

# General Specifications

GS PM97FF51-EN

## Advanced Plant Model Training System with DCS Centum VP and FOUNDATION Fieldbus

### ■ GENERAL

*Advanced Plant Model Training System with DCS Centum VP and Foundation Fieldbus is specially designed for training, research, and development in the field of process instrumentation and control engineering that is used in a wide range of industry including petroleum refining, upstream, downstream, chemistry, iron and steel, food, and electric power. It is a versatile, modular system for the study of Level, Flow, Pressure Control, respectively. The course work and instruction manual which accompany this plant model are designed for both beginners and professionals. Its course contents provide basic principle and in-depth coverage of measurement and control engineering which are focused on pragmatic industrial and supporting the new trend of technology, such as data communication to Distributed control system by using Foundation Fieldbus communication and latest DCS Centum VP and the personal computer as the supervisory computer control, or the peer-to-peer communication between both controllers. This General Specification (GS) describes the system specifications of advanced plant model and components specifications.*

### ■ GENERAL COURSE CONTENTS

The main content of course work and associated laboratories are divided into two parts as follows.

#### ● Part I: Basic Instrumentation

This part is devoted to learners with basic Instrumentation which covers of installation, calibration, and maintenance of electronic instruments.

##### Terminology

- Measured Accuracy
- Precision
- Errors

##### Calibration Problems

- Zero Shift
- Span Error
- Linearity Error

##### Internal and Supplies Auditing

- Traceability
- Calibration Records
- Procedure and Work Instructions

##### Process Measurement

- Flow, Level, Pressure
- The operation of control valve and actuator

##### Smart Transmitters

- Calibration and Configuration by Field Mate Software
- Troubleshooting, Status, and Diagnostic

##### Vibration Transmitters and Gateway

- Technology for wireless solution and industrial IoT by latest communication such as ISA100 or LoRaWAN
- Preventive maintenance and abnormal signals

#### ● Part II: Control Engineering

This part envisions learners to understand the process characteristics, system equation and transfer function. It provides a thorough background in both basic and advance regulatory control strategies, technology, and controller tuning.

##### Terminology

- Continuous process
- Batch process
- Feedback Control
- Feedforward Control
- Sequence Control

##### Mathematical Foundations

- Mass and Energy Balance
- System Equation
- Transfer function

##### Process Characteristics

- Self-Regulation Process
- Non-Self-Regulation process
- Process gain, Time constant and Dead time

##### Control Action

- Direct Action
- Reverse Action

##### Feedback Control

- Conventional PID
- PID Modification in Commercial System

##### PID Parameters Tuning Technical

- Open Loop Testing
- Close Loop Testing
- Self-Tuning

##### Feedforward Control

- Basic Concept
- Implementation
- Combination with Feedback
- Application Perspective

##### Advance Control

- Flow or Level Process Characteristic and Control
- Level Self-Regulating Control
- Pressure Control for Single Self-Regulating
- Ratio Control (Flow, Level)
- Cascade Control (Flow, Level)
- Override Control (Pressure, Flow, Selective)

### ■ COMPONENTS

The Advanced Plant Model consists of a variety of equipment including equipment for operation and monitoring and equipment for control and is built by connecting those components. The main process instruments are industrial grade products and compliant with the standards such CE, UL, IEC, or EMC. The Plant Model Structure is designed and manufactured under standard ISO9001, ISO14001, ISO45001, and OHSAS18001.

## ■ MAIN PROCESS INSTRUMENT

### ● Level Transmitter

There are two Differential Pressure Transmitters, LT-1 and LT-2 for measuring the liquid level inside Process Tank I and Process Tank II, respectively. Both are EJA110E which output is Foundation Fieldbus Communication signal corresponding to the measured differential pressure as proportional to the liquid level. Besides, they also support the remote setup and monitoring through communication with interface device and Field Mate software, or Centum VP system.

#### Standard Specifications

- Measurement range: -10,000 to 10,000 mm H<sub>2</sub>O
- Measurement Span: 200 to 10,000 mmH<sub>2</sub>O
- Output Signal: Foundation Fieldbus communication
- Accuracy:  $\pm 0.055\%$  of span
- Ambient Temperature Limits: -30 to 80 °C
- Process Temperature Limits: -40 to 120 °C
- REMARK Further information is available in GS 01C31B01-01EN

### ● Flow Transmitter

Two EJA115E Low Flow Transmitters, FT-1 and FT-2 are the flow meter comprised of the differential pressure transmitter with the integral orifice. They output Foundation Fieldbus communication signal corresponding to the measured flow. Besides, they also feature remote setup and monitoring through communication with interface device and Field Mate software, or Centum VP system.

#### Standard Specifications

- Differential Pressure range: 200 to 10,000 mm H<sub>2</sub>O
- Flow Range: 2 to 20 Liter/minute
- Output Signal: Foundation Fieldbus communication
- Accuracy:  $\pm 0.055\%$  of span
- Ambient Temperature Limits: -30 to 80 °C
- Process Temperature Limits: -40 to 120 °C
- REMARK Further information is available in GS 01C31K01-01EN

### ● Pressure Transmitter

EJA430E Gauge Pressure Transmitters, PT-1 is used to measure the pressure of air which is replaced by water flowing into the pressure tank. its digital outputs Foundation Fieldbus signal corresponding to the measured gauge pressure. Besides, it also features remote setup and monitoring through communication with interface device and Field Mate software, or Centum VP system.

#### Standard Specifications

- Pressure range: -1 to 35 kgf/cm<sup>2</sup>
- Pressure span: 0.3 to 35 kgf/cm<sup>2</sup>
- Maximum Overpressure: 163 kgf/cm<sup>2</sup>
- Output Signal: Foundation Fieldbus communication
- Accuracy:  $\pm 0.055\%$  of span
- Ambient Temperature Limits: -30 to 80 °C
- Process Temperature Limits: -40 to 120 °C
- REMARK Further information is available in GS 01C31E01-01EN

### ● Final Control Element

There are many devices to use as final control element to be connected with many processes or industries. For this process control training system, use a Control Valve and a Variable Speed Drive to manipulate the liquid flowing from Water Pump1 and Water Pump2.

REMARK: Final Control Element is 3<sup>rd</sup> Party Products. Available 1 or 2 units this system. Contact Yokogawa office for selection.

## ■ DCS CONTROLLER (CENTUM VP)

The DCS controller is main control system which manipulates and calculation process variable as control theory. It consists of controller hardware called Field Control Stations (FCS), human machine interfaces called Human Interface Station (HIS) and a control network.

### ● Field Control Station (FCS)

An FCS implements control computation functions using each function block and I/O functions using process and software I/O. FCS are designed to work without HIS. The fundamental controls can be done only by the FCS, and all the process data, control logic, and procedures are contained in the controllers. HIS works only as a monitor screen under the normal condition. The hardware availability of FCS is 99.99999% which comes from product designs.

For the field control unit (FCU) which is the core control part of an FCS, the following units are available.

AFV30S	Field Control Unit (for FIO, 19-inch Rack Mountable Type)
AFV30D	Duplexed Field Control Unit (for FIO, 19-inch Rack Mountable Type)

For details, refer to the GS "Field Control Unit/Duplexed Field Control Unit (for FIO, 19-inch Rack Mountable Type)" (GS 33J60E10-01EN),

For details on FCS I/O related equipment, refer to the GS "FIO System Overview" (GS 33J60A10-01EN).

#### Basic Software

VP6F1700 Control Function for Field Control Station (for AFV30 /AFV40 )

For details, refer to the GS 33J15C10-01EN

#### Subsystem Communication Function

An FCS can communicate with subsystems and field devices to exchange data. The following types of communication are supported. For details on communication functions, refer to the GS for each hardware.

- Serial Communication  
Serial Communication Module (for N-IO/FIO) (GS 33J60G10-01EN)
- Ethernet Communication  
Ethernet Communication Module (for N-IO/FIO) (GS 33J60G11-01EN)
- Foundation Fieldbus Communication  
Foundation Fieldbus Communication Module (for N-IO/FIO) (GS 33J60G20-01EN)

## ● Human Interface Station (HIS)

CENTUM VP uses a PC for its human machine interface. It is called HIS when the software packages for Operation and Monitoring Functions are installed there. It will be called Engineering Station (ENG) when the software package for Engineering Function is installed in a PC to use for engineering purpose.

Both the Operation and Monitoring Function software and the Engineering Function software can coexist on a PC or separated another PCs.

For this training system, both functions are installed in a PC and called HIS.

### Operation and Monitoring Function Software

The following software is available for operation and monitoring with an HIS. For details on each function, refer to the GS for each software.

VP6H1100 Standard Operation and Monitoring Function  
 VP6H1140 Eight-loop Simultaneous Operation Package (for AIP831)  
 VP6H2411 Exaopc OPC Interface Package (for HIS)  
 VP6H2412 CENTUM Data Access Library VP6H4000 Million Tag Handling Package VP6H4100 Configured Information Reference Package  
 VP6H4150 Output to External Recorder Package  
 VP6H4190 Line Printer Support Package VP6H4200 Historical Message Integration Package (Meeting FDA Regulations)  
 VP6H4410 Control Drawing Status Display Package  
 VP6H4420 Logic Chart Status Display Package  
 VP6H4450 Multiple Project Connection Package  
 VP6H4600 Multiple-Monitor Support Package  
 VP6H4700 Advanced Alarm Filter Package  
 VP6H6510 Long-term Data Archive Package  
 VP6H6530 Report Package  
 VP6H6660 Process Management Package (VP Batch)  
 VP6H6710 FCS Data Setting/Acquisition Package (PICOT)

For details, refer to the following GS.

- Standard Operation and Monitoring Function (GS 33J05D10-01EN)

### Engineering Function Software

This function software package provides an engineering environment for configuring and maintaining overall instrumentation including plant instrumentation, safety instrumentation, and maintenance management. We call it as AD Suite.

The AD Suite consists of Automation Design Server (AD Server), Automation Design Organizer (AD Organizer), and VP Builder.

The AD Server manages all the engineering data of the AD Suite.

VP6E5000 Engineering Server Function is a license to use the AD Server.

The AD Organizer is the main software for engineering for module-based engineering as described later in this document.

The VP Builder is the generic name for System View, Recipe View, and other builders launched by Views. The VP Builder is the main software for engineering for module-less engineering as described later in this document.

VP6E5100 Standard Engineering Function is a license to use the AD Organizer and the VP Builder.

Since the AD Suite centrally manages all the CENTUM VP's engineering data on the AD Server database, the latest design information is always available when expanding, modifying, or maintaining the system, which prevents unnecessary engineering work to confirm inconsistencies between the design information and the actual information stored in the system.

Change histories of the AD Organizer and the VP Builder are stored in the AD Server, and the AD Organizer is used to browse the change history.

The AD Server, the AD Organizer, and the VP Builder can run on a single computer.

Additional functions such as Module-based Engineering, Tuning Parameter Management, Bulk Editing, Change Control, and Dependency Analysis can be performed by using various optional packages for the AD Suite.

### AD Suite Related Software

For details on each function, refer to the GS for each software.

VP6E5000 Engineering Server Function VP6E5100 Standard Engineering Function VP6E5210 Module-based Engineering Package  
 VP6E5215 Tuning Parameter Management Package (for Module-based Engineering)  
 VP6E5216 Batch Editing Package (for Module-based Engineering)  
 VP6E5250 Change Control Package VP6E5260 Dependency Analysis Package

### Other Engineering Related Software

The following software which can even be used with just VP Builder is available for engineering with CENTUM VP. For details on each function, refer to the GS for each software.

VP6E5110 Access Control Package VP6E5150 Graphic Builder VP6E5165 Batch Builder (VP Batch)  
 VP6E5166 Recipe Management Package (VP Batch) VP6E5170 Access Administrator Package (FDA:21 CFR Part 11 compliant) (\*1) VP6E5420 Test Function  
 VP6E5425 Expanded Test Functions VP6E5426 FCS Simulator Package VP6E5427 HIS Simulator Package  
 VP6E5450 Multiple Project Connection Package  
 VP6E5490 Self-documentation Package

### Software Operating Environment

The HIS, AD Server, AD Organizer, and VP Builder run on the following Microsoft Windows operating systems.

Windows 7 Professional SP1 (64-bit)  
 Windows 10 Enterprise 2016 LTSC (64-bit)  
 Windows Server 2008 R2 Standard SP1 (64-bit)  
 Windows Server 2012 R2 Standard (64-bit)  
 Windows Server 2016 Standard (64-bit)

## ● Licenses

A license is the right to use software, software in hardware (firmware), hardware, and related hardware. First license requires is Project ID License.

Project ID License is an essential to identify each VP project. Each software license for system components in the VP project is issued and managed based on this project ID. When purchasing software, version upgrading, or revision upgrading of CENTUM VP, it is necessary to enter the project ID.

Next license, Project I/O License. It is an essential license to manage I/O in a VP project. The number of project I/O license is determined by the number of process I/O and communication I/O used in the VP project.

The last, Software Function License. It depends on software packages and number of logical I/O points. For the Advanced Plant Model, the logical I/O 2,000 points are provided as minimum license points which includes for engineering function, standard operation and monitoring function.

For details on number of logical I/O points, refer to the following GS.

GS "VP6H1100 Standard Operation and Monitoring Function" (GS 33J05D10-01EN)

GS "VP6E51AD Automation Design Suite Standard Engineering Function" (GS 33J10D21-01EN)

## ● Computer for HIS/ENG Specification

The computer for this purpose run on the Microsoft Windows operating systems with requires workstation type at least.

- CPU: Intel Xeon W2123 Processor, 3.6 GHz speed
- Memory: 16 GB (2666 MHz, DDR4, ECC)
- Graphic Card: 2 GB DDR5 memory
- PCI Express Slot for installed Vnet/IP card
- HDD: 1 TB 7200 RPM, 3.5 inch, SATA
- Power Supply: 425 W

Computer is a product based on hardware and software (including OS) of other vendors' products. Therefore, depending on specification changes and the vendor's support condition. Yokogawa may not be able to offer a warranty and maintenance support.

For details on recommended computer, refer to the following GS Global PC Tower Workstation (GS 30A01D15-01EN)

## ● Vnet/IP Interface Card

By installing the Vnet/IP Interface Card model VI702, into the PCI Express slot of the PC computer. The computer can connect to the Vnet/IP.

Vnet/IP is a control network for connecting CENTUM VP components with each other.

For details of the interface card, refer to the GS Vnet/IP Interface Card (GS 33J50C10-01EN).

## ● Electronic Instruction Manual

CENTUM VP's instruction manuals are provided as electronic data on the same DVD as the system software.

VP6C5495 Electronic Instruction Manual

For details, refer to the GS "Electronic Instruction Manual" (GS 33J01W10-01EN).

## ● Other Devices

The printers and other peripheral devices supported by each operating system can also be used. For details on other supported devices, consult Yokogawa.

## ■ SECURITY MEASURES (OPTION)

### ● Endpoint Security Service

Endpoint Security Service reduces the risk of viruses infecting computers and provides support for maintaining the health of the control system throughout the plant's lifecycle. Endpoint Security Service provides services such as AV/OS Implementation Service, AV/OS Update Service, Virus Check Service, and Software Backup Service. For details, refer to the GS "Endpoint Security Service" (GS 43D02T30-02E).

### ● Anti-virus Software

The Anti-virus software AV11000 is dedicated for Yokogawa control system based on the McAfee's intrusion prevention technologies. This product is used as standard anti-virus software for Yokogawa IA systems.

For details, refer to the GS "AV11000 Anti-virus Software for Endpoint Security Service" (GS 30A15A20-01E).

### ● Whitelisting Software

The Whitelisting Software SS1WL1 is a whitelist method software provided for the CENTUM VP system that is based on the application control technology of McAfee, Inc. It restricts the running of malicious programs and unauthorized programs by allowing only programs for which permission has been granted in advance to run. This software can be used together with conventional antivirus software to provide even more effective security measures. For details, refer to the GS "SS1WL1C/SS1WL1S Whitelisting Software for Endpoint Security" (GS 30A15A30-01-E).

## ■ THE PLANT MODEL STRUCTURE

### ● P&ID Diagram

To accomplish in process instrumentation and control engineering theory. The general design for P&ID diagram is provides as in figure 1.

### ● Plant Layout

There are many ways to install equipment. To make variety of learning objective. An example of plant layout show in figure 2.

### ● Controller Cabinet Layout

This unit is for install DCS Controller, Power Supply, and electrical accessories. The general design show in figure 3.

### ● Remarks

The philosophies and objectives of learning may differ, including equipment and the number of devices that will be used. Then, no standard for P&ID, Plant Layout or Structure.

All can be designed upon request. Contact Yokogawa office for customize.

### ■ AN EXAMPLE OF ADVANCED PLANT MODEL STRUCTURE

The information is for general references. It can be designed upon request. Contact Yokogawa office for customize.

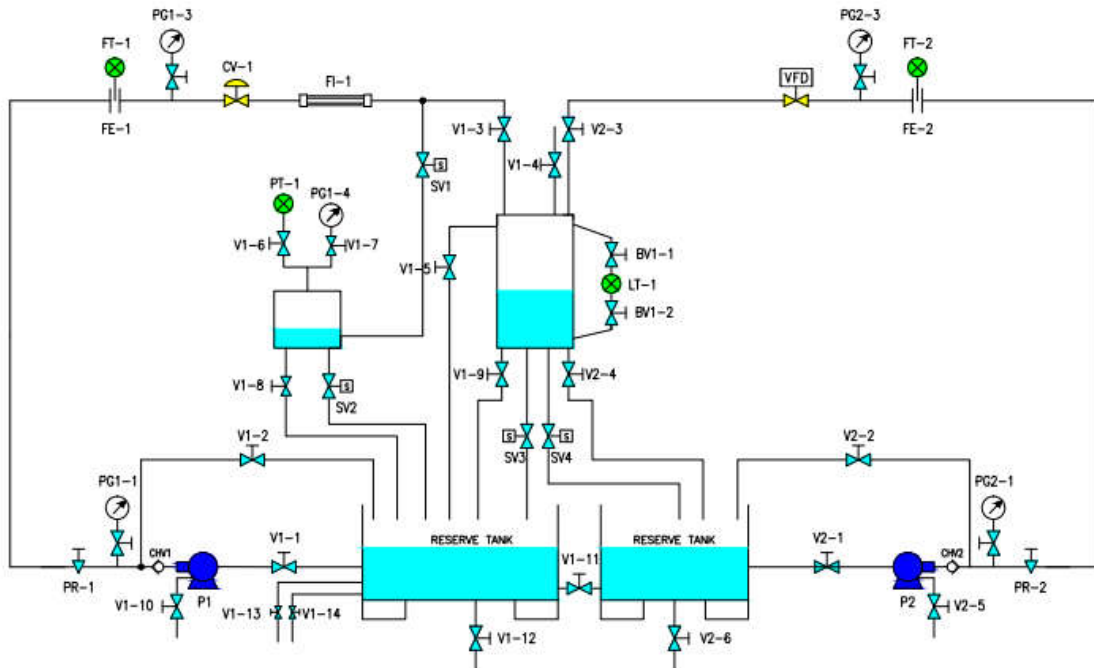


Figure1. P&ID diagram

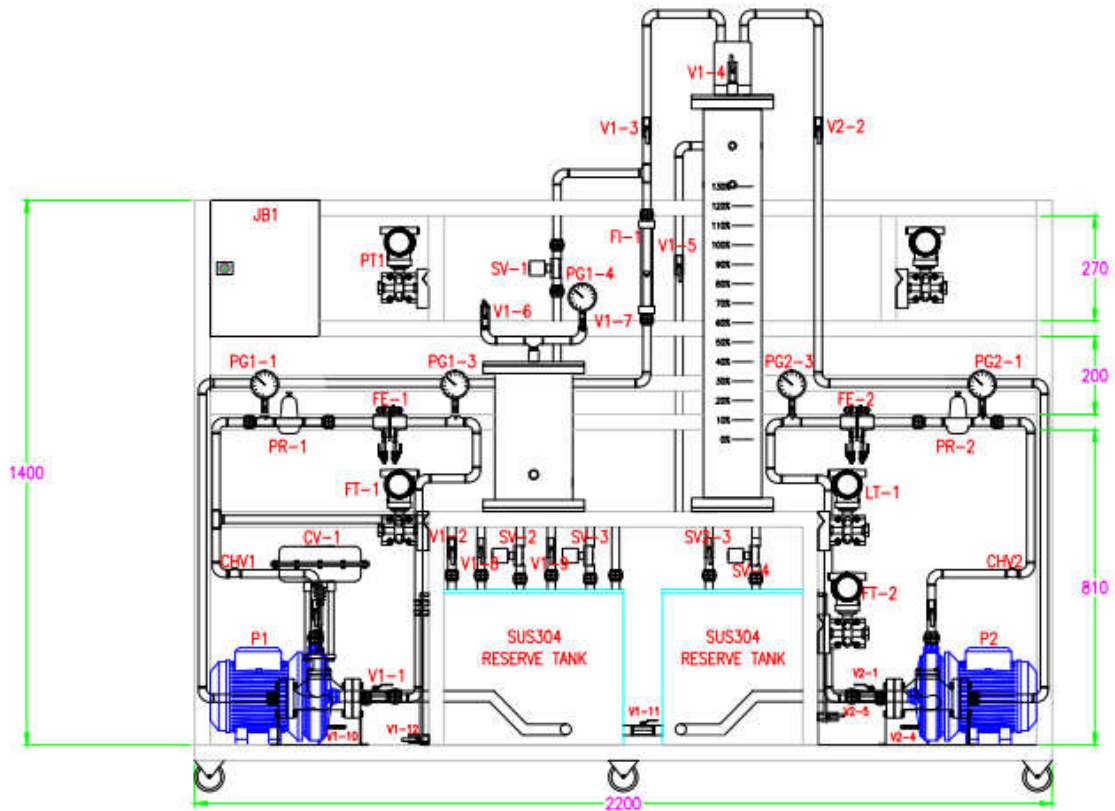


Figure2. Plant Layout

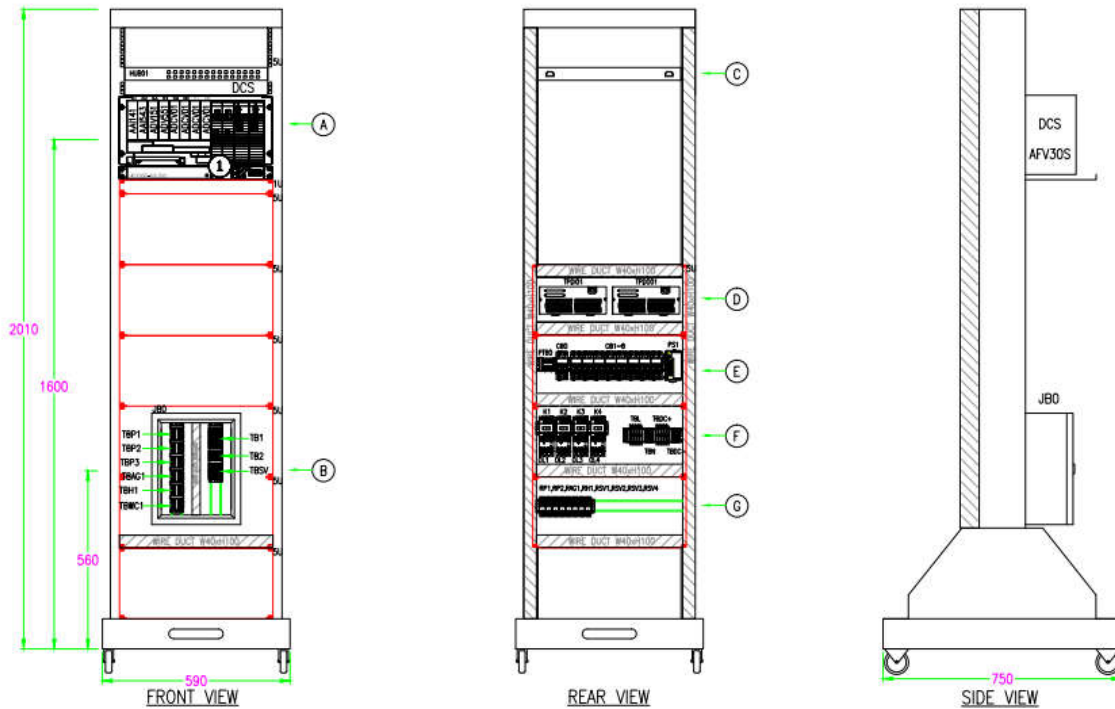


Figure3. Controller Cabinet Layout

**■ INSTALLATION ENVIRONMENT**

Hardware standard installation environment is described as below.

Ambient temperature:

0 to 45 °C

Ambient humidity:

10 to 90% RH

Temperature change rate: ± 10 °C/hour

Power supply:

220 - 240 V AC ± 10%, Frequency; 50/60 Hz ± 1 Hz

Grounding:

Equivalent to JIS class 3 (Ground less than 100 Ω)

**■ TRADEMARKS**

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**■ REMARKS**

- The Plant Model Structure is manufactured in Thailand by Yokogawa (Thailand) Ltd.
- Design, Assembly, Engineering, Laboratory sheet, are property of Yokogawa (Thailand) Limited.
- Yokogawa (Thailand) Ltd. is in recognition to complies standard ISO9001, ISO14001, ISO45001, and OHSAS18001.
- Main process equipment is Yokogawa product that product origin from Japan and Yokogawa Manufacturer in many countries.
- For others part such Control Valve, Inverter or VFD, Power Supply, Water Pump, Air Pump, Pressure Gauge, Pressure Regulator, Computer, Control Desk or Control Cabinet, Aluminum Profile Structure, Storage Water Tank, Process Tank, Wiring and Accessories. All are 3<sup>rd</sup> party products. Some products origin from aboard. Some products are local made in Thailand.
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