ADAM-6022
Dual Loop PID Controller
User's Manual

Warning Message :

The ADAM-6022 is recommended to be used in general purposed air conditioning application. When using this product in applications that required particular safety or when using this product in important facility, pay attention to the safety of the overall system and equipment. For example, install fail-safe mechanism, carry out redundancy checks and periodic inspections, and adopt other appropriate safety measures as required.

ADAM-6022 dual loop PID Controller

Introduction

Function

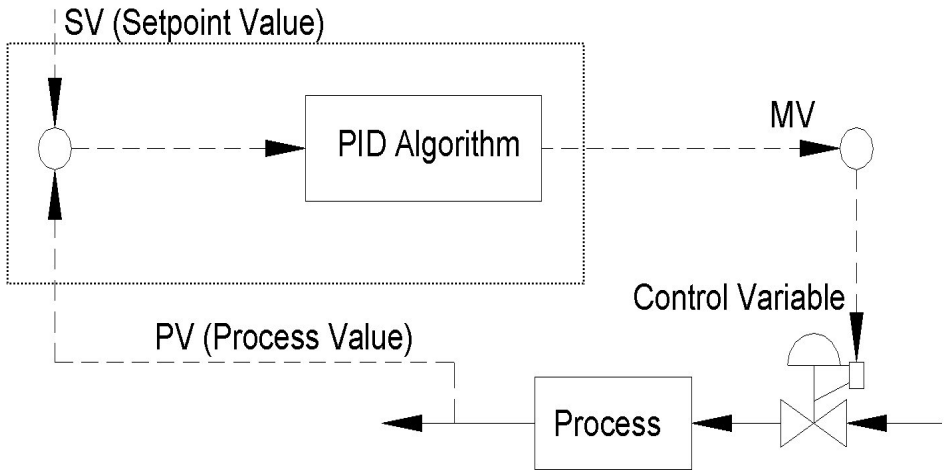
The ADAM-6022 dual loop PID controller is a PC-based stand alone controller. It was designed as the product of Advantech's ADAM-6000 series with web-enabled PID controller
With a excellent accuracy ±0.15%, the ADAM-6022 is an ideal controller for temperature and other process variable in heating and cooling application, test and environmental work.

Easy to operate

ADAM-6022 utility software can help you to select input and range configuration, set the operating parameter (SP, Sv, Pv ….. etc) for your process control needed. ADAM-6022 utility software also integrates the trend chart to help you to monitor and debug your control setting.

Industrial Design

ADAM-6022 was designed to use in industrial environment. It can be installed in standard DIN rail inside the cabinet. And it can be powered by unregulated 10~30Vdc to meet the various power supplied source in field. It also withstands ambient temperature up to 60 ^{o} C and resists the effects of vibration and mechanical shock.



Wiring & Installation

The ADAM-6022 is a 2 loop PID controller. There are three analog input, one analog output, one digital input and one digital out put for each loop usage. The analog input channels is 16-bit, universal signal accepted design. It provides programmable input ranges on all channels. It accepts various analog inputs +/-10V, 0~20mA and 4~20mA. The analog output channel is 12 bit with 0~10V, 0~20mA and 4~20mA acceptable input type. Each analog channel is allowed to configure an individual range for several applications. The digital input can be configured as the emergency shutdown trigger input and the digital output is designed as the common alarm output. The PID loop function can be disabled by ADAM-6022 utility software tool, that is, ADAM-6022 can be a pure universal I/O module after disabling the PID loop function.

ADAM-6022

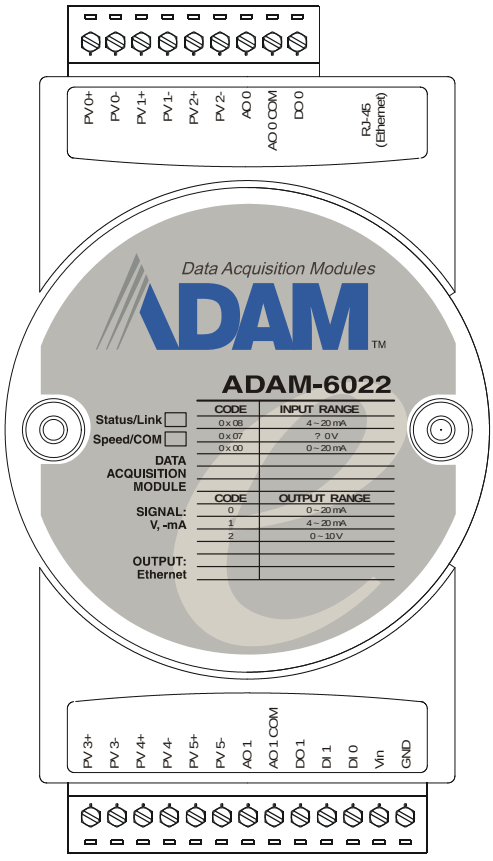


Fig. 7-1 ADAM-6022 Drawing

Application Wiring

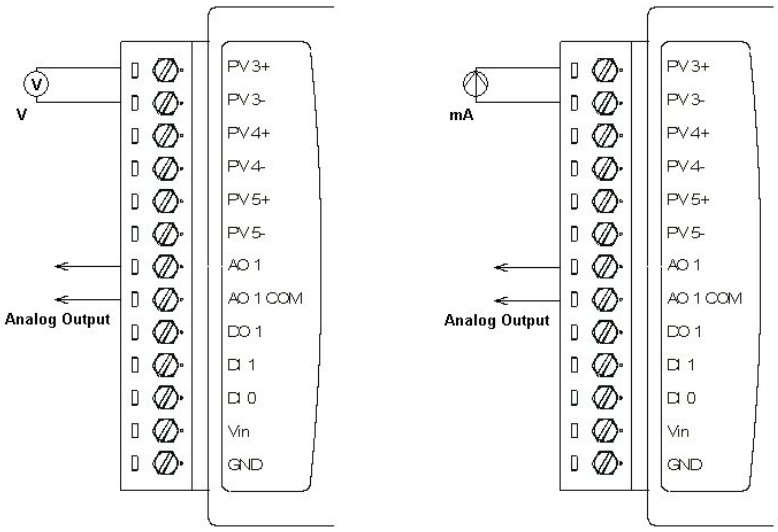


Fig. 7-2 Analog Input/Output Wiring Diagram

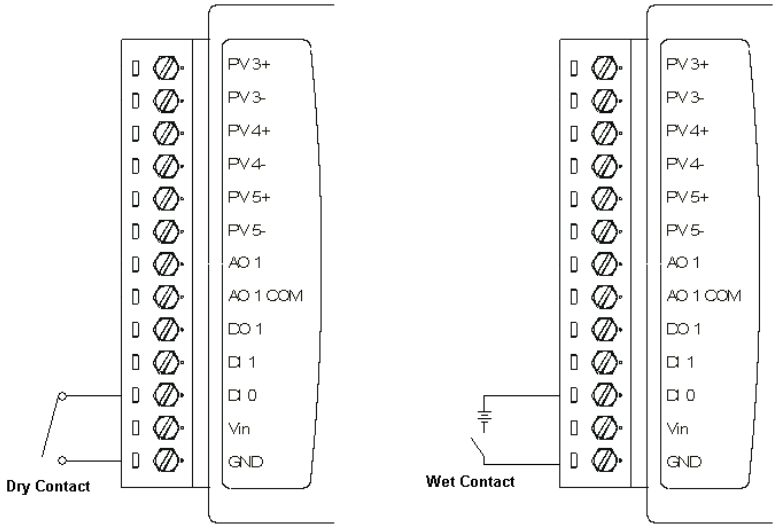


Fig. 7-3 Digital Input Wiring Diagram

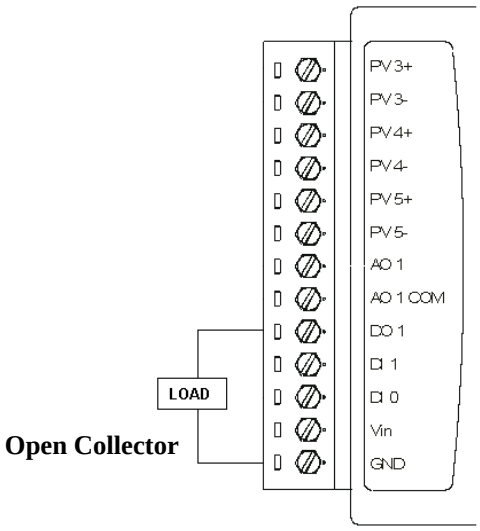
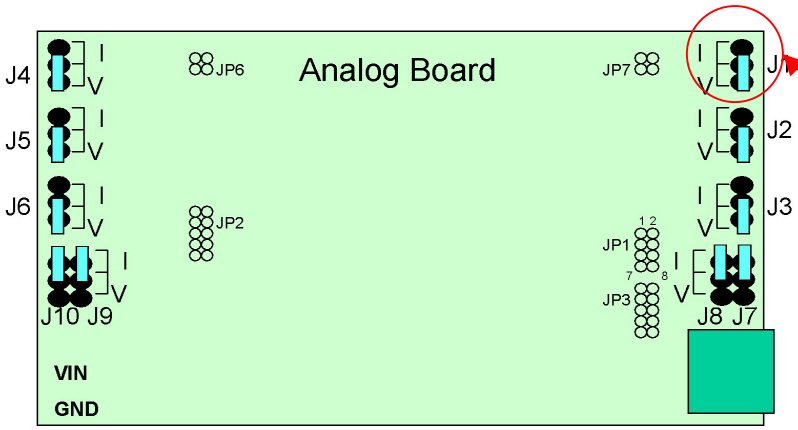


Fig. 7-4 Digital Output Wiring Diagram

Jumper Setting



I : Current Signal

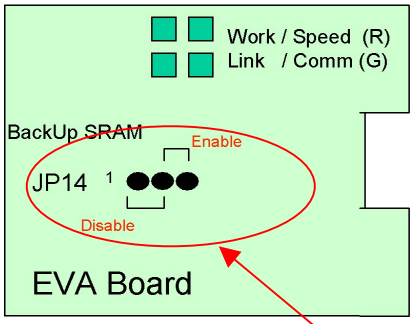
V : Voltage Signal

Input Default : V

Output Default : I

JP1 Definition :
Normal Mode : Short (1,2)(3,4)(5,6)
ROM Mode: Short (7,8)

When Update New API Firmware,
You Must Change It To ROM Mode



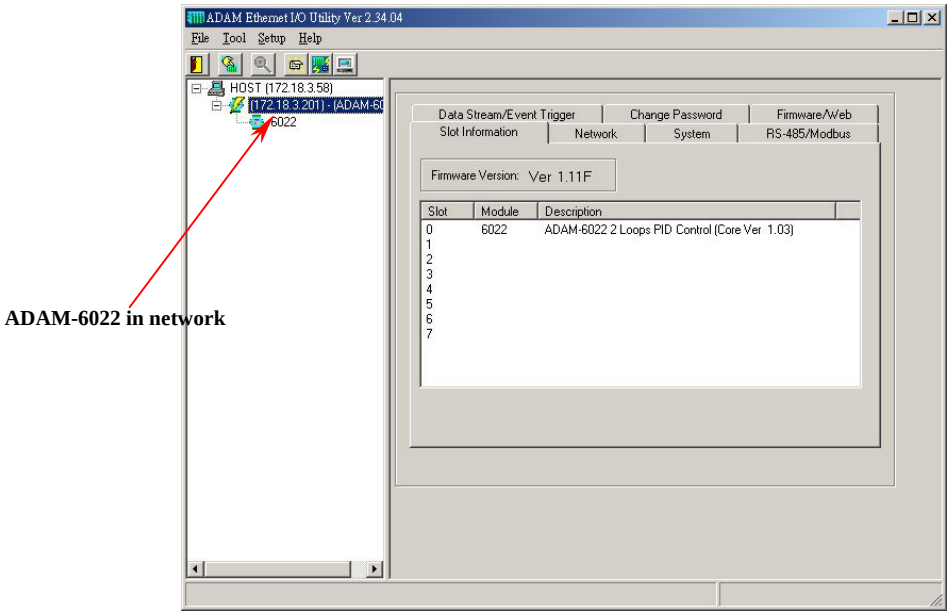
LED Definition :

- Work : Heart Beat
- Speed : Light For 100M / Dark For 10M
- Link : Indicate Link To Ethernet
- Comm : Indicate For Communication

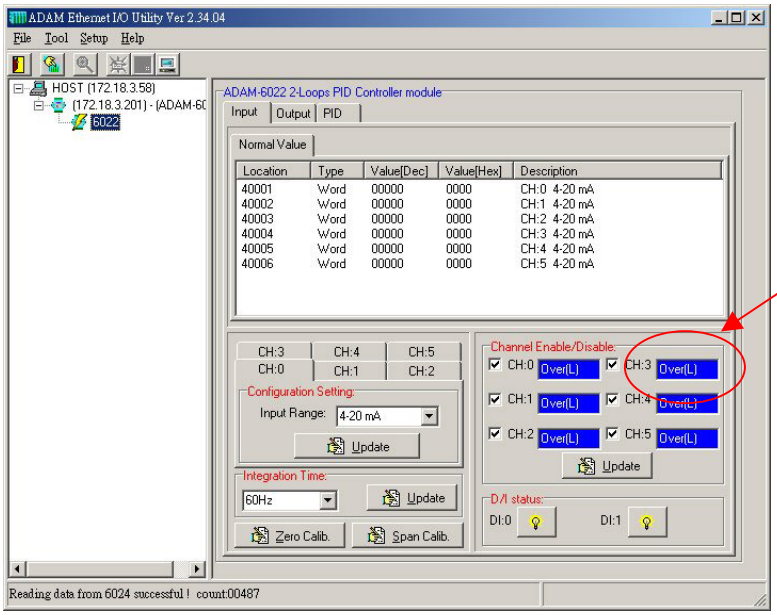
The Backup SRAM jumper default setting is "Disable". Please set the jumper in "Enable" when using ADAM-6022.

Operation Interface

Open the ADAM Ethernet IO Utility Software, the software tool will auto-scan the ADAM Ethernet module through the network. Clicking the “6022” in the system tree of left dialog block,

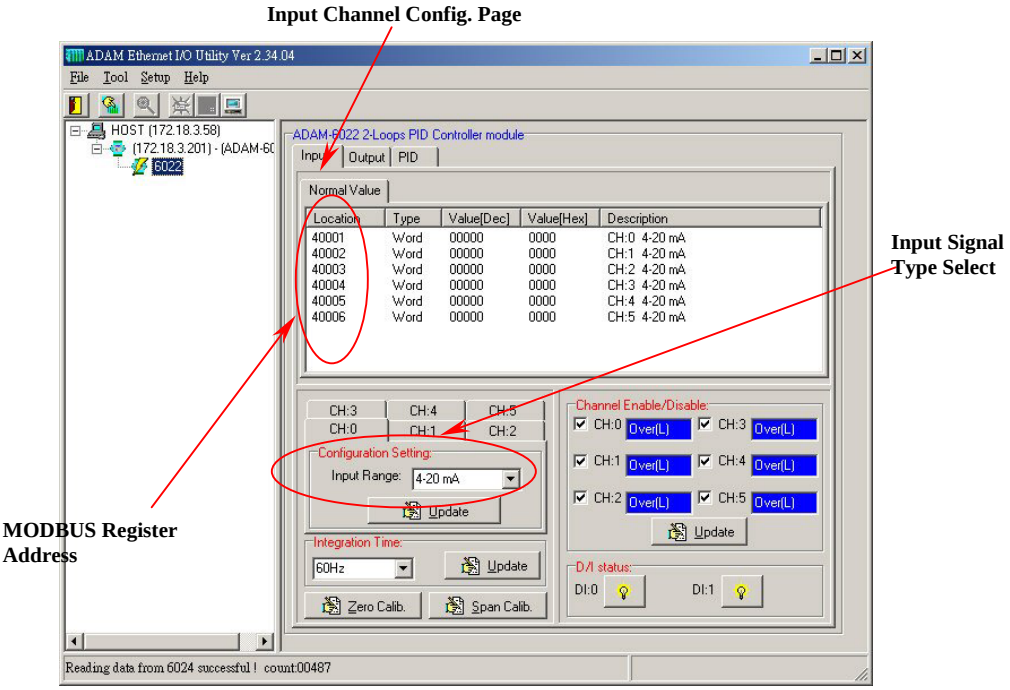


Clicking the “6022” in the system tree of left dialog block to go to ADAM-6022 configuration page. In this page, user can configure the input channel, output channel and PID loop function.

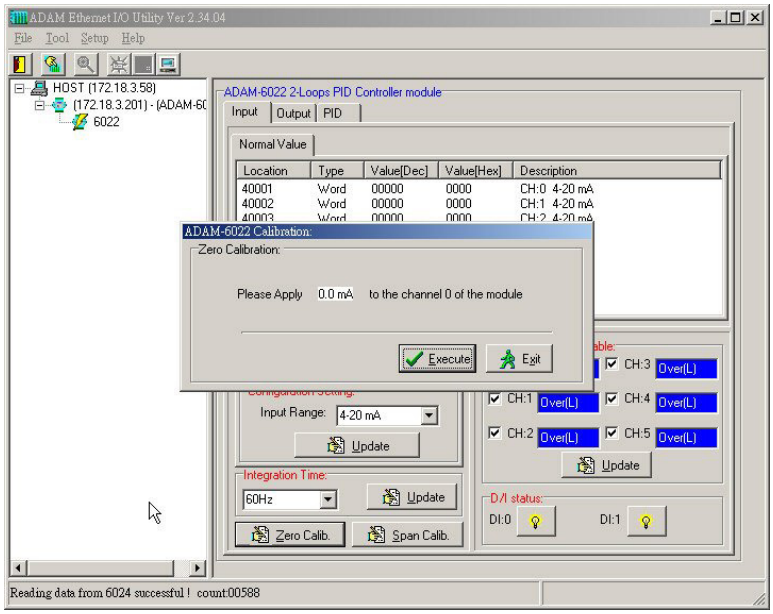


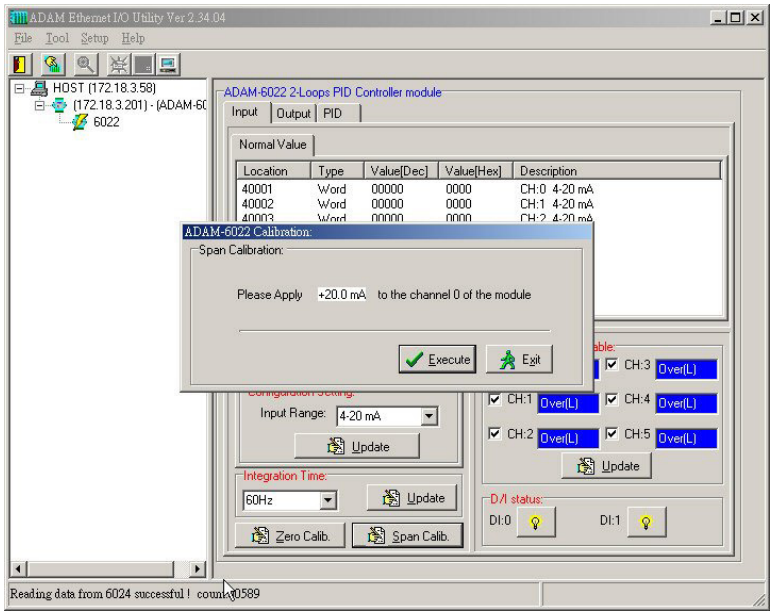
Input Channel Configuration Page :

In ADAM-6022 input channel configuration page, user can enable the input channel, select the input signal type and select the DI status. Channel 0, 1, 2 is the analog input as the control parameter for PID loop 0 and channel 3, 4, 5 is for PID loop 1 when the PID loop function is enabled. ADAM-6022 also support MODBUS/RTU protocol, user can see the detail MODBUS address register number for each channel in this page. It can be a very important reference for communication work.



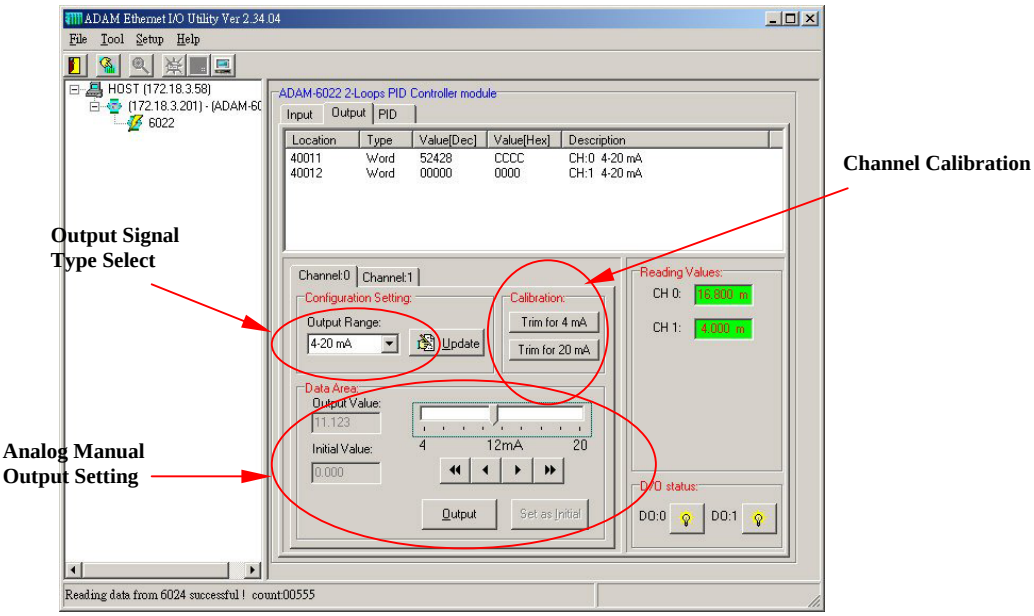
ADAM-6022 input channel configuration also support Zero and Span calibration function. Clicking the “Zero Calib” and “Span Calib” bottom to go to the calibration dialog block, user can set the initial zero value and span range then click the “Execute” bottom to proceed the channel calibration work. Please refer the following pictures for operation guideline.


ADAM Ethernet I/O Utility Ver 2.34.04
File Tool Setup Help
HOST (172.18.3.58)
(172.18.3.201) - (ADAM-60
6022
ADAM-6022 2-Loops PID Controller module
Input Output PID
Normal Value
Location Type Value[Dec] Value[Hex] Description
40001 Word 00000 0000 CH:0 4-20 mA
40002 Word 00000 0000 CH:1 4-20 mA
ADAM-6022 Calibration:
Zero Calibration:
Please Apply 0.0 mA to the channel 0 of the module
Execute
Exit
Input Range: 4-20 mA
Update
Integration Time:
60Hz
Update
Zero Calib.
Span Calib.
CH:1 Over[L]
CH:2 Over[L]
CH:3 Over[L]
CH:4 Over[L]
CH:5 Over[L]
Update
D/I status:
DI:0
DI:1
Reading data from 6024 successful ! count:00588


ADAM Ethernet I/O Utility Ver 2.34.04
File Tool Setup Help
HOST (172.18.3.58)
(172.18.3.201) - (ADAM-60
6022
ADAM-6022 2-Loops PID Controller module
Input Output PID
Normal Value
Location Type Value[Dec] Value[Hex] Description
40001 Word 00000 0000 CH:0 4-20 mA
40002 Word 00000 0000 CH:1 4-20 mA
ADAM-6022 Calibration:
Span Calibration:
Please Apply +20.0 mA to the channel 0 of the module
Execute
Exit
Input Range: 4-20 mA
Update
Integration Time:
60Hz
Update
Zero Calib.
Span Calib.
CH:1 Over[L]
CH:2 Over[L]
CH:3 Over[L]
CH:4 Over[L]
CH:5 Over[L]
Update
D/I status:
DI:0
DI:1
Reading data from 6024 successful ! count:00589

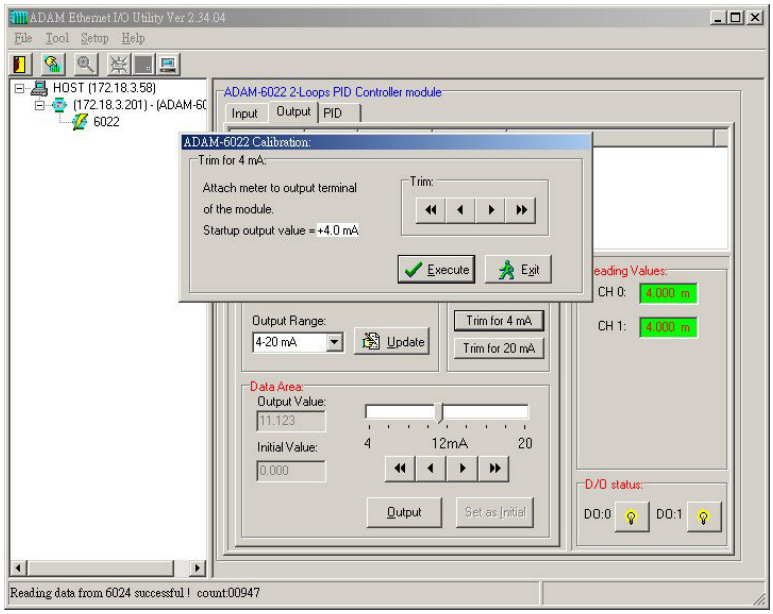
Output Channel Configuration Page :

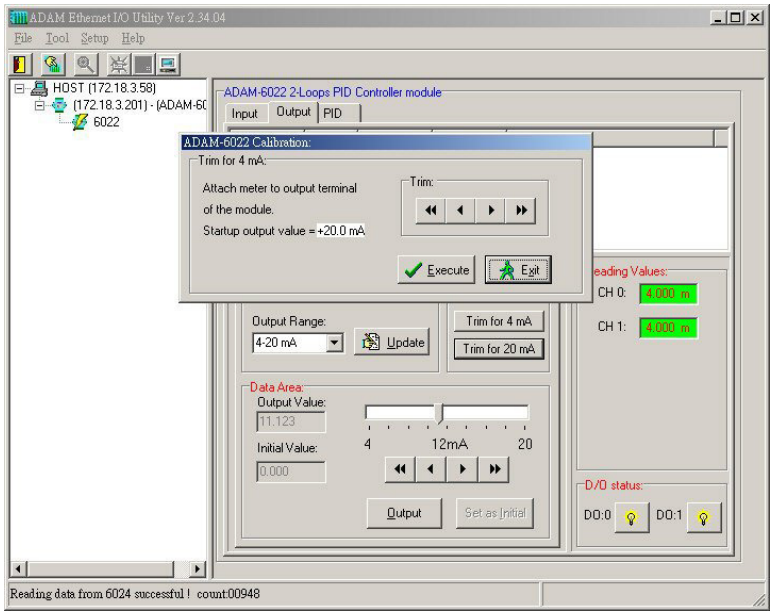
For output channel configuration, there are two analog output channel in ADAM-6022. The output channel 0 is used as the control output for PID loop 0 and channel 1 is for PID loop 1 when PID loop function is enabled. The configuration for output channel is quite similar as input configuration. User can easily to finish the configuration with the friendly operating interface of ADAM-6022 utility software.



ADAM-6022 can be a pure universal I/O module when PID being set in Free mode. User can use “Data Area” to setup the analog output to send a specific value for such kind application. This function can also be controlled with MODBUS/TCP protocol through Ethernet network for HMI/SCADA application.

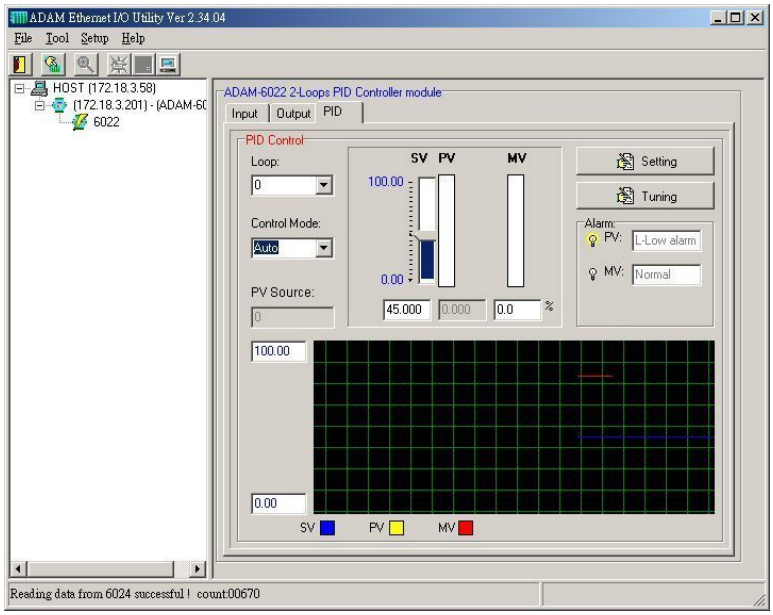
For calibrating the analog output channel, user can use external certificated signal measured device as calibrator then use the “Trim for 4mA” and “Trim for 20mA” calibrating function to fine tuning the channel output signal for calibration requirement.


ADAM Ethernet I/O Utility Ver 2.34.04
File Tool Setup Help
HOST (172.18.3.58)
(172.18.3.201) - (ADAM-60
6022
ADAM-6022 2-Loops PID Controller module
Input Output PID
ADAM-6022 Calibration:
Trim for 4 mA:
Attach meter to output terminal
of the module.
Startup output value = +4.0 mA
Trim:
Execute
Exit
eading Values:
CH 0: 4.000 m
CH 1: 4.000 m
Output Range:
4-20 mA
Update
Trim for 4 mA
Trim for 20 mA
Data Area:
Output Value:
11.123
Initial Value:
0.000
4
12mA
20
Output
Set as Initial
D/O status:
DO:0
DO:1
Reading data from 6024 successful ! count:00947

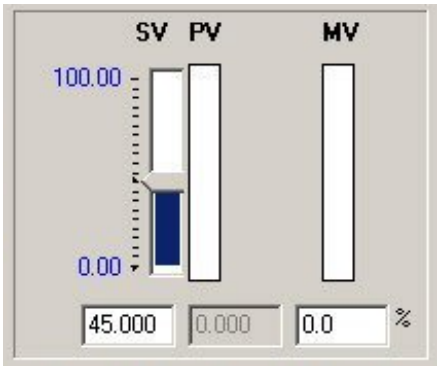

ADAM Ethernet I/O Utility Ver 2.34.04
File Tool Setup Help
HOST (172.18.3.58)
(172.18.3.201) - (ADAM-60
6022
ADAM-6022 2-Loops PID Controller module
Input Output PID
ADAM-6022 Calibration:
Trim for 4 mA:
Attach meter to output terminal
of the module.
Startup output value = +20.0 mA
Trim:
Execute
Exit
eading Values:
CH 0: 4.000 m
CH 1: 4.000 m
Output Range:
4-20 mA
Update
Trim for 4 mA
Trim for 20 mA
Data Area:
Output Value:
11.123
Initial Value:
0.000
4
12mA
20
Output
Set as Initial
D/O status:
DO:0
DO:1
Reading data from 6024 successful ! count:00948

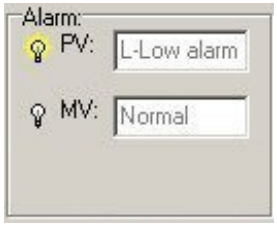
PID Loop Configuration

ADAM-6022 is designed as a stand alone PID controller. We offer a very convenient software tool for user to configure the PID controlled parameter. In this configuration page, there is a real time trend chart to show the values changing of SV, PV and MV. It is very helpful for user to monitor and diagnose the PID control situation.



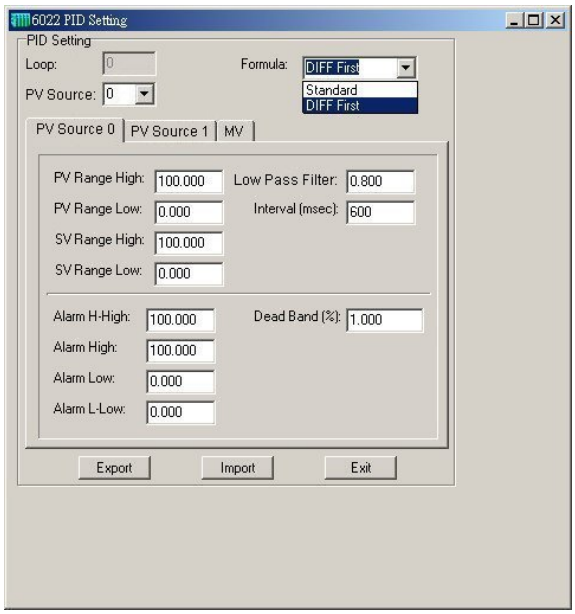
For the functionality of the bottom in PID configuration page, please refer the explanation of the following table.

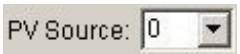
Bottom	Function
	PID loop number
	Control Mode Selection : Free : Stop PID Control Auto : PID Loop Automatically Manual : Manual Control
	Parameter Setting and Monitoring SV : Setpoint Value PV : Process Value MV : Controlled Output Value

	PV, MV Alarm Status
	PID Setting Bottom (go to PID setting page)
	PID Tuning Bottom (go to PID tuning page)

After finishing the setup work in configuration page, please click the setting bottom to go to the detail parameter setting screen.

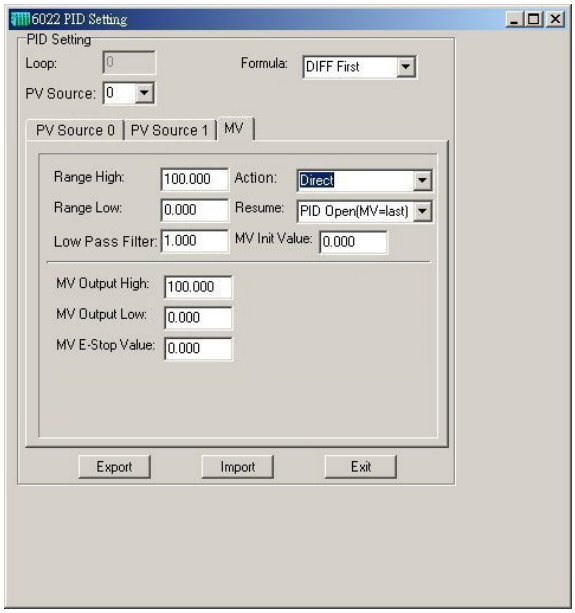
PV/SV Setting :

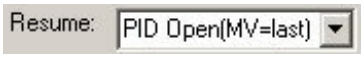


Bottom	Function
	Input channel for PV selection : For Loop 0 : PV set : 0 or 1 For Loop 1 : PV set : 3 or 4
	Formula Selection : Standard : Standard PID calculation DIFF First : Differentiation as first pirority
SV Range High	SV high limit value
SV Range Low	SV low limit value
PV Range High	PV high limit value

PV Range Low	PV low limit value
Low Pass Filter	Low Pass Filter set value Low Pass Filter Calculation : MV Feedback = Reading MV x Filter Value + Previous MV x (1- Filter Value)
Interval (msec)	PID loop sensing time interval
Alarm H-High	SV & PV High High alarm setpoint
Alarm High	SV & PV High alarm setpoint
Alarm Low	SV & PV Low Low alarm setpoint
Alarm L-Low	SV & PV Low alarm setpoint

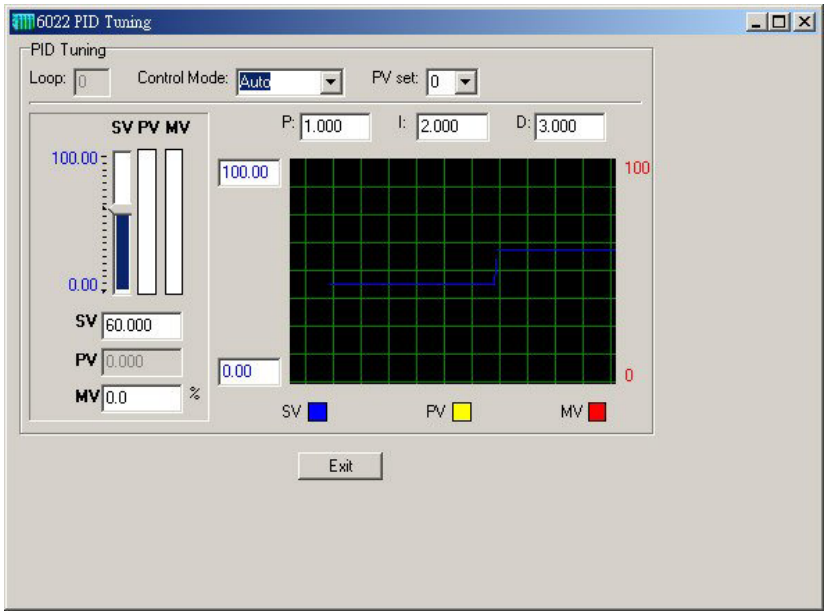
MV Setting



Bottom	Function
	Control Action Mode Setting : Direct : Direct (Heating) Action Reverse : Reverse (Cooling) Action
	PID Resume Status Setting
Range High	MV/FB high limit value
Range Low	MV/FB low limit value
Filter (0.0~1.0)	Filter set value
MV Init. Value	Setting MV initial value
MV Output High	MV output high limit
MV Output Low	MV output low limit

MV E-Stop Value	Setting MV frozen value while PID being emerged shutdown

For PID parameter tuning, please refer the PID tuning page.



In this page, the P, I, D parameters can be adjusted to achieve the optimal control result. The real time trend chart provide a powerful tool for user to supervise the parameters adjustment result.

Appendix A

Command Set

ASCII command

Command	Description	Remarks
$aaArr	Set the integration time for the module	!01: OK ?01: error
$aaAccrr	Set the channel input range code	!01: OK ?01: error
$aaB	Read the integration time for the module	!0150: 50ms(60Hz) !0160: 60ms(50Hz) ?01: error
$aaBcc	Read the channel input range code	!01RR: RR is range code in HEX ?01: error
$aaCcc	Read the channel output range code	!01RR: RR is range code in HEX ?01: error
$aaCccrr	Set the channel output range code (after set, the output will be set to startup value)	!01: OK ?01: error
$aaDcc	Read the channel startup output value	!01hhh: hhh is value in HEX (scaled, range from ‘000’ to ‘FFF’) ?01: error
$aaDcchhh	Set the channel startup output value cc: channel hhh: value (scaled, range from ‘000’ to ‘FFF’)	!01: OK ?01: error
$aaD	Set the EVA status to 0	!01: OK ?01: error
$aaDA1	Ask module to open TCP port 5451 for ADuC 824 firmware download	!01: OK ?01: error
$aaDA0	Ask module to close the download port.	!01: OK ?01: error
$aaE0	Reset EVA to download mode (status = 0)	
$aaF	Return the firmware version code from the specified ADAM-6000 module.	!01 V.vv: OK ?01: error
$aaFMPV	Return the AD firmware version code from the specified ADAM-6000	!01 V.vv: OK ?01: error

	module.	
$aaM	Return the module name from the specified module	!016022: OK ?01: error
$aaRST	Reset password to “00000000”	!01: OK ?01: error
$aaRcchhh	Set analog output without calibration (raw data)	!01: OK ?01: error
$aa0	Calibrate the analog input module to correct the gain error	!01: OK ?01: error
$aa1	Calibrate the analog input module to correct the offset error	!01: OK ?01: error
$aa2cc	Read the MAX calibration value for analog output cc: channel (00~01)	!01hhh: OK ?01: error
$aa2cchhh	Calibrate the analog output to correct the MAX value cc: channel (00~01)	!01: OK ?01: error
$aa3cc	Read the MIN calibration value for analog output cc: channel (00~01)	!01hhh: OK ?01: error
$aa3cchhh	Calibrate the analog output to correct the MIN error cc: channel (00~01)	!01: OK ?01: error
$aa5mm	Enable/Disable multiplexing	!01: OK ?01: error
$aa6	Asks a specified input module to return the status of all AI channels	!01mm: OK ?01: error
$aa7	Asks a specified module to return the status of all DI channels	!01mm: OK ?01: error
#aa	Return the input values from all channels of the specified analog input module	>+xx.xxx+xx.xxx+xx.xxx+xx.xxx+xx.xxx+xx.xxx: OK ?01: error
#aacc	Return the input value from the specified channel in the analog input module	>+xx.xxx: OK ?01: error
#aaccdd	Set a single or all digital output channels.	>: OK ?01: error
#aaccdd.ddd	Analog output to the specified channel cc: channel (00~01) dd.ddd: engineering units	>: OK ?01: error
#aaRcc	Read analog input without calibration (raw data)	>HHLL: OK ?01: error
@aaMAC	Read MAC address	!01mmmmmmmmmmm

		?01: error
@aaMASK	Read subnet mask	!01mmmmmmmm ?01: error
@aaGW	Read default gateway	!01mmmmmmmm ?01: error
@aaDEVNAME	Read device name	!01sssssss… ?01: error
@aaDEVDESC	Read device description	!01:ssssss… ?01: error
%aaGETUDPST	Return the scan time of data streaming	
%aaGETUDPcSTU	Return channel status for indicated module order (c=0~7)	
%aaGETUDPc	Return the monitored module IP (c=0~7)	
%aaSETUDPSTtttttttt	Set the scan time in milli-second, tttttttt is a hex-number	
%aaSETUDPcs	Set the stream status for single module. c: module order (0~7) s: ‘R’, set to running ‘P’, set to pause	
%aaSETUDPcppppppppp	Set the module IP for streaming c: module order ppppppppp: IP address in hex	

Appendix B

Communication Specification

Serial communication

- Baud rate: 19200 bps
- Data bits: 8
- Parity: 0
- Stop bit: 1
- Flow control: none

Analog input channel

Channel index in command	Channel index in hardware
0	AI00
1	AI01
2	AI02
3	(Read back AO0)
4	AI10
5	AI11
6	AI12
7	(Read back AO1)

Input range code mapping

Range code	Range value
0x07	4~20 mA
0x08	± 10 V
0x09	± 5 V
0x0A	± 1 V
0x0B	± 500 mV
0x0C	± 150 mV
0x0D	0~20 mA

Output range code mapping

Range code	Range value
0	0 ~ 20 mA
1	4 ~ 20 mA
2	0 ~ 10 V

Default setting

- Convert rate: 60 Hz
- Range code: 0x08 (± 10 V)
- Automatic ADC convert: false

- Channel mask: 0x77 (AI channel 3 and 7 are disabled)
- Auxiliary ADC: temperature sensor

Appendix C

PID Parameters Table：

Modbus Register	Code	Read/ Write	Decimal Place	Descriptions
41000	Open/Close Mode	Read / Write	0	Enable/Disable PID loop function 0:Open mode -- no PID control, ADAM-6022 will be a pure I/O module 1:Close mode – enable PID loop function 2:Manual mode – manual control analog output
41002	PID Mode	Read / Write	0	PID Mode Selection 0:Standard PID Calculation Mode 1:Differential First Mode
41004	PV Mode	Read / Write	0	0:Select PV Source 1 as “PV” 1:Select PV Source 2 as “PV”
41008	Process value_1 bare data	Read Only	3	Loop 0 PV value。
41010	Process value_2 bare data	Read Only	3	Loop 1 PV value
41012	Manipulator value bare data	Read Only	3	MV value
41016	DI On/Off	Read Only	0	DI for Emergency Shutdown
41018	DO On/Off	Read Only	0	Alarm DO On
41020	Set point Value(for PV-1)	Read / Write	3	SV (Setpoint Value) for loop 0
41022	Set point Value(for PV-2)	Read / Write	3	SV (Setpoint Value) for loop 1
41024	PV_1 RH (Range high)	Read / Write	3	PV Source 1 Engineering Value Range high (PV_1 RH must > PV_1 RL)
41026	PV_1 RL (Range low)	Read / Write	3	PV Source 1 Engineering Value Range low (PV_1 RL must < PV_1 RH)
41028	PV_2 RH (Range high)	Read / Write	3	PV Source 2 Engineering Value Range high (PV_1 RH must > PV_1 RL)
41030	PV_2 RL (Range low)	Read / Write	3	PV Source 2 Engineering Value Range low (PV_1 RL must < PV_1 RH)
41032	MV RH (Range	Read /	3	MV Engineering Value Range high

	high)	Write		MV RH must > MV RL
41034	MV & FB RH (Range low)	Read / Write	3	MV Engineering Value Range high MV RL must < MV RL
41036	PV-1 engineering data	Read Only	3	PV Source 1 engineering data
41038	PV-2 engineering data	Read Only	3	PV Source 2 engineering data
41040	MV engineering data	Read / Write	3	MV engineering data MV engineering data can not only be automatically created by PID loop, but it also can be manual setup when PID loop set in “manual” mode. It will be translated as MV bare data AO output。 MV RL<MV engineering data<MV RH
41044	PID PV value	Read Only	3	PID PV value
41046	PID SV value	Read Only	3	PID SV value
41048	PV_1 Filter value	Read / Write	3	1st order filter value for PV source 1 0<(PV_1 Filter value/1000)<1.0
41050	PV_2 Filter value	Read / Write	3	2nd order filter value for PV source 1 0<(PV_2 Filter value/1000)<1.0
41054	PV_1 Signal Range	Read Only	0	0: -10 ~ 10V、 1: 0 - 20mA、 2: 4 - 20mA
41056	PV_2 Signal Range	Read Only	0	0: -10 ~ 10V、 1: 0 - 20mA、 2: 4 - 20mA
41060	MV Signal Range	Read Only	0	0: 0 ~ 10V、 1: 0 - 20mA、 2: 4 - 20mA
41062	PID KP (PV-1)	Read / Write	3	PID Proportional factor for PV Source 1 PID KP=(Input value/1000)
41064	PID KI (PV-1)	Read / Write	3	PID Integrated factor for PV Source 1 PID KI=(Input value/1000)
41066	PID KD (PV-1)	Read / Write	3	PID Differential factor for PV Source 1 PID KD=(Input value/1000)
41068	PID KP (PV-2)	Read / Write	3	PID Proportional factor for PV Source 2 PID KP=(Input value/1000)
41070	PID KI (PV-2)	Read / Write	3	PID Integrated factor for PV Source 2 PID KI=(Input value/1000)
41072	PID KD (PV-2)	Read / Write	3	PID Differential factor for PV Source 2 PID KD=(Input value/1000)
41074	PID KP (PID)	Read Only	3	PID Proportional factor for PID calculation
41076	PID KI (PID)	Read Only	3	PID Integrated factor for PID calculation
41078	PID KD (PID)	Read Only	3	PID Differential factor for PID calculation
41080	Control loop	Read /	0	<=0 : Loop empty

	period setting (msec) for PV-1	Write		>0 : Loop controlling
41082	Control loop period setting (msec)for PV-2	Read / Write	0	<=0 : Loop empty >0 : Loop controlling
41084	Control loop period setting (msec)for PID	Read Only	0	<=0 : Loop empty >0 : Loop controlling
41086	Count down value of control loop period	Read Only	0	counting value<=0 then calculating PID loop
41088	Previous Loop Open/Close status	Read Only	0	Record the previous Loop Open or Close mode for Loop Initial set。
41090	NSEC	Read Only	0	Calculating the newest Loop interval as nsec
41092	OLD NSEC	Read Only	0	Calculating the previous Loop interval as old nsec
41094	Power recovery action setting	Read / Write	0	0: maintaining the previous MV output keep PID open 1: setting the previous MV output as initial value and keeping PID Close 2: PID open, using MV initial value as MV output
41096	MV Initial Value	Read / Write	3	MV initial value for power recovery action
41098	Last DI State	Read Only	0	Previous Scan DI State (reference for control program)
41100	Last DO State	Read Only	0	Previous Scan DO State (reference for control program)
41102	PV-1 Alarm HH limit	Read / Write	3	PV-1 Alarm High High Limit Value (<PV-1 RH)
41104	PV-1 Alarm H limit	Read / Write	3	PV-1 Alarm High Limit Value (<PV-1 RH & PV-1 Alarm HH)
41106	PV-1 Alarm LL limit	Read / Write	3	PV-1 Alarm Low Low Limit Value (>PV-1 RL)
41108	PV-1 Alarm L limit	Read / Write	3	PV-1 Alarm Low Limit Value (>PV-1 RL & PV-1 Alarm LL)
41110	PV-1 Alarm Dead Band %	Read / Write	3	PV-1 Dead band % 0<(Input Value/1000)%<10 %
41112	PV-1 Alarm Status	Read Only	0	PV-1 Alarm Status 0：Normal、1:HH、2：H、3:L、4:LL。
41114	PV-2 Alarm HH limit	Read / Write	3	PV-2 Alarm High High Limit Value (<PV-2 RH)
41116	PV-2 Alarm H limit	Read / Write	3	PV-2 Alarm High Limit Value (<PV-2 RH & PV-2 Alarm HH)
41118	PV-2 Alarm LL	Read /	3	PV-2 Alarm Low Low Limit Value

	limit	Write		(>PV-2 RL)
41120	PV-2 Alarm L limit	Read / Write	3	PV-2 Alarm Low Limit Value (>PV-2 RL & PV-2 Alarm LL)
41122	PV-2 Alarm Dead Band %	Read / Write	3	PV-2 Dead band % 0<(Input Value/1000)%<10 %
41124	PV-2 Alarm Status	Read Only	0	PV-2 Alarm Status 0：Normal、1:HH、2：H、3:L、4:LL。
41138	MV Output High Limit	Read / Write	3	MV Output High Limit (<MV RH)
41140	MV Output Low Limit	Read / Write	3	MV Output Low Limit (>MV RL)
41142	MV Output Alarm Status	Read Only	0	MV Output Alarm Status 0：Normal、1:H、2：L
41144	MV Emergency Value	Read / Write	3	MV output value while emergency shutdown DI being active
41146	PV-1 open wire flag	Read Only	0	0：Normal 1：Open wire
41148	PV-2 open wire flag	Read Only	0	0：Normal 1：Open wire
41150	PID Direct/Reverse	Read / Write	0	0：Direct Mode 1：Reverse Mode
41152	SV-1 High Limit	Read / Write	3	SV-1 High Limit value
41154	SV-1 Low Limit	Read / Write	3	SV-1 Low Limit value
41156	SV-2 High Limit	Read / Write	3	SV-2 High Limit value
41158	SV-2 Low Limit	Read / Write	3	SV-2 Low Limit value