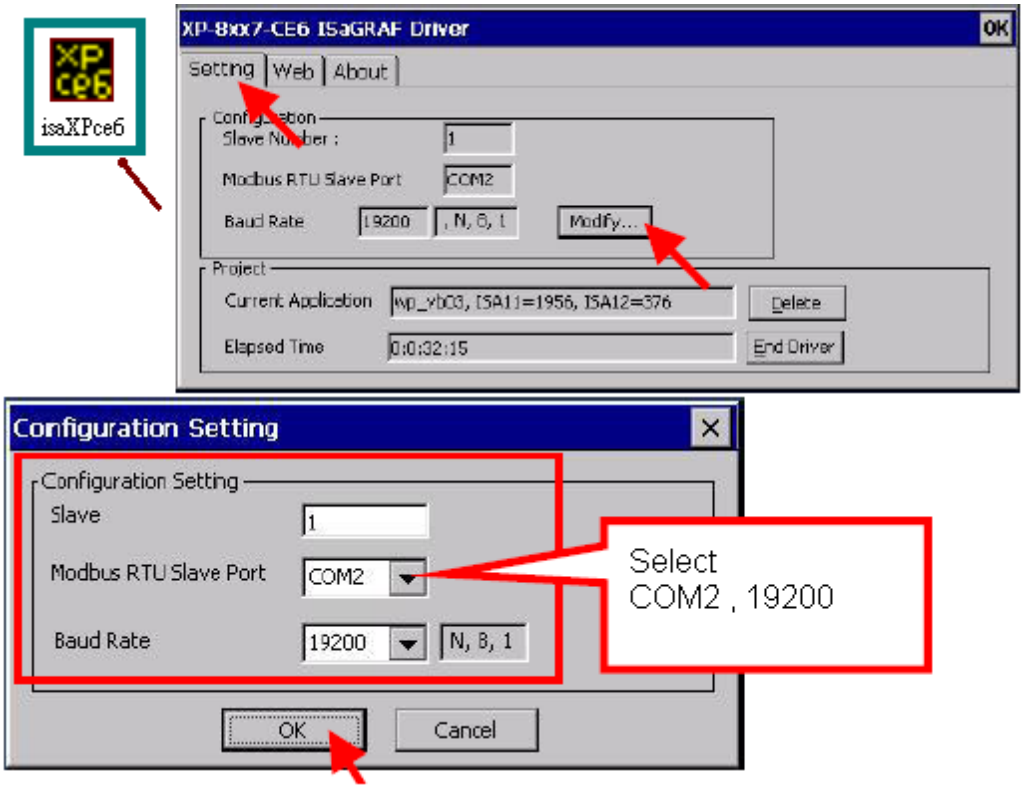
2. After setting the proper hardware IP address, run the XPAC Utility (should be version 1.0.2.5 or later version) to check the "**Manual Save To Flash**" . Then run "File > Save and Reboot".

Note :DO NOT check the "Auto Save To Flash" for the XP-8xx7-CE6 redundant system.

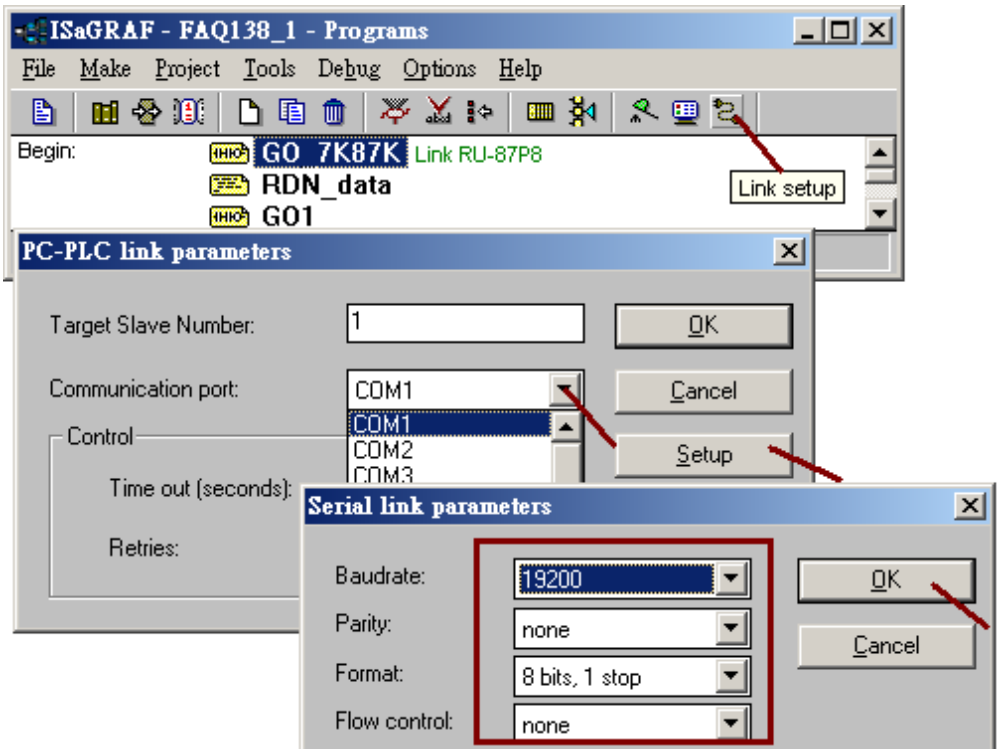


After answer "OK" to the pop-up dialog, the XP-8xx7-CE6 will reset once automatically.

When the XP-8xx7-CE6 booting up completely, set both XP-8xx7-CE6 's COM2 as “Modbus RTU slave Port”. Then click ok and reset the XP-8xx7-CE6 once to make the setting happen. This COM2 setting is for downloading the ISaGRAF project .



Note: The PC / ISaGRAF can download the ISaGRAF project to the XP-8xx7-CE6 redundant system only when they are booting up at rotary swtich 0. The position 7 and 9 are for running the redundant system (not for downloading project) .



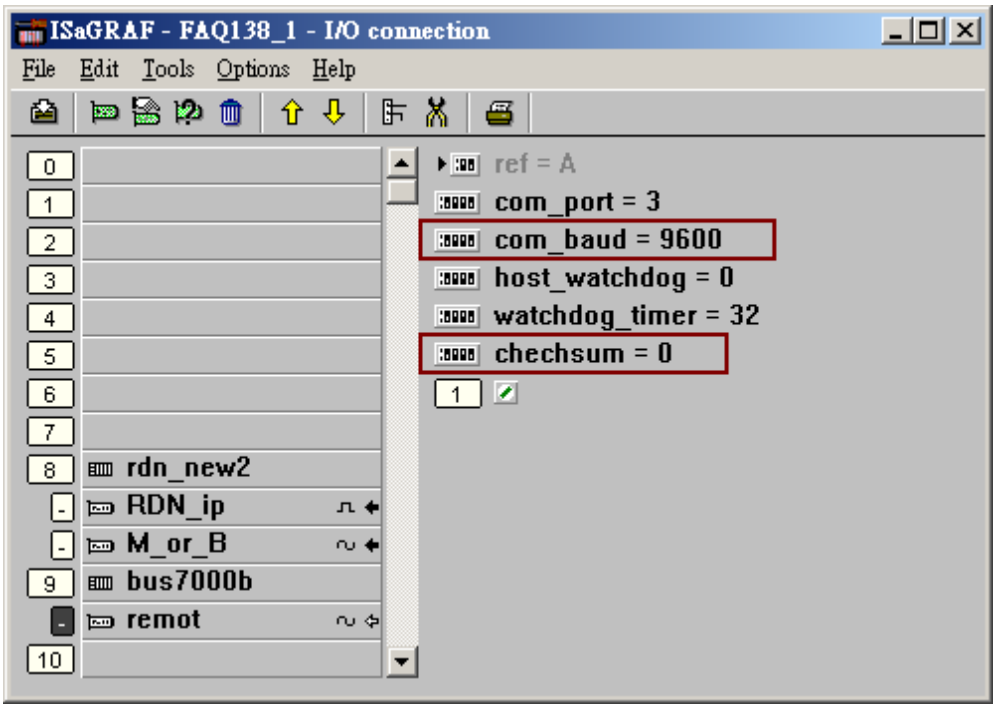
3. If the redundant system has the I-87K8 (with I-87xxx cards) expansion unit installed, like the configuration 1 and 3 listed in section 1.1 of this paper, please must run PC / DCON utility to configure all the I-87xxx cards in the I-87K8 once (includes the settings of Address, baud-rate, checksum, ...) .

For example, the “faq138_1.pia” project uses two XP-8047-CE6 's COM3:RS-485 to connect one I-87K8 base and there are three I/O cards in the I-87K8. They are I-87053W (16-Ch. D/I) and I-87057W (16-Ch. D/O) and I-87017W (8-Ch. A/I). Please must configure these three I/O cards as the following settings by the DCON utility before running the “faq138_1.pia” project .

I-87053W :
address : 2 , baud-rate : 9600 , checksum disabled
I-87057W :
address : 3 , baud-rate : 9600 , checksum disabled
I-87017W or I-87017RW :
address : 4 , baud-rate : 9600 , checksum disabled, format: 2's compliment
range-type of Ch.1 to 8 : +/- 10V

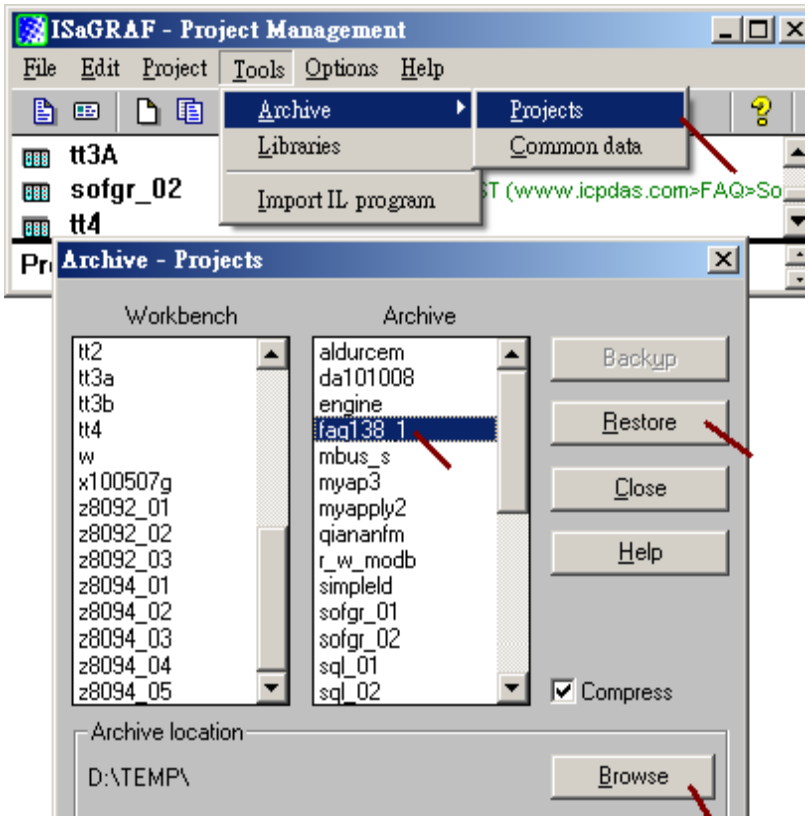
Note: All remote RS-485 I-7000 A/I modules and remote I-87xxxW A/I cards connectted by the ISaGRAF PAC must using format “2's compliment” , or they will become disconnectted.

All the “baud-rate” and “checksum” setting of all remote I/O modules must use the same setting as the setting in the ISaGRAF PAC 's “bus7000b” .


ISaGRAF - FAQ138_1 - I/O connection
File Edit Tools Options Help
0
1
2
3
4
5
6
7
8
rdn_new2
RDN_ip
M_or_B
9
bus7000b
remot
10
ref = A
com_port = 3
com_baud = 9600
host_watchdog = 0
watchdog_timer = 32
chechsum = 0
1

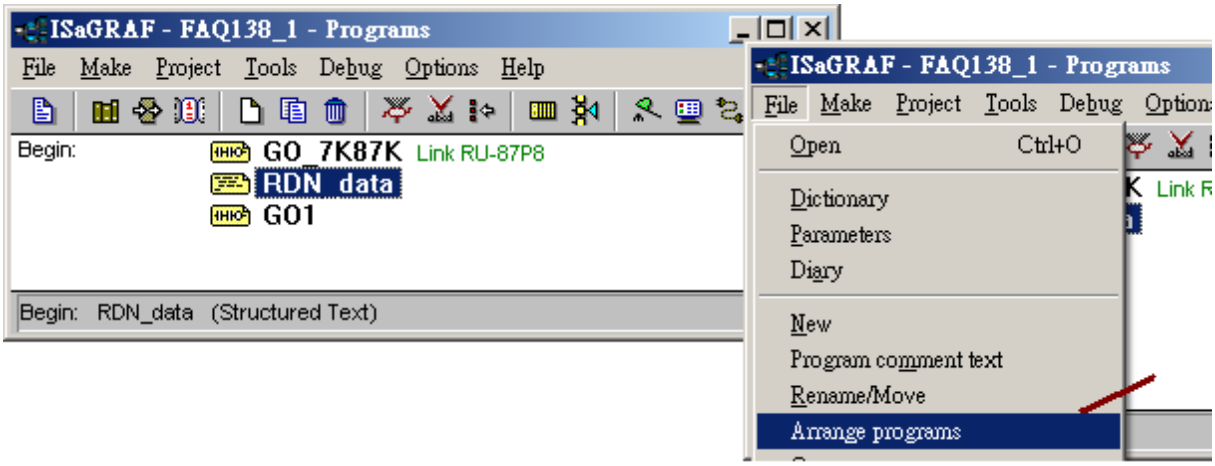
1.3 : Program the redundant system

This section lists the example project “faq138_1.pia”. User may download this project file from https://www.icpdas.com/en/faq/index.php?kind=280#751 .Then restore it to the PC/ISaGRAF.



Project structure:

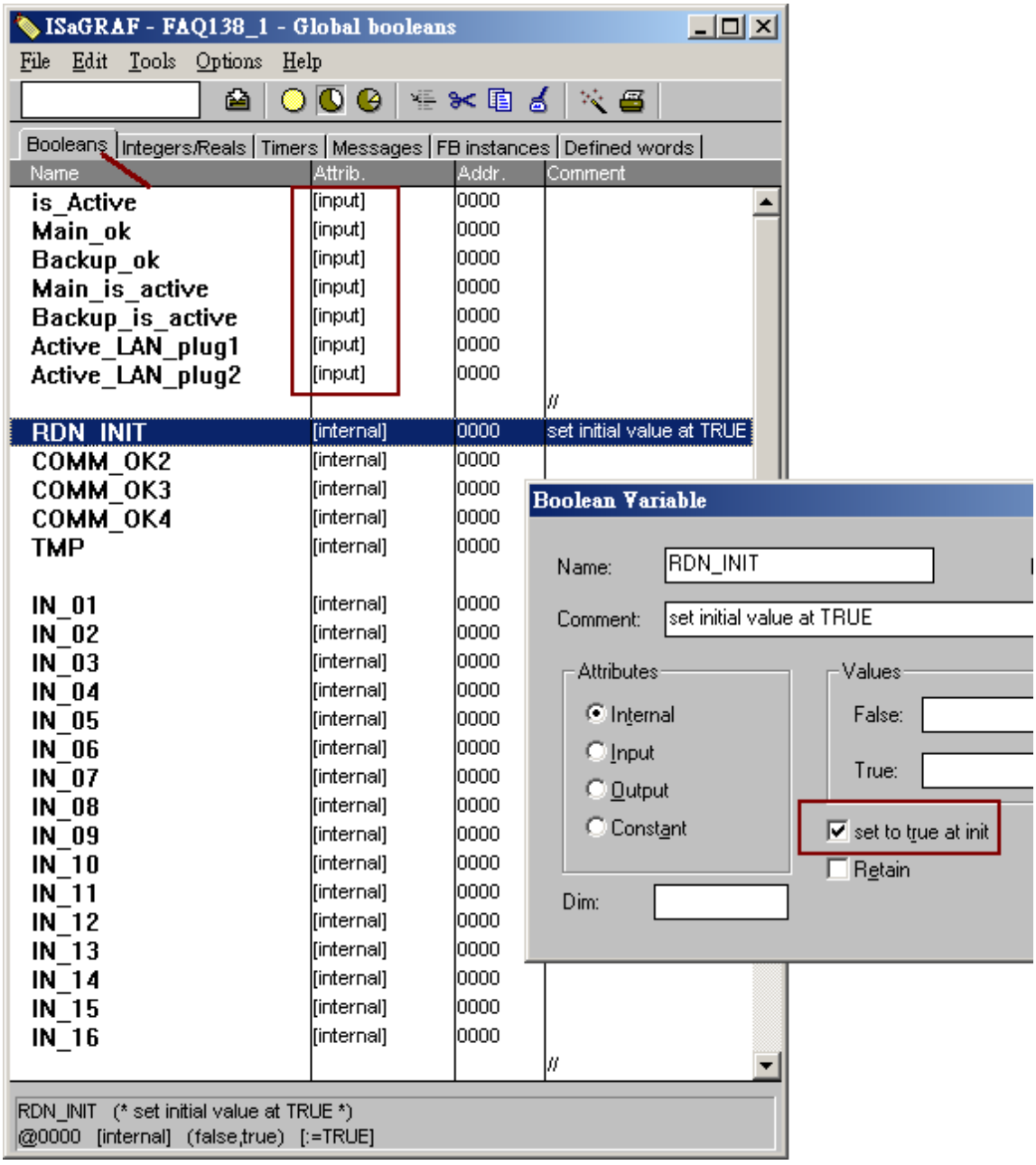
The “faq138_1” project contains two Ladder programs and one ST program. The “GO_7K87K” must place on the top-most position followed by the “RDN_data” program. Then place the “GO1” program after the “RDN_data” .



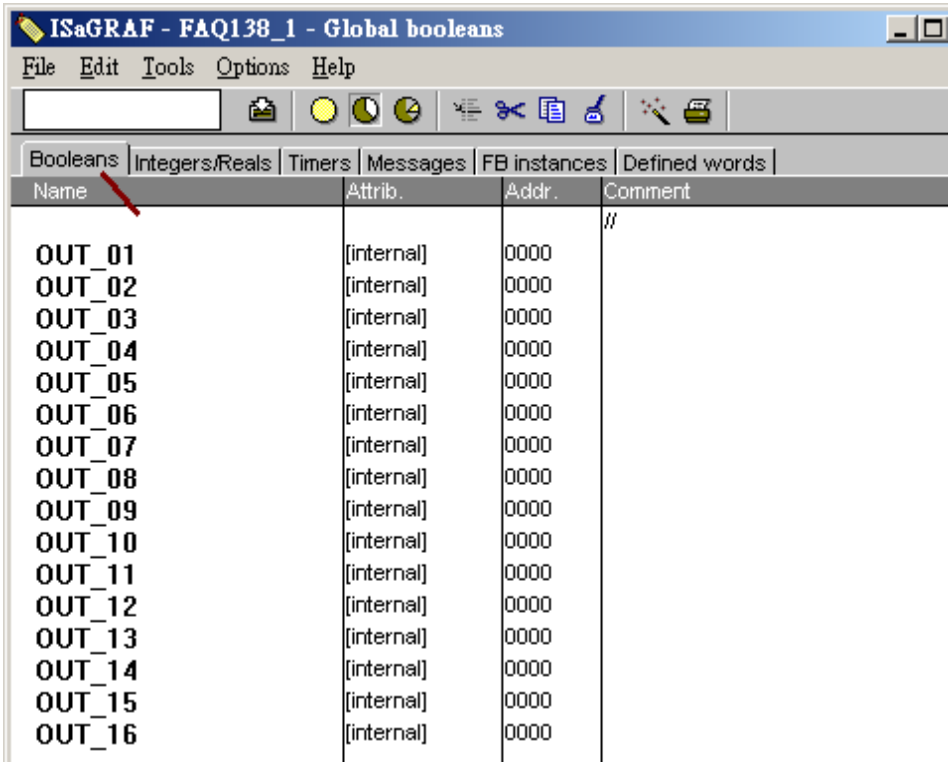
Variable declaration:

Boolean :

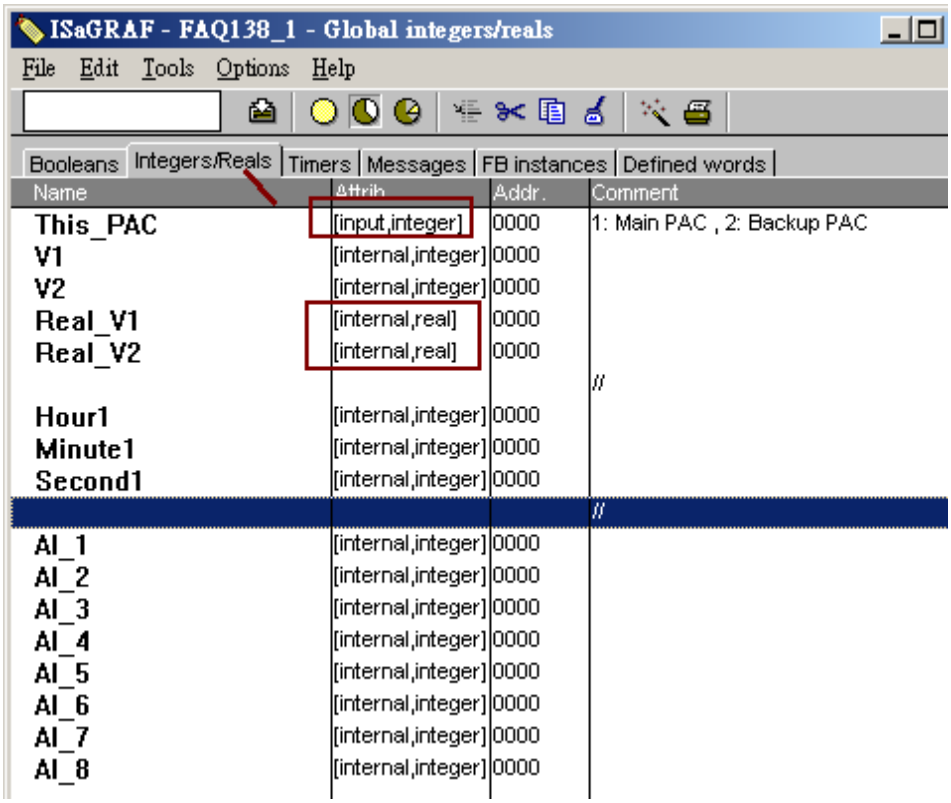
Please must set “RDN_INIT” 's initial value to TRUE.



(more Boolean variables on the next page)

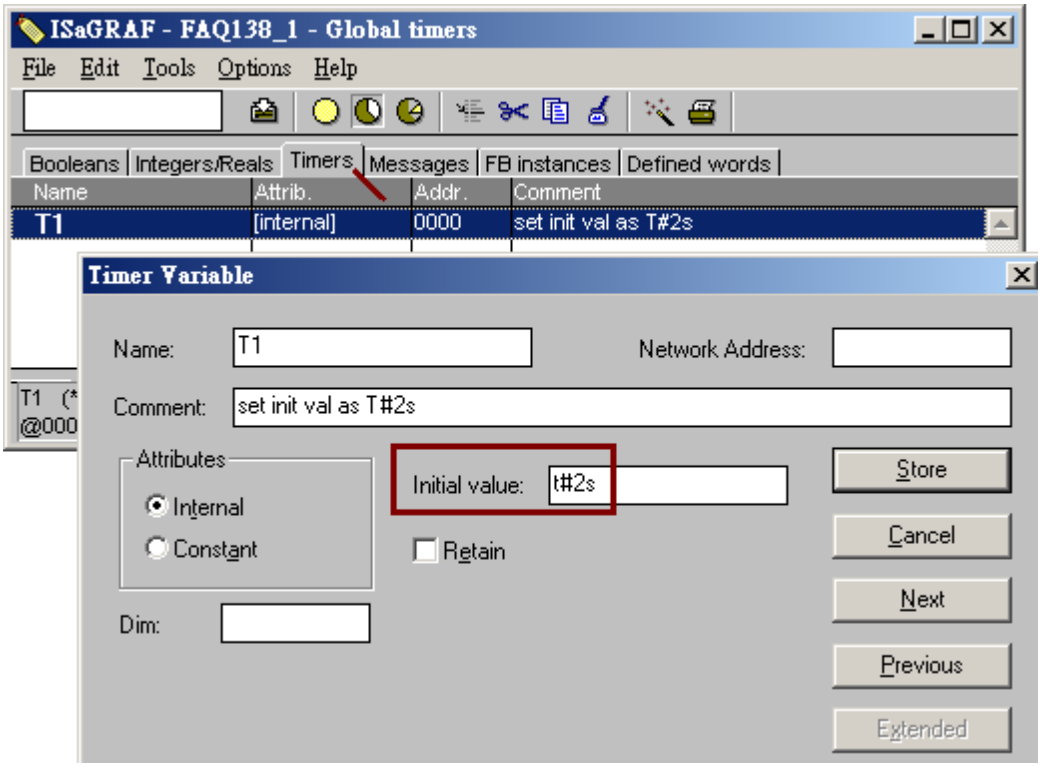


Integer / Real : Please must set “This_PAC” to “input” attribution .

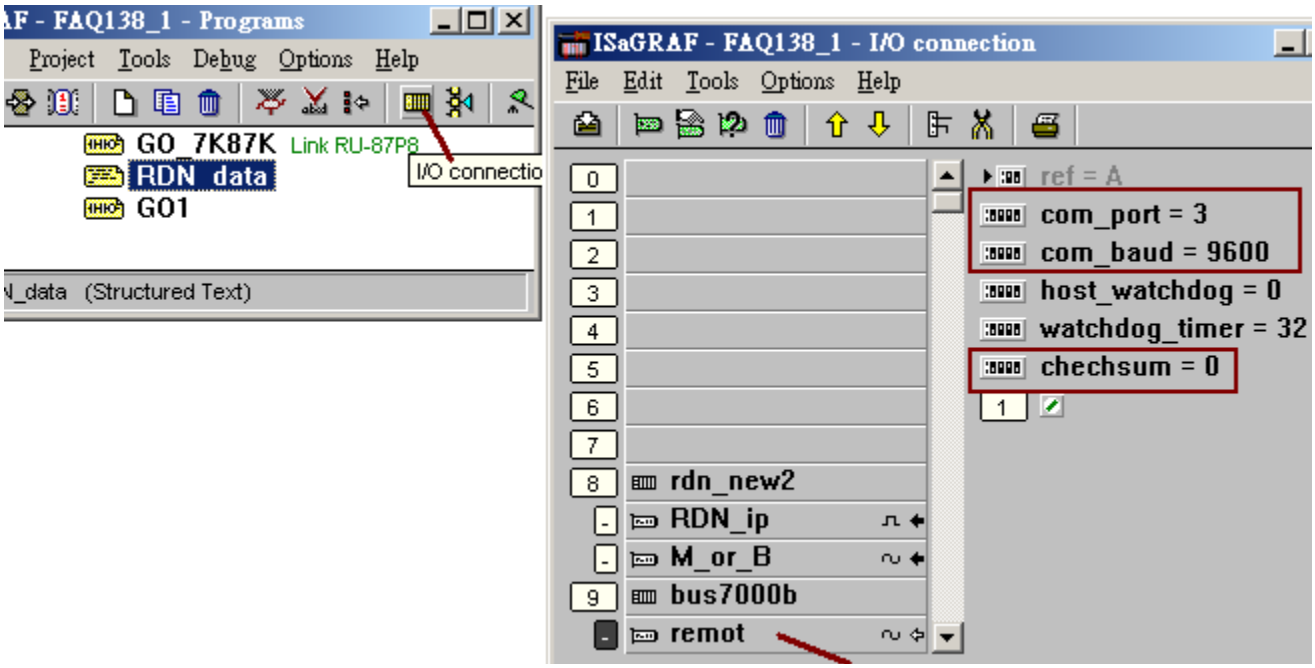


Timer :

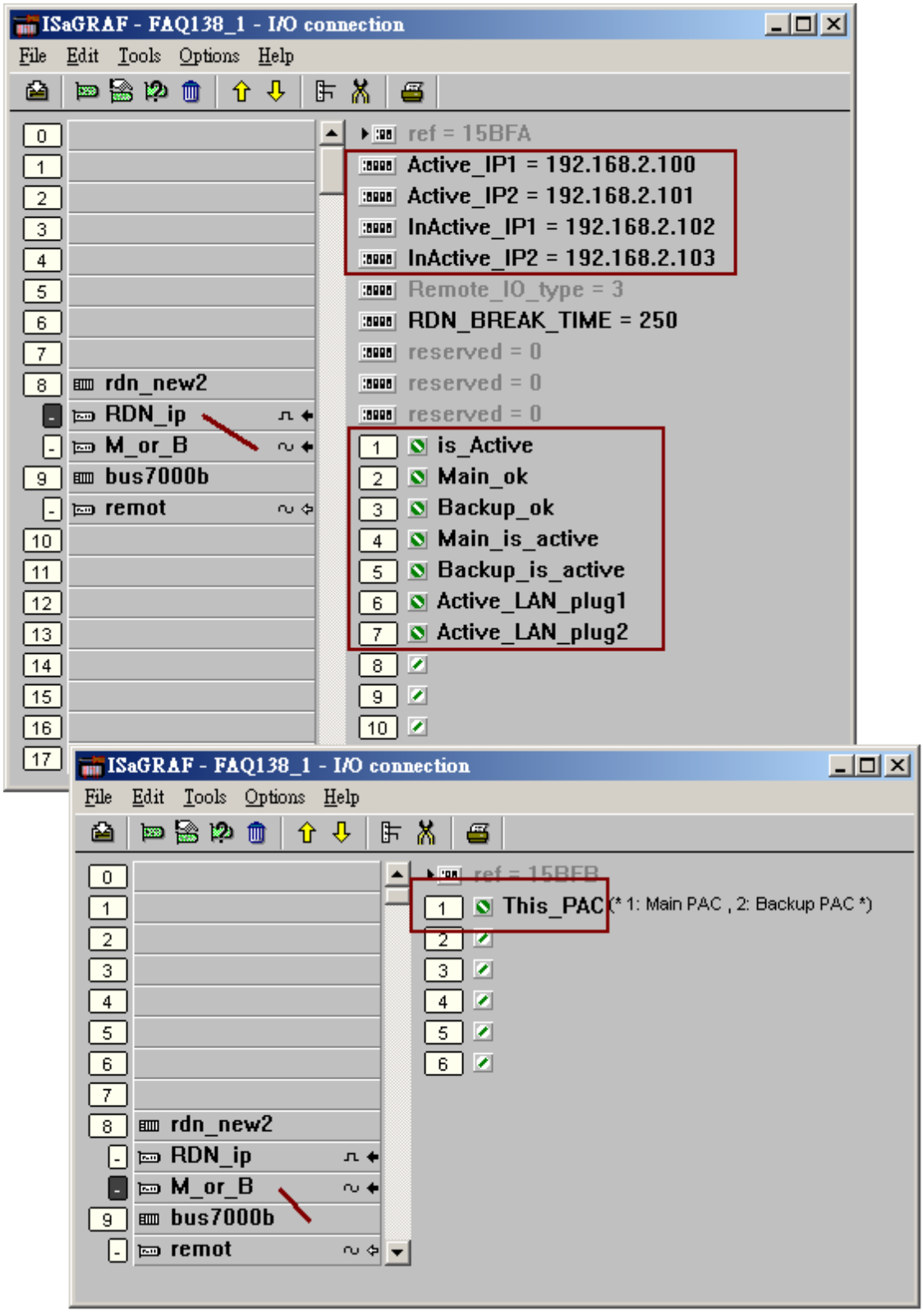
Set “T1” 's initial value as T#2s



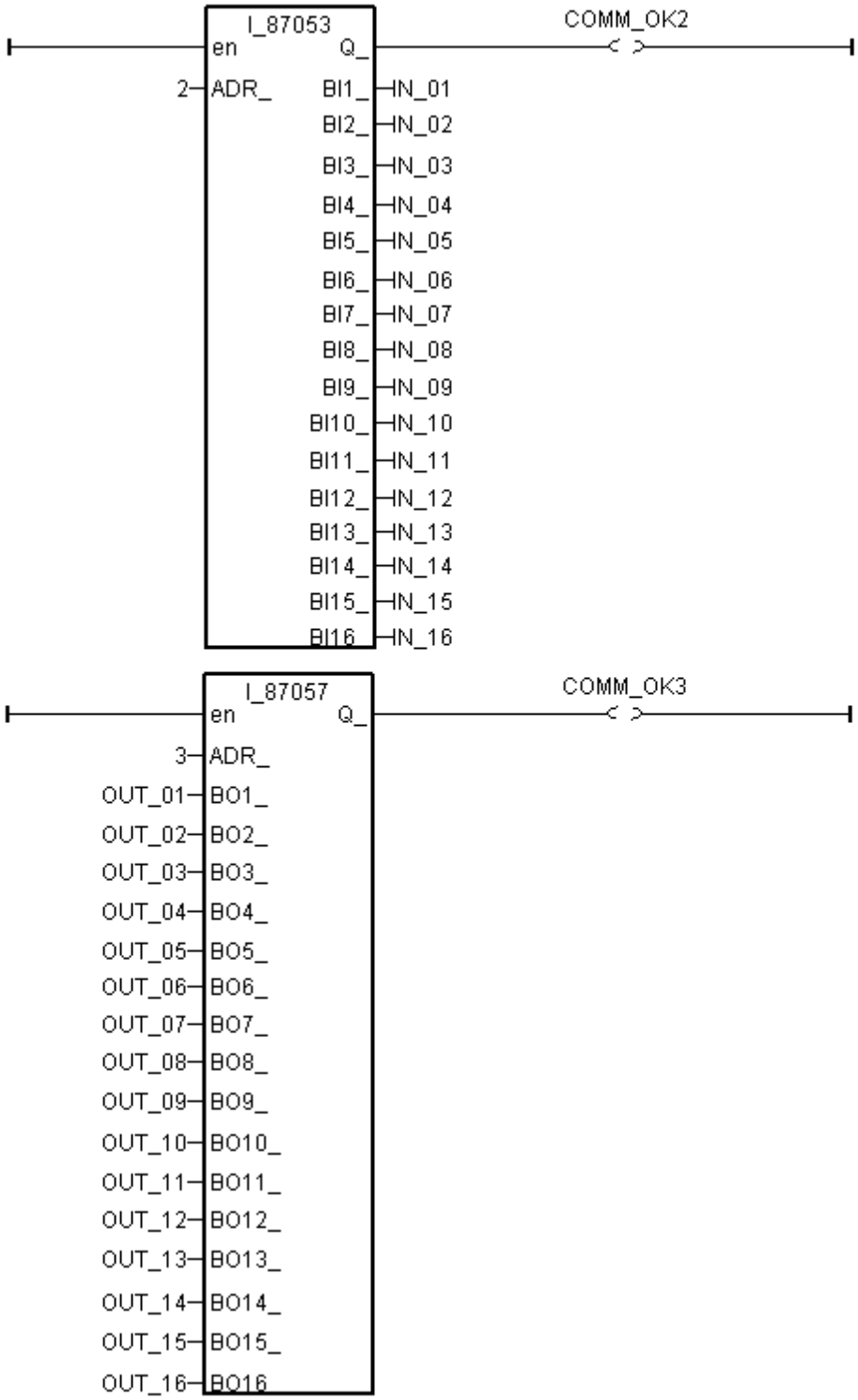
IO connection :



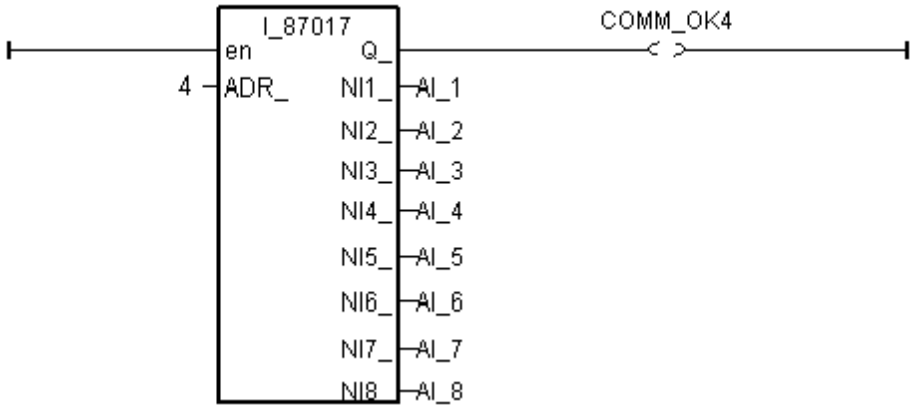
(more IO connection on the next page)


ISaGRAF - FAQ138_1 - I/O connection
File Edit Tools Options Help
ref = 15BFA
Active_IP1 = 192.168.2.100
Active_IP2 = 192.168.2.101
InActive_IP1 = 192.168.2.102
InActive_IP2 = 192.168.2.103
Remote_IO_type = 3
RDN_BREAK_TIME = 250
reserved = 0
reserved = 0
reserved = 0
rdn_new2
RDN_ip
M_or_B
bus7000b
remot
is_Active
Main_ok
Backup_ok
Main_is_active
Backup_is_active
Active_LAN_plug1
Active_LAN_plug2
ISaGRAF - FAQ138_1 - I/O connection
File Edit Tools Options Help
ref = 15BFB
This_PAC (* 1: Main PAC , 2: Backup PAC *)
rdn_new2
RDN_ip
M_or_B
bus7000b
remot

“GO_7K87K” program :



(more program on the next page)



"RDN_init" program :

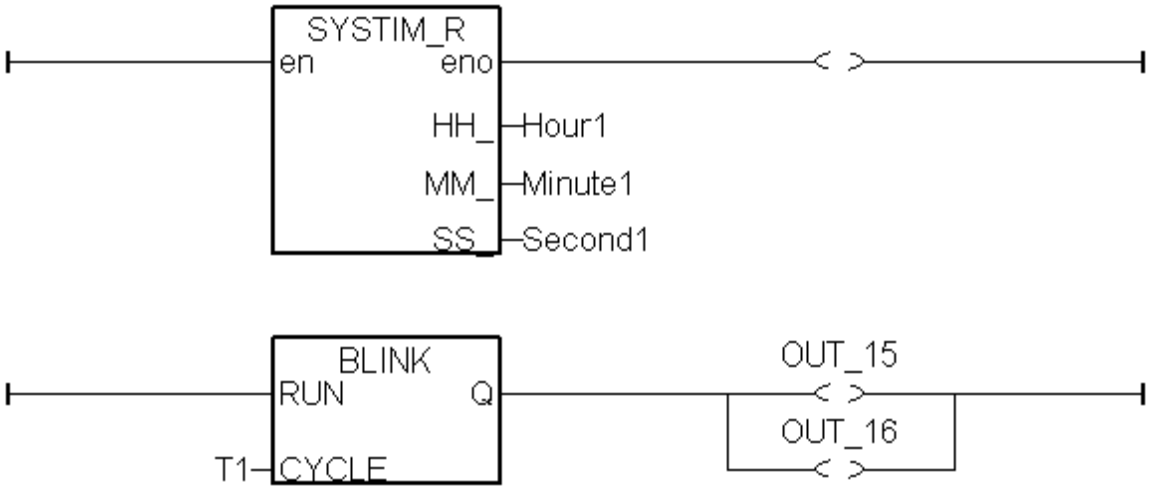
```
if    RDN_INIT    then

      RDN_INIT := False ;
      TMP := RDN_T(T1) ;
      TMP := RDN_N(V1) ;
      TMP := RDN_N(V2) ;
      TMP := RDN_F(Real_V1) ;
      TMP := RDN_F(Real_V2) ;
      TMP := RDN_B(OUT_01) ;
      TMP := RDN_B(OUT_02) ;
      TMP := RDN_B(OUT_03) ;
      TMP := RDN_B(OUT_04) ;
      TMP := RDN_B(OUT_05) ;
      TMP := RDN_B(OUT_06) ;
      TMP := RDN_B(OUT_07) ;
      TMP := RDN_B(OUT_08) ;
      TMP := RDN_B(OUT_09) ;
      TMP := RDN_B(OUT_10) ;
      TMP := RDN_B(OUT_11) ;
      TMP := RDN_B(OUT_12) ;
      TMP := RDN_B(OUT_13) ;
      TMP := RDN_B(OUT_14) ;
      TMP := RDN_B(OUT_15) ;
      TMP := RDN_B(OUT_16) ;

end_if ;
```

All the D/I and A/I channels on the I-7000 modules and I-87xxx cards don't need to set as Redundant data. Their value are auto-update between both PACs.

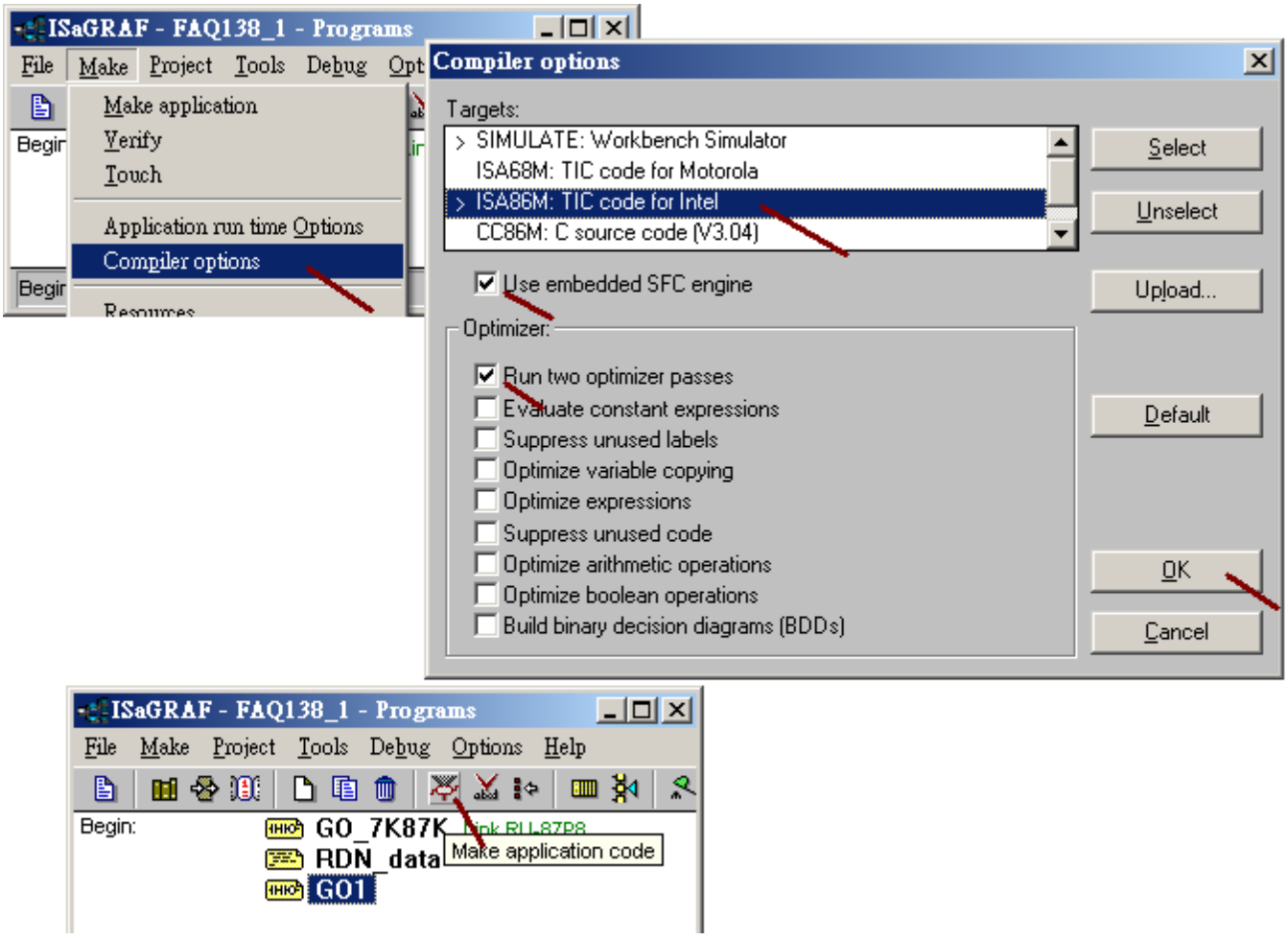
However all D/O and A/O channels must set as redundant data to be exchanged between both PAC.

Some other control data ("internal" attribution) should be set as redundant data too.

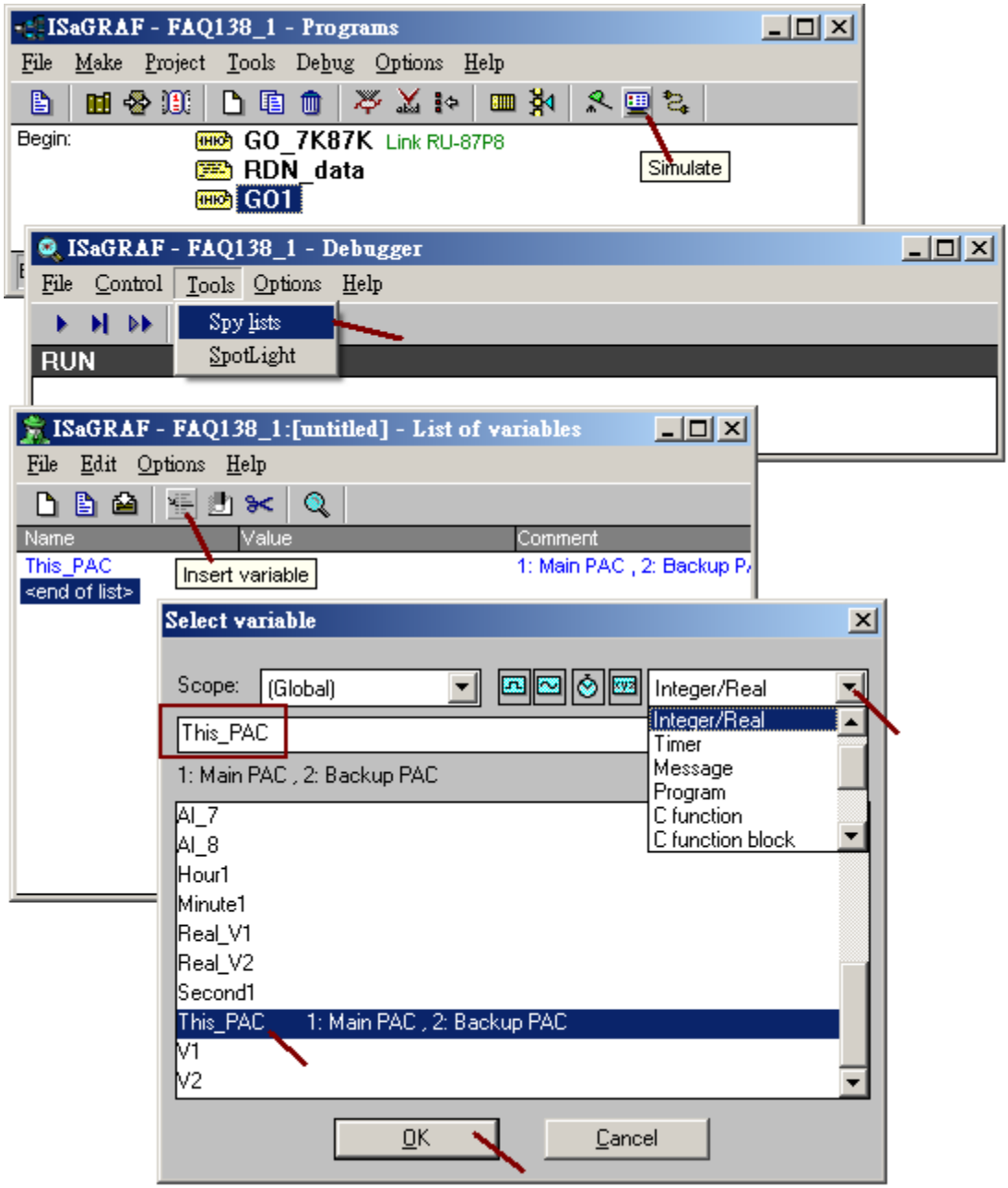
"GO1" program:



After finishing all the above programs, compile the project.

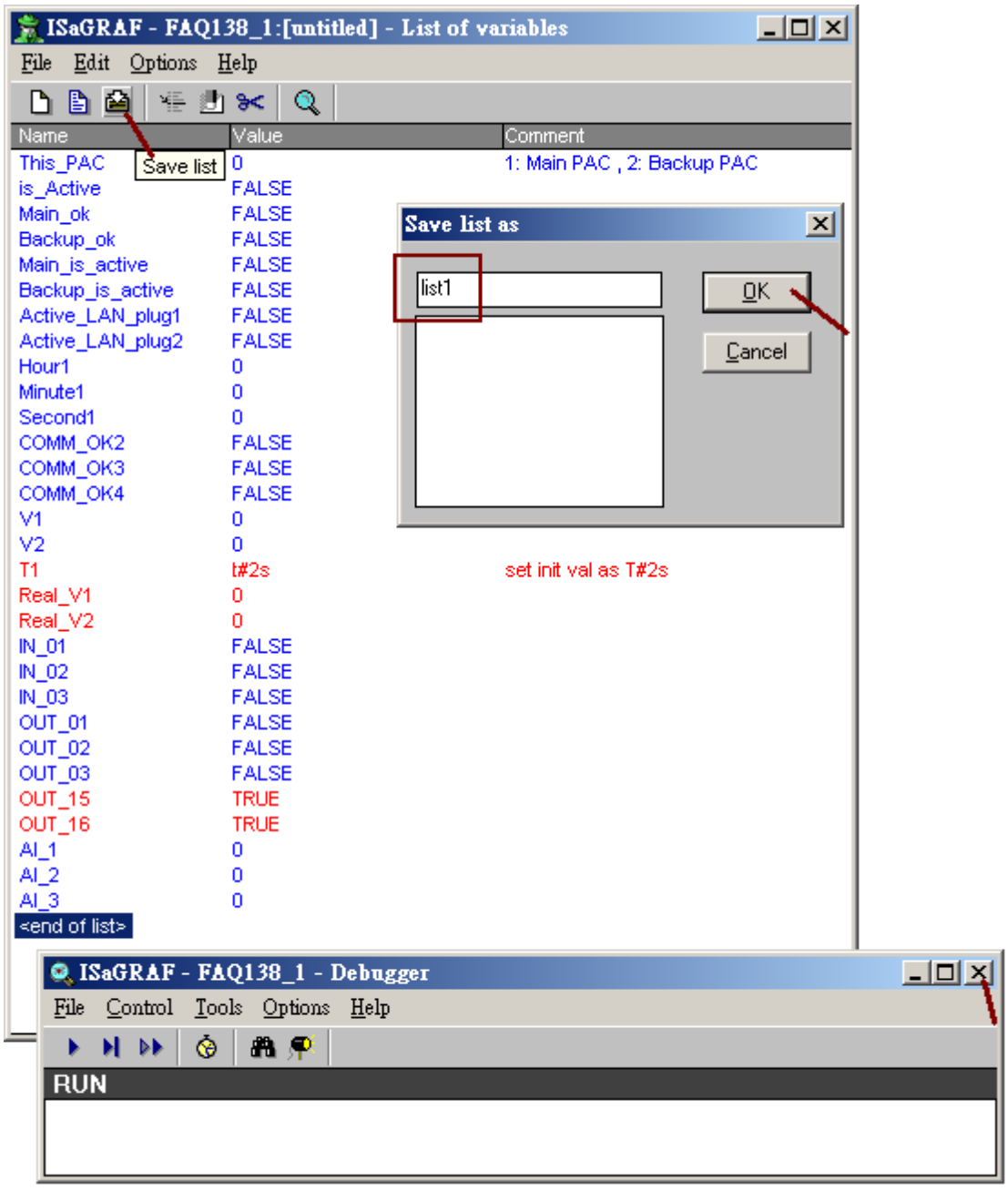


To easily debug the project and test it, better to add the “Spy lists” as the following.



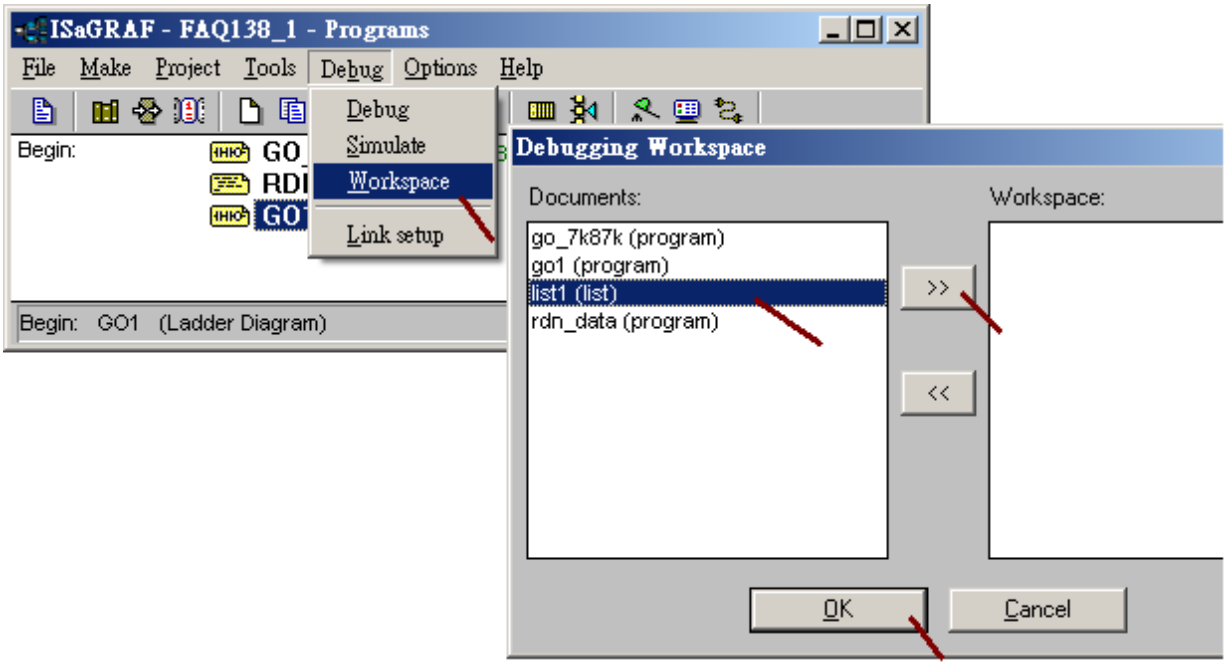
(more on the next page)

Insert all the following variables to the “Spy lists”, then save it and exit simulation.



(more on the next page)

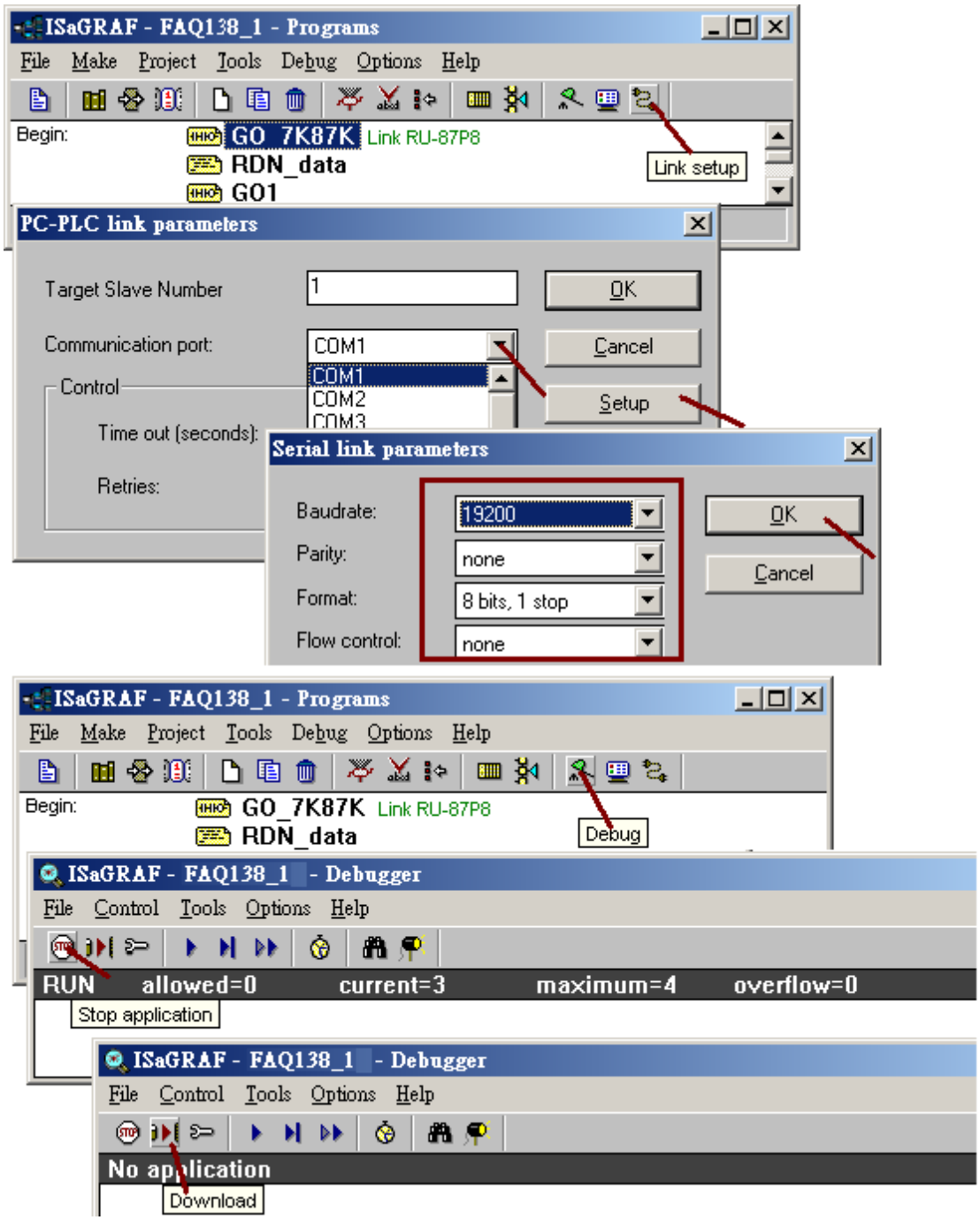
Then move the spy-lists to the right hand side (Workspace). The new created spy-lists will automatically pop-up every time when using PC / ISaGRAF to connect (debug) the XP-8xx7-CE6 .



1.4 : Download the project to the redundant system and test it

The following steps are for downloading and testing the “faq138_1” project to the application which listed in the configuration 1 in the section 1.1. Please first make sure the XP-xx7-CE6 's COM2 has enabled as Modbus RTU slave port and with baud-rate as 19200 (refer to item 2 listed in the section 1.2) . Then power off both XP-8xx7-CE6, turn rotary-switch to 0, then power it on. Connect PC to the XP-8xx7-CE6 's COM2 port by a RS-232 cable to download the project. Both XP-8xx7-CE6 should run the same project. (If has modified the program, variables, IO connection, please must re-compile the project and download it to both PAC again).

Note: Please DO NOT re-compile the project if modify only the “Link setup” .



After completely downloading the project to the two XP-8xx7-CE6, power off them first. Then turn the Min PAC 's rotary switch to position 7, while 9 for Backup PAC. Then make sure all the cables (includes LAN1, LAN2, COM3: RS-485, ...) has been connectted well as listed in the configuration 1 (refer to section 1.1). This “faq138_1” project connect only one I-87K8 with one I-87053W and one I-87057W and one I-87017W in it (I/O cards should be configured once as listed in item 3 listed in the section 1.2). Then turn on both PAC and the I-87K8 (The time for booting up the XP-8xx7-CE6 takes about 75 to 120 seconds).

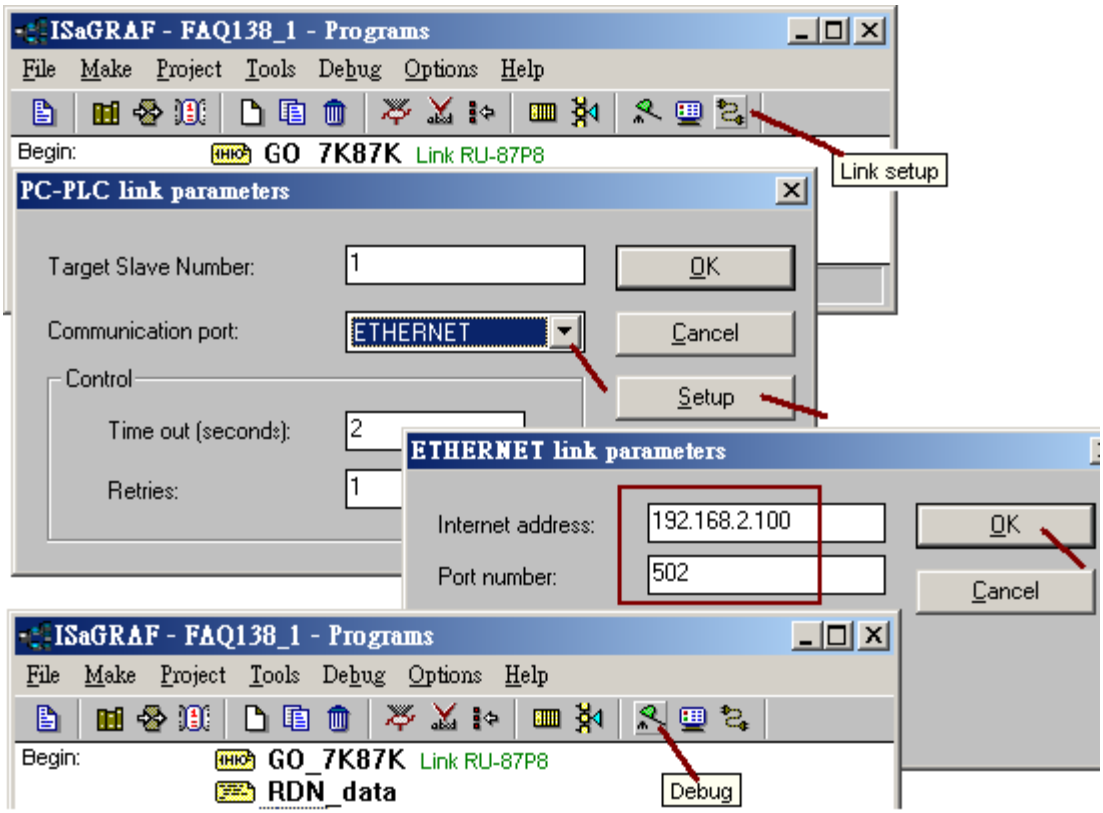
Note:

1. Each Ethernet cable in the redundant system must be plugged in a fixed port. The Ethernet communication may have problem if plug an Ethernet cable to different ports. Recommend to stamp a label on every Ethernet cable and specify ID something like“Main, LAN1”, “Main, LAN2” , “Backup, LAN1” , “Backup, LAN2”, “iDCS, LAN1”, “iDCS, LAN2” to make sure all of them are plgged in the correct ports.

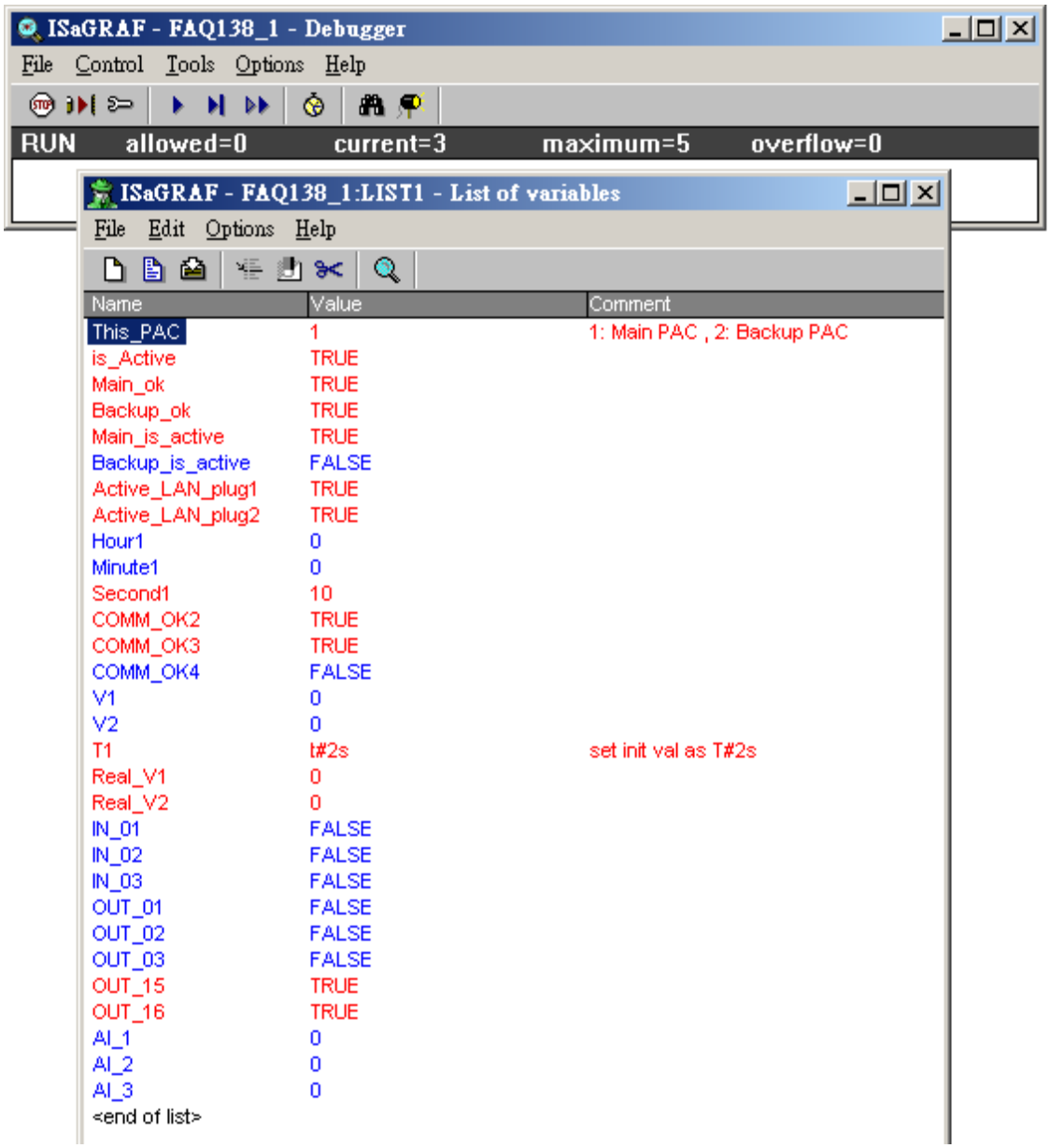
2. The“Active_IP1”of this demo is 192.168.2.100. It will auto-switch to one working Ethernet port of the active PAC. When the active PAC is dead or damaged, the active PAC will switch to the other PAC and also the“Active_IP1” will auto-swich to one working port of the new active PAC . So the PC / HMI / SCADA just need to connect this“Active_IP1”(not necessary to connect the“Active_IP2”).The PAC switching time is about 0.5 second.

3. The new active PAC will not release its control right to the other PAC until it is damaged or its “Active_IP1” communication is broken.

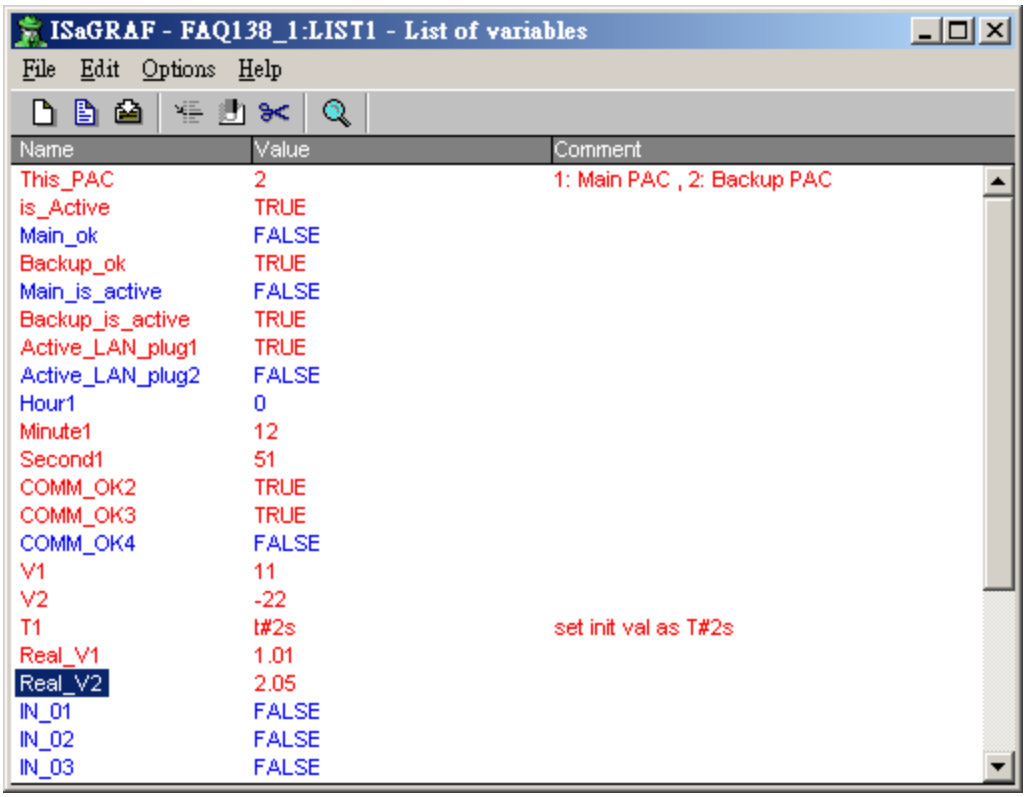
Then the PC / ISaGRAF can debug the XP-8xx7-CE6 redundant system (rotary switch at 7 and 9) by ethernet communication. Please connect the IP = 192.168.2.100 and port = 502 as below
(The PC 's IP should set in the same IP domain as the the XP-8xx7-CE6 's Active_IP1)



The “Spy lists” will auto pop-up when PC / ISaGRAF connect the redundant system well.
The below figure shows “This_PAC” as 1, it means the Main PAC is connected by the ISaGRAF. The “is_Active” is TRUE, it means this Main PAC is currently active. “Backup_ok” and “Main_ok” are TRUE, it means these two PAC are working well. The “COMM_OK2” and “COMM_OK3“ shows TRUE, it means the addr=2: I-87053W and addr=3: I-87057W in the I-87K8 are communicated well. The “COMM_OK4” is False, it means the addr=4:I-87017W are disconnectted (then it need to check the setting of address, baud-rate, checksum of the I-87017W is correct or not. The format should set as “2's compliment” for A/I cards).



Test 1: Modify the value of “V1” to 11, “V2” to -22, “Real_V1” to 1.01 and Real_V2 to 2.05, then power off the Main PAC. Check if the control right switch to the Backup PAC (check the value of “This_PAC” and “is_Active”). And also check if the value of the V1, V2, Real_V1 and Real_V2 are correct or not when the Backup PAC takes the control.



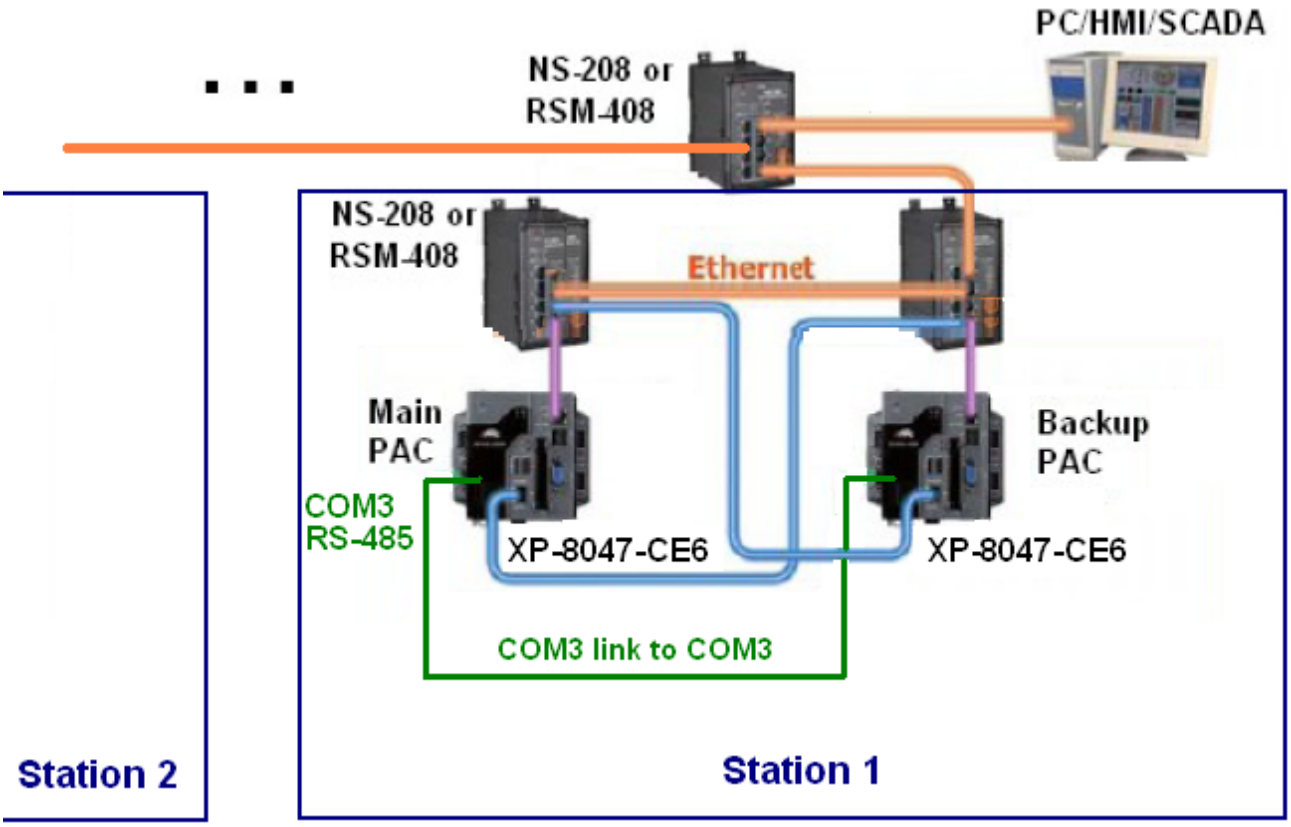
Test 2: Power on the Main PAC (it takes about 75 to 120 to boot up well). Then check if the “Main_ok” becomes TRUE. Then plug-out the Backup PAC 's LAN1 cable. Check if the control right will release to the Main PAC. (Remember to plug in the LAN1 cable of the Backup PAC after this testing).

Test 3: Modify the “OUT_01” and “OUT_02” as TRUE and “T1” as T#4s. Then check if the behavior of the relative output LED on the I-87057W is correct or not. Then plug out the LAN1 cable of the Main PAC to see if the control right is released to the Backup PAC. (Remember to plug in the LAN1 cable of the Main PAC after this testing)

Note:
1. If the COM3 port of both XP-8xx7-CE6 doesn't link the I-87K8 + I-87053W + I-87057W + I-87017W, the redundant system will not work and the PC / ISaGRAF can not connect them well.
2. When doing switching test (release control right to the other), please make sure the other PAC is power ON and booting up well already .
3. If the application has no I-7000 and I-87xxx cards installed, please use the configuration listed in the section 1.5.

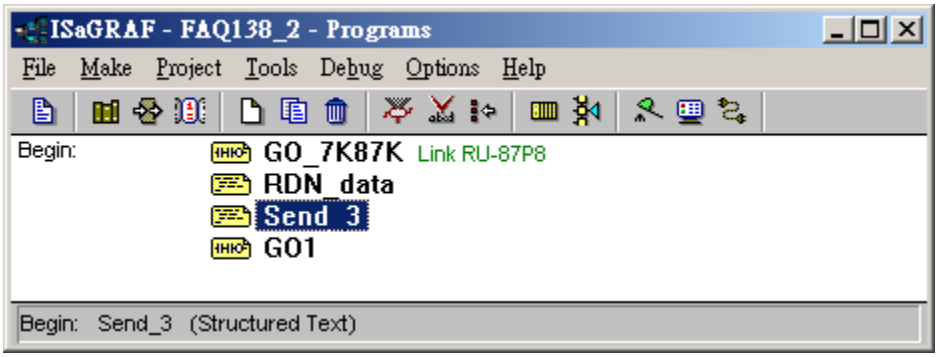
1.5 : The XP-8xx7-CE6 redundant system without linking any I-87K and I-7000 I/O

This section is for the configuration 2 listed in the section 1.1. The project is “faq138_2.pia” . This configuration must connect both XP-8xx7-CE6 's COM3: RS-485 to each other.

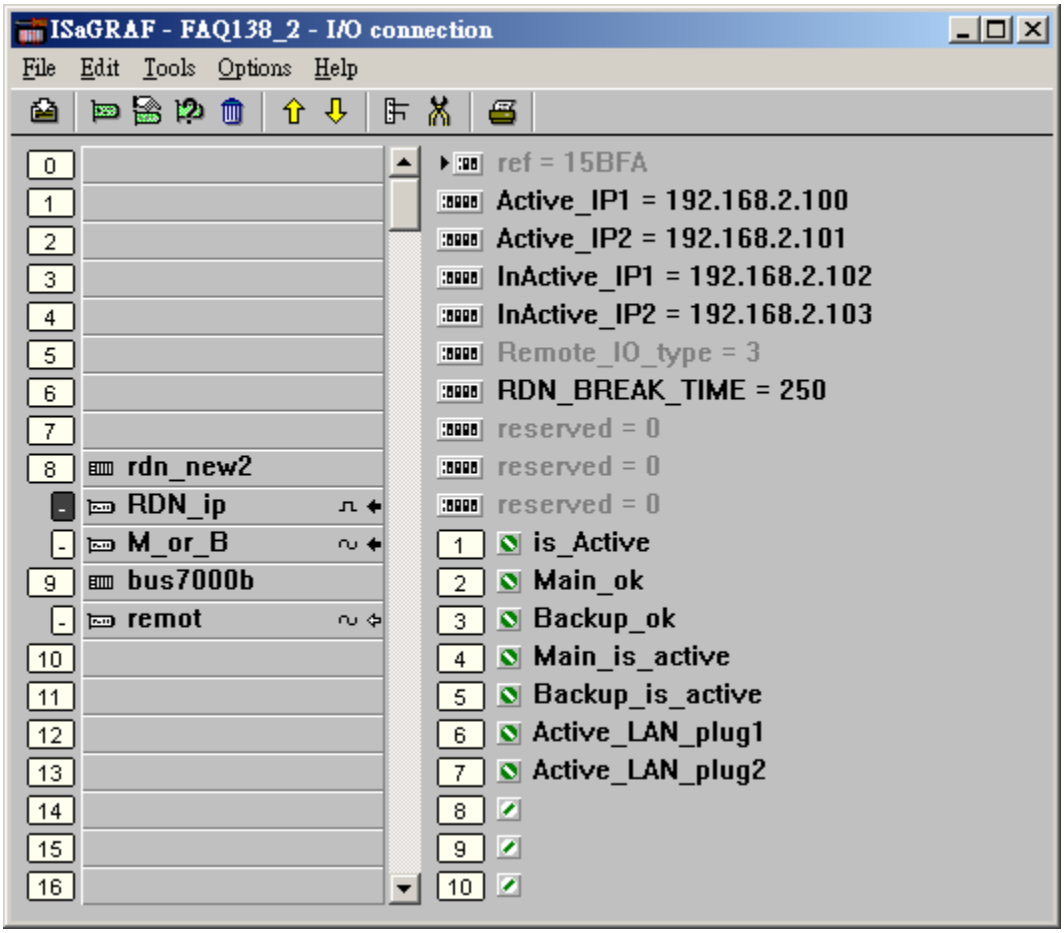


Project structure:

The “faq138_2” adds one more ST program “Send_3”, however its “GO_7K87K” program is empty compared with the “faq138_1” project.

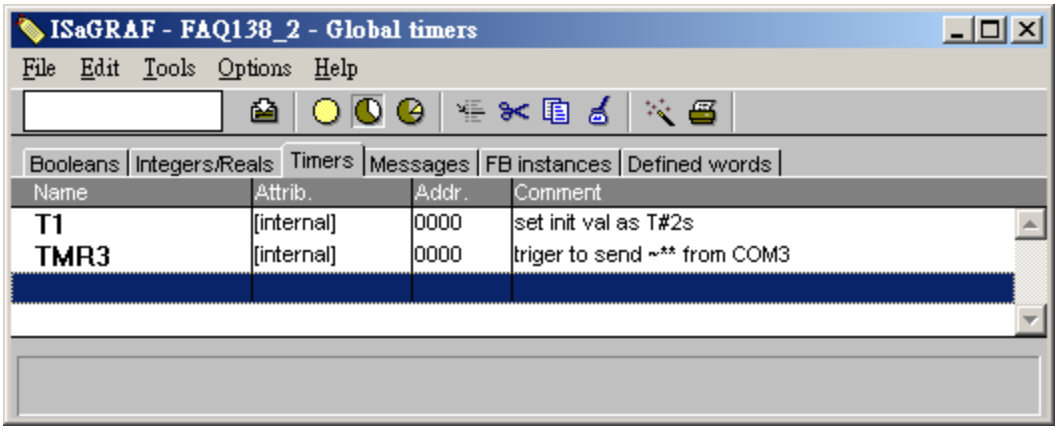


The IO connection of the “faq138_2” is the same as the “faq138_1”.

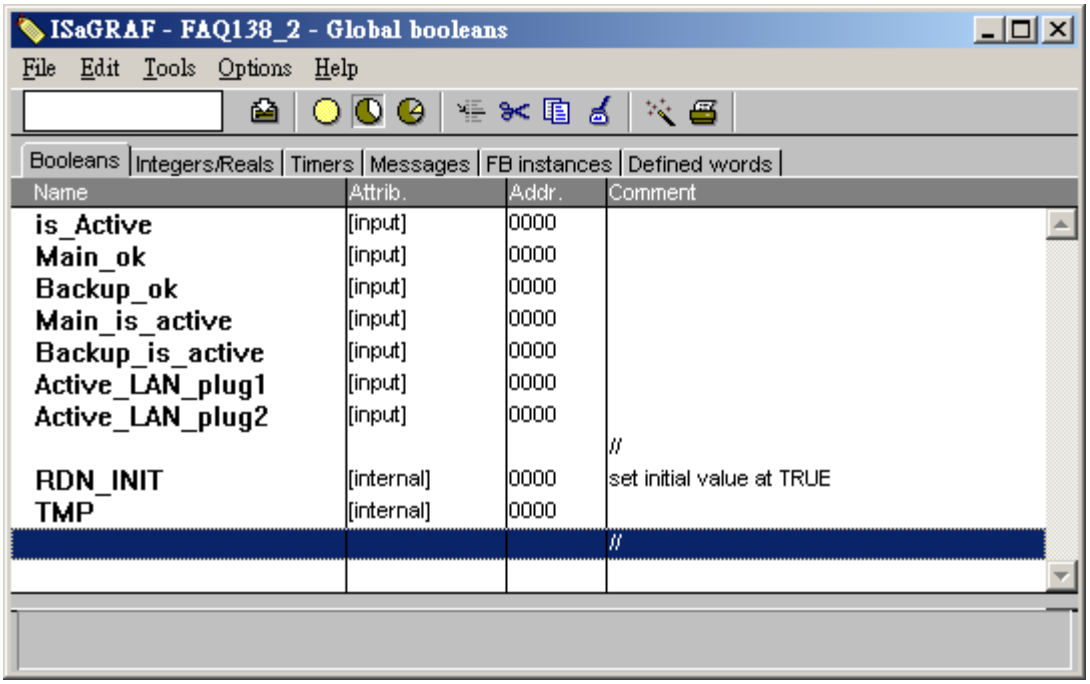


The “faq138_2” adds one more timer variable - “TMR3” than the “faq138_1”.

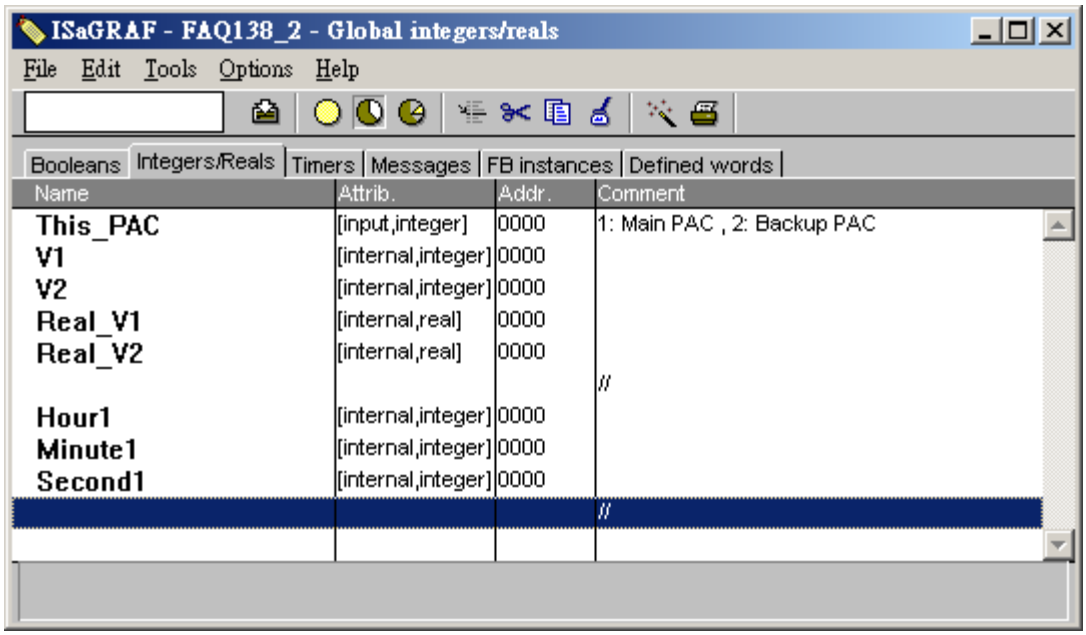
Timer variables : set initial value of the “T1” to T#2s.



Boolean variables : Must set initial value of the “RDN_INIT” to TRUE



Integer / Real variables :



"GO_7K87K" program: (its content is empty)

"RDN_data" program:

```
 if    RDN_INIT    then

       RDN_INIT := False ;
       TMP := RDN_T(T1) ;
       TMP := RDN_N(V1) ;
       TMP := RDN_N(V2) ;
       TMP := RDN_F(Real_V1) ;
       TMP := RDN_F(Real_V2) ;

       TMR3 := T#0s ;    (* reset as 0 *)
       Tstart(TMR3) ;    (* start ticking TMR3 to triger to send ~** from COM3 *)

 end_if ;
```

All the D/I and A/I channels on the I-7000 modules and I-87xxx cards don't need to set as Redundant data. Their value are auto-update between both PACs.

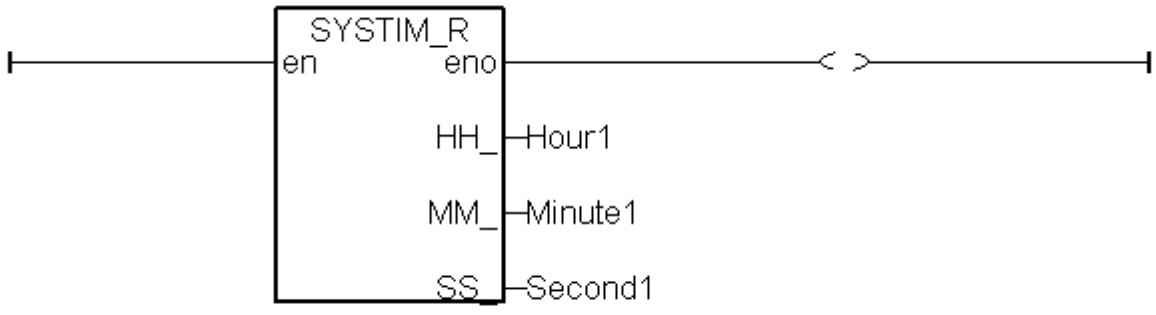
However all D/O and A/O channels must set as redundant data to be exchanged between both PAC.

Some other control data ("internal" attribution) should be set as redundant data too.

"Send_3" program :

```
 (* Send '~**' to XP-8xx7-CE6 's COM3 every 50 ms if this PAC is active *)

 if    is_Active    then
    if    TMR3 > T#50ms    then
          TMP := COMSTR_W( 3 , '~**' ) ;
          TMR3 := T#0s ;      (* reset as 0 *)
      end_if ;
 end_if ;
```

"GO1" program :



The testing steps of the "faq138_2" is similar as the "faq138_1", please refer to section 1.4.

1.6 : The XP-8xx7-CE6 redundant system with Modbus RTU or Modbus ASCII or Modbus TCP device installed

This section is for the configuration 3 and 4 listed in the section 1.1.

The project for the configuartion 3 can use the “faq138_1.pia” and do some modifications.

The project for the configuartion 4 can use the “faq138_2.pia” and do some modifications.

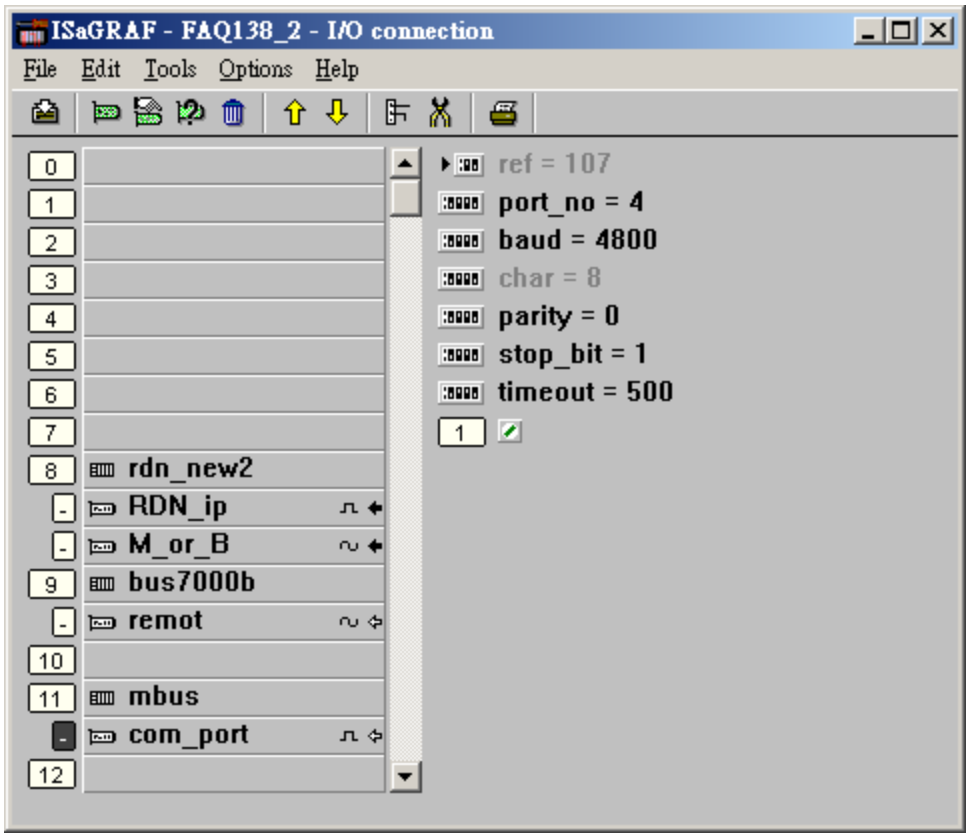
The main difference is in the I/O connection windows and should add some “Mbus_xxx” function blocks in a Ladder program to control the Mobus devices.

For example, the following figure shows both XP-8xx7-CE6 's COM4 are enabled as Modbus RTU Master port to connect some other Modbus RTU slave devices.

Please refer to the Chapter 8 of the “ISaGRAF User's manual” for more information about programming the Modbus device .

(http://www.icpdas.com/en/download/show.php?num=333&nation=US&kind1=&model=&kw=isagraf),

And also refer to https://www.icpdas.com/en/faq/index.php?kind=280#751 > FAQ-075, FAQ-101 , 096, 047, 046.

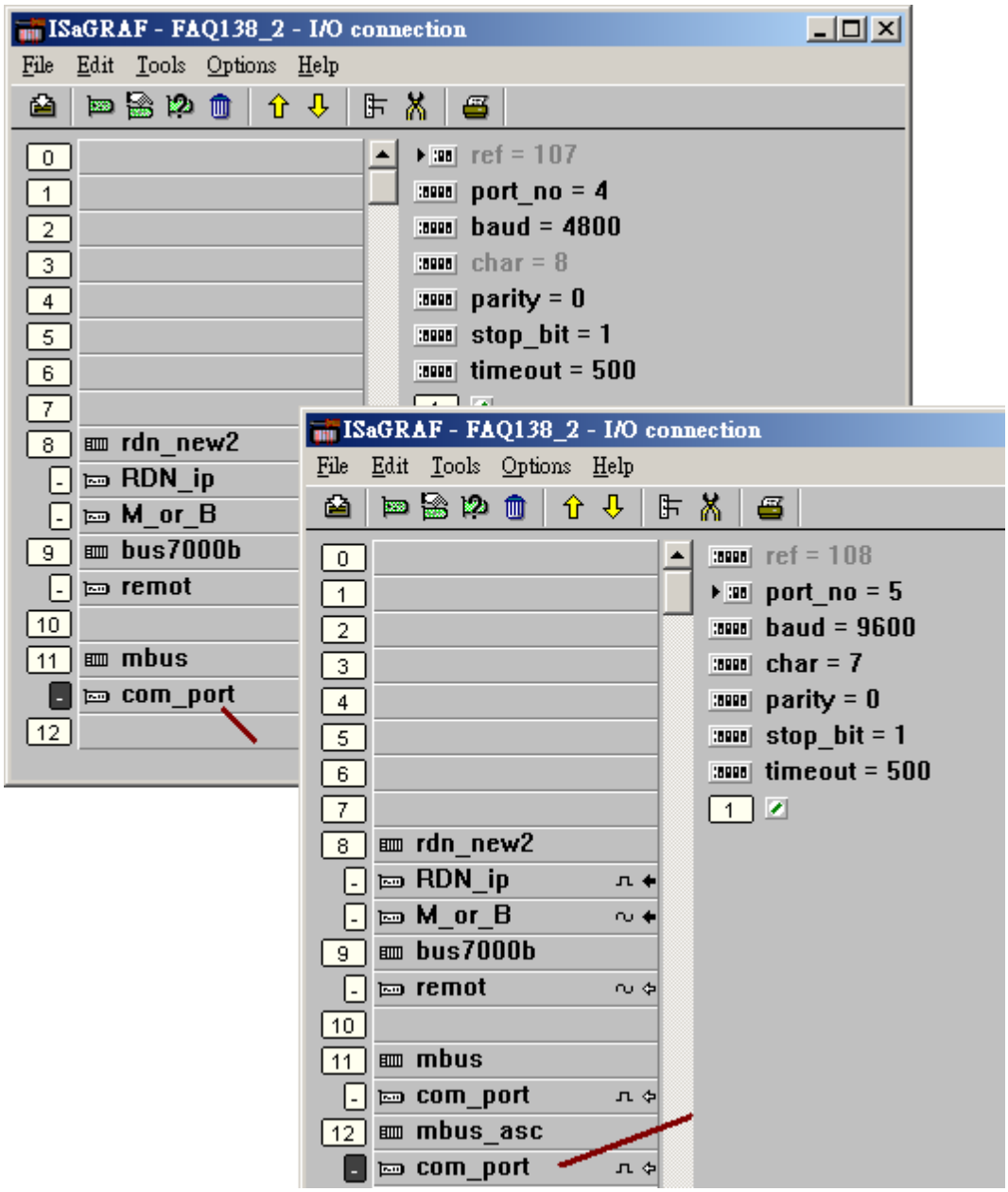


For example, the following figure shows both XP-8xx7-CE6 's COM4 are enabled as Modbus RTU Master and COM5 are enabled as Modbus ASCII Master.

Please refer to the Chapter 8 of the “ISaGRAF User's manual” for more information about programming the Modbus device .

(http://www.icpdas.com/en/download/show.php?num=333&nation=US&kind1=&model=&kw=isagraf),

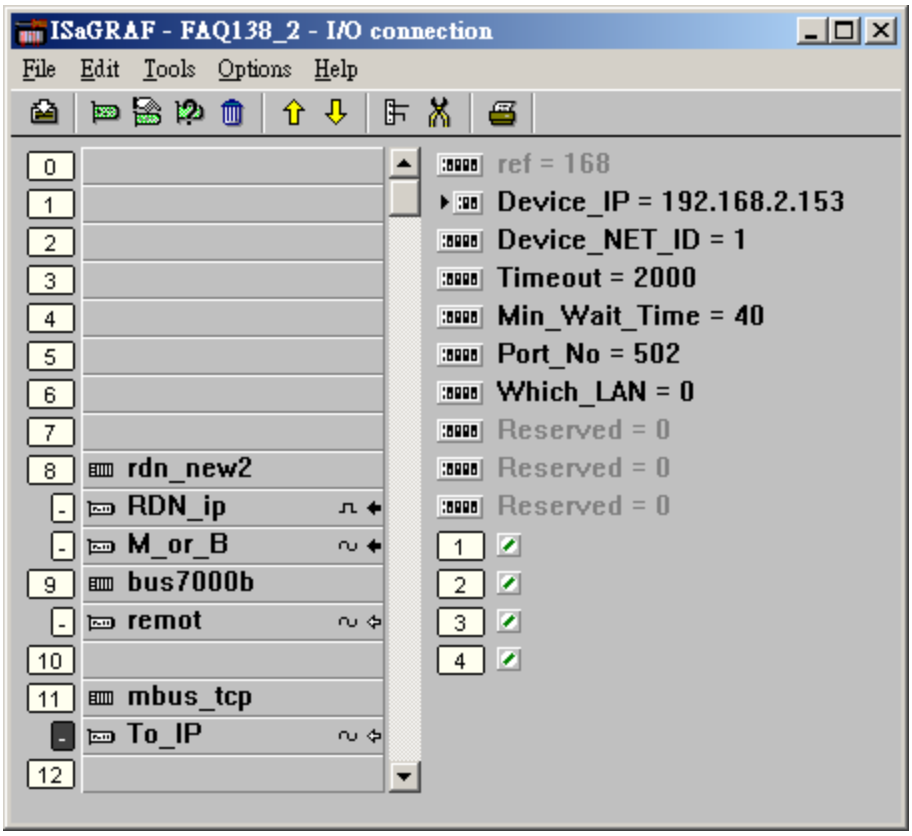
And also refer to https://www.icpdas.com/en/faq/index.php?kind=280#751 > FAQ-075, FAQ-101 , 096, 047, 046.



For example, the following figure shows both XP-8xx7-CE6 have enabled one Modbus TCP Master to connect the Modbus TCP device which has IP address 192.168.2.153.

Please refer to the https://www.icpdas.com/en/faq/index.php?kind=280#751 > FAQ-113 and then refer to the Chapter 8 of the "ISaGRAF User's manual" for more information about programming the Modbus device (http://www.icpdas.com/en/download/show.php?num=333&nation=US&kind1=&model=&kw=isagraf).

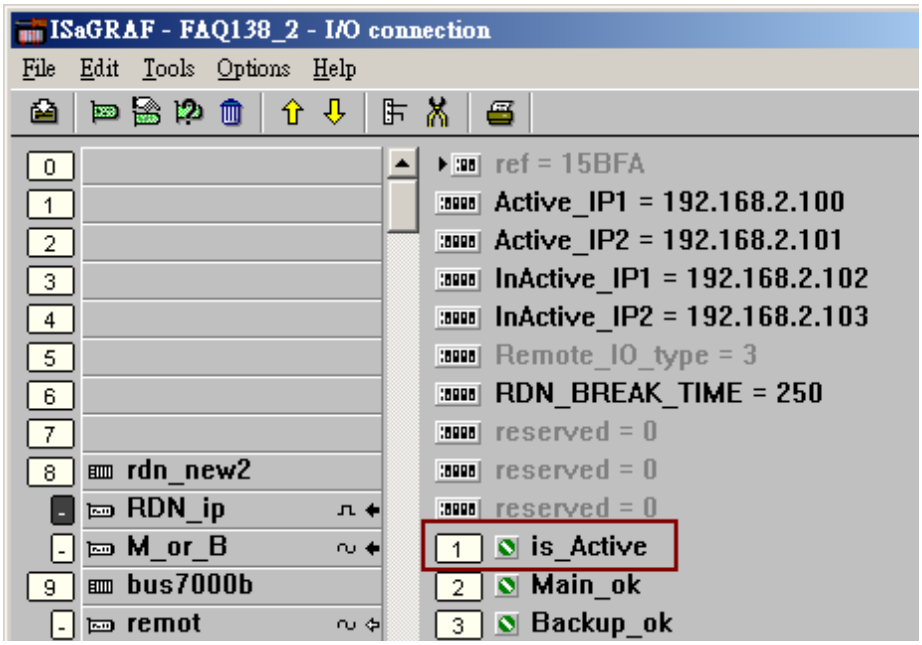
And also refer to https://www.icpdas.com/en/faq/index.php?kind=280#751 > FAQ-075, FAQ-101 , 096, 047, 046.



1.7: Connecting some other non-DCON I/O and non-Modbus devices

The XP-8xx7-CE6 redundant system is enabled when programing the “RDN_new2” in the ISaGRAF IO connection window. This ”RDN_new2” will automatically control all the connected DCON series I/O (like the I-7000 series I/O, I-87K4/5/8/9 base + I-87xxx I/O or + I-87xxxW cards and RU-87P4/8 base+ I-87xxxW I/O cards) and automatically control all Modbus devices (like the Modbus RTU, Modbus ASCII and Modbus TCP devices). The XP-8xx7-CE6 redundant system will only let the active PAC to communicate with the above I/Os and devices. The in-Active PAC will not send the command to those devices until it becomes active (means takes the control right).

However if the XP-8xx7-CE6 redundant system has installed some other non-DCON I/O and non-Modbus devices, the “RDN_new2” will not automatically control them. For example, both XP-8xx7-CE6 connecting to some 3rd party communication devices, or both XP-8xx7-CE6 connecting to one I-7530 to become CAN signal to link other CAN/CANopen devices. These case may happen both XP-8xx7-CE6 will try to communicate with those devices at the same time. The result will be “communication error”. To solve this problem, user should add the following similar codes to only let the active PAC do the communication (let the in-active PAC stand-by).

For example, there is some application which stores data to the Microsoft Database (SQL server) , then user can use the “is_Active” to let the active PAC to do the writing action to the SQL server.(refer to https://www.icpdas.com/en/faq/index.php?kind=280#751 > FAQ-135 for SQL server applications)

```
If   is_Active   then
    (*   Do the communication only when the PAC is active *)
    (*   ... *)
End_if ;
```