# General Specifications

VP6E5800
Turbomachinery I/O Module
Logic Builder Package

**GS 33J10U10-01EN**

***[Release 6]***

## ■ GENERAL

*Turbomachinery I/O modules are the modules that built-in with the high-speed interlock blocks, PID control blocks and many other control function blocks, and applied in CENTUM VP system.*

*The main interfaces for turbine control such as speed pulse signal input, LVDT(Linear Variable Differential Transformer)input and servo output interfaces are supported by theses modules. The Turbomachinery I/O Module Logic Builder Package (VP6E5800) is the specific application package for configuring and engineering the Turbomachinery I/O modules.*

*More information regarding the Turbomachinery I/O modules can be found in the General Specification of Turbomachinery I/O Modules (GS 33J50F60-01EN). Please read it together with this document.*

## ■ USAGE OF TURBOMACHINERY I/O MODULES

An example is illustrated below to show the usage of Turbomachinery I/O modules in a turbine control system.

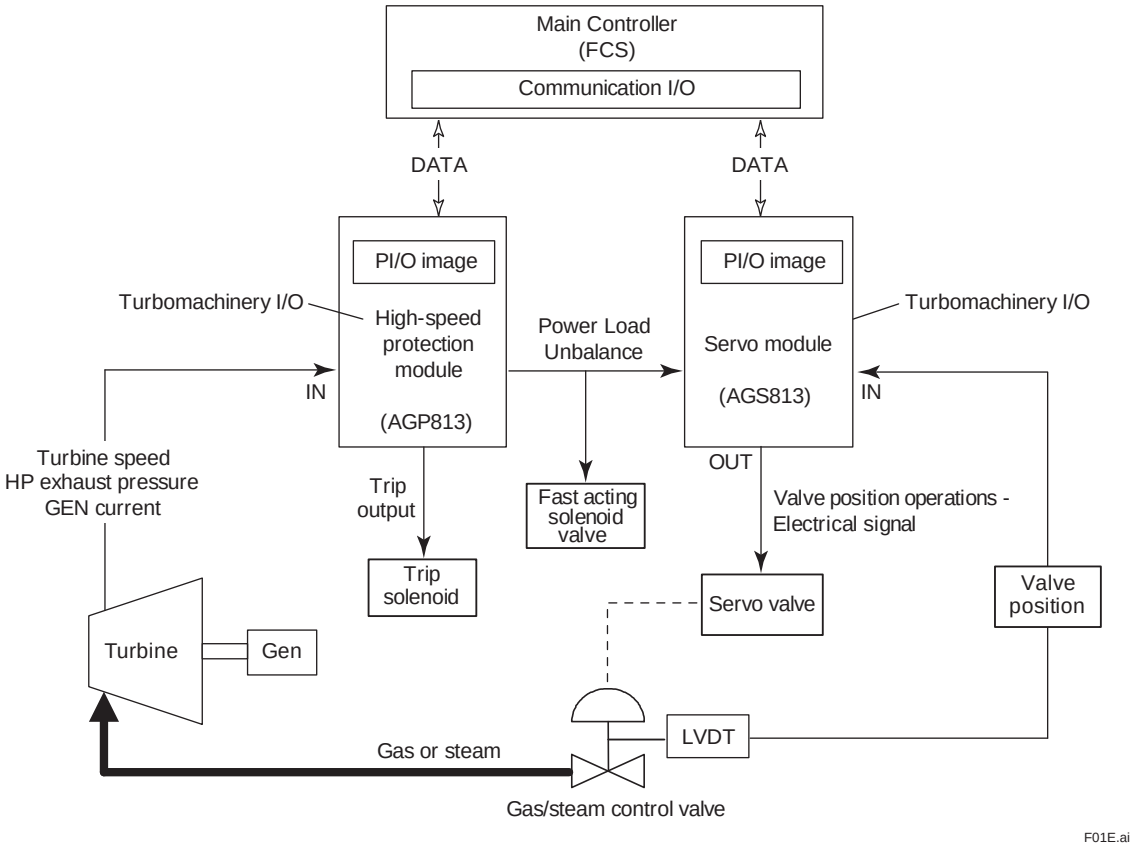


**Figure Usage of Turbomachinery I/O Modules in Turbine Control System**

The turbine control loops, typical applications using the Turbomachinery I/O modules, are running in the FCS for main control activities to regulate the speed and load of the turbine. For the high-speed control actions, the Servo Module (AGS813) for adjusting the servo valve openings and the High Speed Protection Module (AGP813) for monitoring the turbine revolutions so as to protect the turbine from power load unbalance and over-speed are available.

Moreover, an AGS813 module has two built-in PID function blocks, and an AGP813 has many user-defined logic calculation blocks. Therefore, the module can carry out the high-speed control activities independently from the field control station (FCS).

The control unit of the FCS communicates with the Turbomachinery I/O modules for the I/O data through the communication I/O areas.

The turbine control system engineering builders are available to define the modules for constructing the turbine control systems. The turbine control system engineering builders are included in the package of VP6E5800.

YOKOGAWA

Yokogawa Electric Corporation
2-9-32, Nakacho, Musashino-shi, Tokyo, 180-8750 Japan

GS 33J10U10-01EN

5th Edition Apr. 26, 2024 (YK)

## ■ SYSTEM COMPONENTS AND SOFTWARE PACKAGES

### ● Field Control Stations (FCS)

The Turbomachinery I/O modules are supported by the following types of the field control stations.
AFV30S, AFV30D, AFV40S, AFV40D

### ● Turbomachinery I/O Modules

AGS813 and AGP813 are two models of the Turbomachinery I/O modules.

**Table Turbomachinery I/O Modules**

| IOM Model(Name) | I/O Channels Per IOM | | Redundancy(*1) | Built-In Logics | IOM Scan-Period | SOE |
|---|---|---|---|---|---|---|
| AGS813<br>(Servo Module) | Position Feedback: 4 Channels<br>DI: 2 Channels<br>AO: 2 Channels<br>POWER OUT: 4 Channels | | ○ | × | Built-In PID<br>Control-Period<br>5 msec | — |
| AGP813<br>(High Speed Protection Module) | Scan-Period | | ○ | ○ | Built-In Logic<br>Control-Period<br>5 msec,10 msec | ○<br>(DI Only) (*2) |
| | 5 msec | 10 msec | | | | |
| | AI: 4 Chs<br>PI: 0 Chs<br>DI: 4 Chs<br>DO: 4 Chs | AI: 6 Chs<br>PI: 4 Chs<br>DI: 8 Chs<br>DO: 8 Chs | | | | |

*1: Install the two modules of same model in the adjacent slots(An odd number slot and the odd number + 1 slot) for dual redundancy.
*2: The SOE (sequence of events) capability is supported in the same way as the SOE capability of FIO. For more information about SOE capabilities, see GS 33J30D10-01EN or GS 33J30D20-01EN of Sequence of Events Manager.

### ● Turbomachinery I/O Module Logic Builder Package (Model VP6E5800)

Turbomachinery I/O Module Logic Builder Package (VP6E5800) needs to be used with the Standard Engineering Function (VP6E5100) since the Turbomachinery I/O modules need to be defined using the Standard Engineering Function.

Turbomachinery I/O Module Logic Builder Package has the following features:

- Logic Builder
  This builder can be used to create the logics for running in the High Speed Protection Module (AGP813) on a computer. The created logics can be downloaded from the computer to the AGP813 module via FCS.
- Logic Test Tool
  This tool can be used on a computer for simulating and testing the logics created on the Logic Builder.

## ■ SYSTEM SPECIFICATIONS

The Turbomachinery I/O modules and the control unit exchange the input and output data through the FCS communication I/O areas. The Turbomachinery I/O modules use the same communication areas with other modules. Therefore, the number of Turbomachinery I/O modules to be installed subjects to the following restrictions:

Regarding the restrictions on the number of installed modules caused by the power capacity, see the following documents:

GS 33J60A10-01EN FIO System Overview
GS 33J62A10-01EN N-IO System Overview

**Table Restriction on Number of Turbomachinery I/O Modules (for Vnet/IP)**

| Field Control Unit | Control Function | Item | |
|---|---|---|---|
| | | Maximum number of modules can be installed | Communication I/O size |
| AFV30S, AFV30D, AFV40S, AFV40D | Control Function for Field Control Station (VP6F1700) | Up to 32 modules (16 sets for dual-redundant use) combined with the ALR111, ALR121, ALE111, ALP121, A2LP131, and A2LP141 modules | 8000 words/FCS |
| A2FV50S (*1), A2FV50D (*1) | Compressor Control for FCS (VP6F8100) | Up to 32 modules (16 sets for dual-redundant use) combined with the ALR111, ALR121, ALE111, ALP121, A2LP131, and A2LP141 modules | |

*1: The model for ordering is A2FVX1.

## ■ SPECIFICATIONS OF SERVO MODULE (AGS813)

### ● Functional Overview

A servo module holds two PID control blocks. The PID control blocks use the LVDT inputs or 1-5 voltage inputs as the measured process variables and perform the PID control calculation in accordance with the set-point values defined by control unit of FCS. The calculated results will be output as the servo outputs or the linear outputs. Moreover, the PID can run in cascade-direct mode to output the set-point values and can run the high-speed logic shutdown to a specified value by an external DI signal. The control period of the PID blocks is 5 msec.

## ■ SPECIFICATIONS OF HIGH SPEED PROTECTION MODULE (AGP813)

### ● Functional Overview

A high speed protection module holds the user-definable logic control capability. The logic calculations can be performed using the discrete, pulse and analog inputs as well as the constants in the module and set-point values defined from FCS.

The logic calculations can generate the trip signals for over-speed of turbine revolution and over-load shutdown signals.

The over-speed trip signals and the over-load shutdown signals are output through the DO interface.

## ● Logic Control Capability

The logics created on the Logic Builder of CENTUM VP, i.e., the Logic for Turbomachinery I/O Module, can be executed in the high speed protection module as the application logics.

The application logics (hereinafter referred to as APL) performs the logic calculations using the pulse signals (turbine revolution signals) and other field data. It also uses the parameters set by FCS and returns the calculation results to the FCS. Accordingly, it can send the trip signals through DO and shutdown commands to servo module. In an APL, the built-in logic blocks which are previously built with may types of logic functionalities can be used for various logic controls.

The control period of the logic blocks is 5 msec or 10 msec user-definable.

**Table Application Logic Specifications**

| | |
|---|---|
| Application logic (APL) | Up to 100 blocks can be used as long as the logic calculation can complete within the limit of APL processing time. |
| Limit of APL Processing Time | Control Period of I/O Module and Limit of APL Processing Time<br>AGP813:<br>5 ms Fast Scan Mode: 1.5 ms<br>10 ms Basic Scan Mode: 3.0 ms |
| Number of APL Buffers | Number of APL Buffer for External Interface: 113<br>Number of APL Buffer For Internal Use in I/O Module: 928 |

The logic blocks built-in the High Speed Protection Module for creating the application logics are shown below:

**Table Internal Blocks Built-In AGP813 (1/2)**

| Category | Block Name | Block Model | Processing Time (µs) |
|---|---|---|---|
| Typecasting Blocks | 15-0 Bits Coder | CODE15-0 | 57.3 |
| | 15-0 Bits Decoder | DECO15-0 | 54.4 |
| | 15-8 Bits Coder | CODE15-8 | 37.6 |
| | 7-0 Bits Coder | CODE7-0 | 37.6 |
| | 15-12 Bits Coder | CODE15-12 | 27.6 |
| | 11-8 Bits Coder | CODE11-8 | 27.6 |
| | 7-4 Bits Coder | CODE7-4 | 27.6 |
| | 3-0 Bits Coder | CODE3-0 | 27.6 |
| | Size Converter | SIZE | 28.3 |
| Numeric Blocks | Sign Change | SIGN | 13.6 |
| | Absolute Value | ABS | 14.7 |
| Arithmetic Blocks | 16Bit Adder | ADD16 | 32.0 |
| | 32Bit Adder | ADD32 | 30.5 |
| | 32&16Bit Adder | ADD32&16 | 31.3 |
| | 16Bit Subtractor | SUB16 | 32.0 |
| | 32Bit Subtractor | SUB32 | 30.6 |
| | 32&16Bit Subtractor | SUB32&16 | 30.1 |
| | 16Bit Multiplier | MUL16 | 31.6 |
| | 32Bit Multiplier | MUL32 | 31.8 |
| | Fixed-Point 32Bit Multiplier | MUL32F | 33.9 |
| | 32&16Bit Multiplier | MUL32&16 | 31.3 |
| | 16Bit Divider | DIV16 | 39.1 |
| | 32Bit Divider | DIV32 | 40.8 |
| | Fixed-Point 32Bit Divider | DIV32F | 43.6 |
| | 64&32Bit Divider | DIV64&32 | 42.4 |
| | 64&16 Bit Divider | DIV64&16 | 42.7 |
| Bit Shift Blocks | Right Shifter | SHIFT-R | When shifting 64-bit data: Number of shift x1.4 + 32.7 |
| | | | When shifting 32-bit data: 28.9 |
| | | | When shifting 16-bit data: 25.6 |
| | Left Shifter | SHIFT-L | When shifting 64-bit data: Number of shift x 1.4 + 31.3 |
| | | | When shifting 32-bit data: 26.5 |
| | | | When shifting 16-bit data: 24.3 |

Table Internal Blocks Built-In AGP813 (2/2)

| Category | Block Name | Block Model | Processing Time (µs) |
|---|---|---|---|
| Bitwise Blocks | AND | AND | 32.8 |
| | OR | OR | 32.7 |
| | NOT | NOT | 15.0 |
| | 16Bit Buffer | BUFF16 | 14.7 |
| | 2 out of 3 Voter | VOTE2&3 | 18.0 |
| | 2 out of 4 Voter | VOTE2&4 | 22.0 |
| Selection Blocks | 2 to 1 Selector | SEL2&1 | 18.2 |
| | Redundant 2 to 1 Selector | RSEL2&1 | 32.4 |
| | Dual 2 to 1 Selector | DSEL2&1 | 20.5 |
| | Data Selector | SEL | Number of data x 1.9 + 23.3 |
| | 3 to 1 Max Selector | MAX3&1 | 28.4 |
| | Max Selector | MAX | (Number of data -2) x 9.9 + 55.1 |
| | 3 to 1 Min Selector | MIN3&1 | 28.4 |
| | Min Selector | MIN | (Number of data -2) x 9.7 + 61.3 |
| | 3 to 1 Mid Selector | MID3&1 | 36.1 |
| | Mid Selector | MID | (Number of data -2) x 43.8 + 88.4 |
| | 3-Input Average Calculator | AVG3&1 | 66.3 |
| | Average Calculator | AVG | (Number of data -2) x 14.4 + 89.8 |
| Comparator Blocks | Comparator | COMP | 24.6 |
| Bistable Blocks | SR Flip-Flop | SR-FF | 17.9 |
| Edge Detection Blocks | D Flip-Flop | D-FF | 21.1 |
| Timer Blocks | On-Delay Timer | OND | 16.6 |
| | Off-Delay Timer | OFFD | 16.6 |
| | One Shot Timer 1 | TON1 | 18.0 |
| | One Shot Timer 2 | TON2 | 18.0 |
| Advanced Blocks | High Value Holder | HOLD-H | 18.9 |
| | Low Value Holder | HOLD-L | 18.9 |
| | 32Bit Buffer | BUFF32 | 11.8 |
| | Line Segment | FUNC | Number of data x 2.8 + 99.2 |
| | Scaling | SCALE | 88.5 |
| | First-Order LAG | LAG | 100.7 |
| | Velocity Calculator | VEL | 84.9 |
| Auxiliary Blocks | END | END | 5.6 |
| | NOP | NOP | 11.1 |

## ■ REDUNDANCY OF TURBOMACHINERY I/O MODULES

Dual redundancy of Turbomachinery I/O modules can be configured by Installing the two modules of same model in the adjacent slots(An odd number slot and the odd number + 1 slot).

One of the paired turbomachinery I/O modules is the control side module while the other is the standby side module. Both modules are independently performing the same internal calculations, only the control side module sends the calculation results as the outputs. Switching between the control side module and the standby side module is determined by the diagnostic feature of the Turbomachinery I/O modules.

## ■ ENGINEERING FUNCTIONS

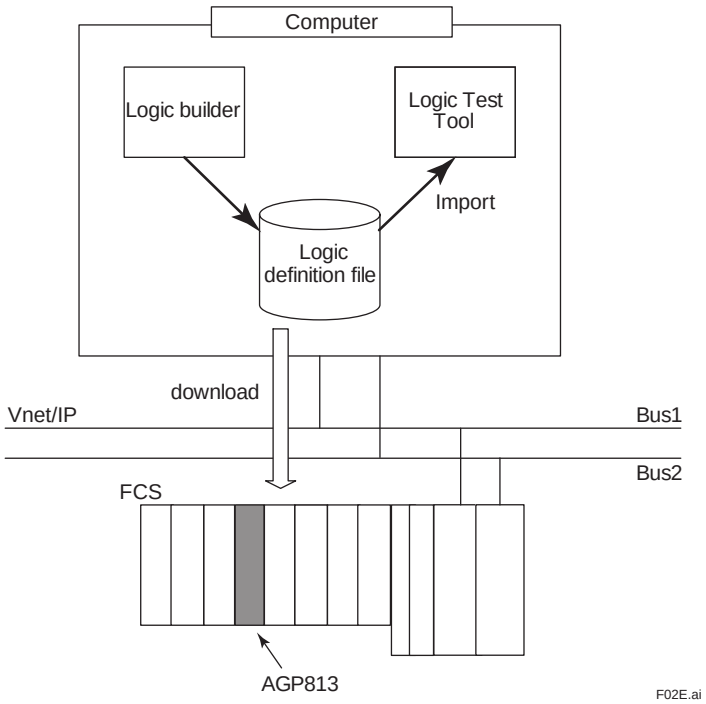


**Figure Scheme of Engineering Functions**

### ● Turbomachinery I/O Module Logic Builder

The Turbomachinery I/O Module Logic Builder is the engineering builder for creating the logic applications in the high speed protection (AGP813) modules. The created logic applications need to be downloaded to the high speed protection (AGP813) modules through FCS.

### ● Turbomachinery I/O Module Logic Test Tool

The Turbomachinery I/O Module Logic Test Tool is an engineering tool for testing the logic applications created by the Turbomachinery I/O module logic builder on a computer. This tool can perform the simulation test for the logics on the computer instead of using the actual Turbomachinery I/O modules or connecting the physical field devices. This tool has the following features:

| Feature | Description |
|---|---|
| Logic Simulation | Simulates the logics created on the logic builder. The simulation test can be performed in Step mode or Break Point mode.<br>User can enter the values to simulate the input signals for testing. The simulation signals can also be prepared beforehand and saved chronologically in a file for testing. |
| Set and Display | Sets and displays the follows:<br>• Modify application logics<br>• Set line segment tables<br>• Set simulated input signal<br>• Set output value to the APL buffers<br>• Clear set data areas<br>• Display block details<br>• Display specified variable values<br>• Display internal variable values<br>• Display Logic definitions |
| Save Simulation Data | Saves the following data used during the logic simulation test into files:<br>• Application logics<br>• Line segment data<br>• Constants<br>• Simulated inputs<br>• Simulated outputs |
| Import Simulation Data | Imports the simulation data saved in a file for simulation test. |
| Display Logic Processing Time | Displays the processing times of application logics. |
| Import Logic File Information | Imports the information file of the application logics created on the Turbomachinery I/O module logic builder. |

## ■ OPERATING ENVIRONMENT

### ● Hardware Requirement

Conforms to the operating environment of VP6E5100 Standard Engineering Function.

### ● Software Requirement

Conforms to the operating environment of VP6E5100 Standard Engineering Function.

Necessary software:
VP6E5100 Standard Engineering Function
VP6E5800 Turbomachinery I/O Module Logic Builder Package
Microsoft Excel

For the supported software versions of Microsoft Excel, refer to General Specifications of VP6E5100 Standard Engineering Function (GS 33J10D10-01EN).

## ■ LIMITATION OF INSTALLATION AND NOTICE

AGS813 and AGP813 cannot be installed in a remote node.

## ■ MODEL AND SUFFIX CODES

Turbomachinery I/O Module Logic Builder Package

| | | Description |
|---|---|---|
| **Model** | VP6E5800 | Turbomachinery I/O Module Logic Builder Package |
| **Suffix Code** | -V | Software license |
| | 1 | Always 1 |
| | 1 | English version |

## ■ ORDERING INFORMATION

Specify the model, and suffix code(s).

## ■ TRADEMARK ACKNOWLEDGMENT

The names of corporations, organizations, products and logos herein are either registered trademarks or trademarks of Yokogawa Electric Corporation and their respective holders.