Overview

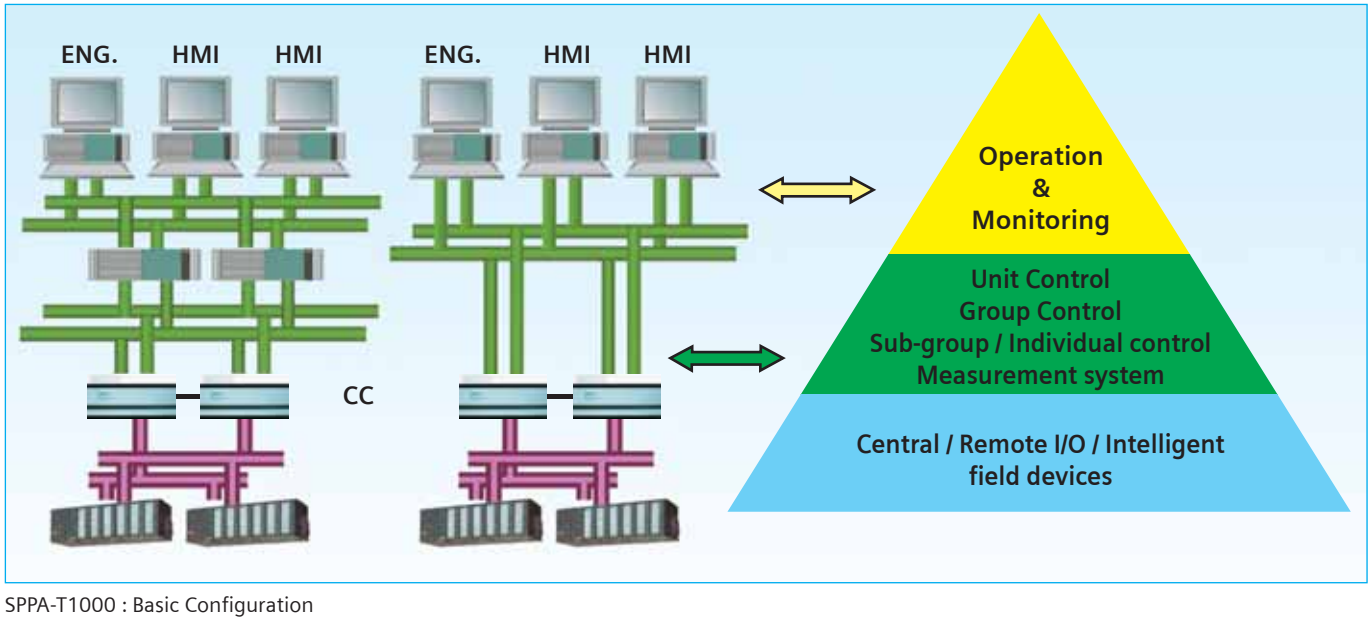
SPPA-T1000 is an advanced Distributed Control System enriched with the latest concepts and features to fulfill the growing requirements of the market. It has been specifically designed for control of all types and sizes of power plants. It is based upon the proven features of Teleperm XP innovated with latest technological enhancements to offer open, universal and web-enabled platforms, excellent availability, high operational comforts and an extremely easy engineering process.

SPPA-T1000 comprises of the following major constituents:

- SoftAS Automation System
- SoftOM Operation & Monitoring System
- SoftTurbo Turbine Control System
- SoftFS TMR (Triple Modular Redundant) Control System for high safety and high availability applications
- SoftBuzz Bus System & Interfaces
- GUES+ Graphical User Engineering System

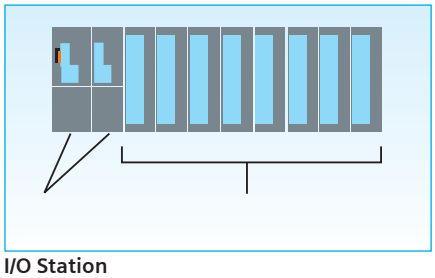
- FIM Field Interface Module
- DAD Debugging and Diagnostic System

SoftAS has a Central Controller (CC) architecture with remote and/or central I/Os. It has very fast response times, achieved through the ultra high speed processing and data handling capabilities. The CC implements all functions like open loop control, closed loop control and measurements. It supports fully the automation hierarchy (individual control level, group control level, unit control level) of the control structure in a plant. All the process control algorithms implemented in the system conform to the concepts laid down for distributed control systems.



SPPA-T1000 : Basic Configuration

Input/ Output modules mounted in I/O stations serve as the interface to the process. These I/O stations communicate with the CC via PROFIBUS and other field bus systems. Thus SoftAS acquires analog values and statuses from the process via the field bus, carries out the control functions and transmits the resulting commands to the process. Use of both remote and central I/Os is possible. Remote I/O configurations with I/O stations mounted directly in the field provide the user with the benefits of reduced cabling, reduced termination panels, faster and easier commissioning and maintenance. Central I/O stations are located in the vicinity of control room.



I/O Station

The architecture is designed to address redundancy issues at each level, starting from I/O and field communication to CC and system bus. It provides the user the flexibility to freely choose the configuration and the extent of redundancy. The system redundancy is plannable and can be matched to fulfill user's requirements and can be implemented as per redundancy class definition.

Additionally, the system is supported with engineering and commissioning tool, GUES+ for planning and documentation, as well as greater ease of modification during commissioning.

The high performance open Operation and Monitoring System SoftOM is used as operator interface for process control. It is a highly intelligent, open and decentralized system. The high degree of processing capability, short response times, complete modularity, flexibility and online system engineering make it a very powerful system.

System conformance

The SPPA-T1000 system conforms to the following standards :

Environmental conditions

IEC 68-2-2	Dry heat
IEC 68-2-3	Damp heat steady state
IEC 68-2-14	Rapid change in temperature
IEC 68-2-30	Damp heat cyclic

Electromagnetic compatibility

EN55011	Radio interference
IEC61000-4-4	Fast transient burst
IEC60255-22-1	High frequency disturbance
IEC61131-2	Insulation resistance
IEC61000-4-5	Surge withstand
IEC61000-4-2	Immunity to electrostatic discharge
IEC61000-4-3	Immunity to electromagnetic HF field
IEC61000-4-6	Conducted susceptibility

The following rules and guidelines for process control installations are recommended :

DIN/VDE 0100/0190	For protective measures and room dimensioning
DIN/VDE 01600	For function safety and protective voltages
VDI/VDE 2180	For plant protection
VDI/VDE 3546	For design of control rooms, structural requirements
VDI/VDE 3512	For test setups in the Process
VDI/VDE 3516	For test setups in the Process

It is recommended to observe in addition the following rules and guidelines in order to provide for a low-inductive functional compensation and a sufficient internal and external lightning protection:

IEC 1024, Section 1	Internal and external lighting protection
DIN/VDE 0185, Section 100	Building lighting protection
DIN/VDE 0800	Functional potential compensation

SoftAS – Automation System

The SoftAS uses the latest Siemens hardware with very fast processors. The Central Controllers (CCs) are based on 32 bit high performance processors, upgradable to 64 bit.

The smallest processing unit in the CC is called PLU (Process Logic Unit), which handles the control, data transfer and protection routines. Multiple PLUs run parallel and synchronously in the CC distributing the control tasks amongst themselves, resulting in fast processing cycles (typically 50ms). Faster cycle times are available for specific applications. For even faster cycle times, intelligent and dedicated front-end processing units are available which can be directly connected to the PROFIBUS.

Each CC has in-built fault detection, which performs regular self-check routines, and annunciates problems on the diagnostic tool. Also a complete history of the problems, prior to any fault or failure, is logged in a file.

Each CC is equipped with fast access memory for storing system and simulation events. The engineering and configuration files are also available here in addition to their being stored in the engineering station.

Signal Conditioning and Calculation

The following functions are available :

- Acquisition, distribution and output of analog signals
- Acquisition of thermocouple and resistance transmitters for temperature measurement
- Acquisition, distribution and output of binary signals
- Binary signal conditioning and processing
- Analog signal conditioning and processing
- Monitoring of input signals for permissible range limits
- Integrated Sequence of Events with 1ms resolution

Typical calculations possible are:

- Mass flow calculations
- Volume flow calculations
- Level calculations
- Limit formation
- Generation of curves
- Linearization of characteristics
- Boolean logics

Closed Loop Control

One of the primary and important functionality is closed loop control. Standard control algorithms are provided to implement

- Closed loop step controller
- Closed loop continuous controller

These algorithms are available as function blocks and can be configured as P, PI, PD or PID controller. The user can also configure additional control logics.

The control tuning parameters e.g. the proportional gain Kp or the reset time Tn can be fed to these control algorithms.

Set point Formation

A set point block is available for set point input and storage. This block is operator accessible

- From SoftOM system
- Via push button on the back-up control station

The setpoint block can also be made to track external setpoints. Any application specific setpoint inputs are possible instead of this function block.

Standard Functions

- Command logic
  - Command for mode switchover (manual/ automatic), static and dynamic
  - Output commands “close” and “open” for the final control element (manual or automatic)
  - Protection commands “close” and “open”

The protection commands are assigned the highest priority.

- Triggering of soft indications on SoftOM operation and monitoring system and the lamps on control tile of back-up control station

Lamp signals are generated in the lamp logic section depending on the operating mode and monitoring function to indicate statuses and faults.

These signals are output via:

- Face plate display in the SoftOM system. The transferred signals are supplemented in the SoftOM coupling block according to the monitoring functions implemented there
- Display on the control tile of a back-up control station

Freely configurable functions

Application specific freely configurable functions can be implemented for

- multi variable control
- override control
- follow up control
- data correction
- manual loader

Open loop Control

Drive Control Function

In order to implement drive control functions, function blocks for motor, actuator and solenoid valve elements are available. The associated protection and release interlocking logic circuits are integrated with these functions.

Subgroup control function for sequential control

In the operating mode section, the manual, automatic and protection commands for determining the mode applicable to the sequence control are linked and the effective mode is determined for processing further functions.

In the program section, the manual, automatic and protection command as well as plant feedback and the effective mode are linked to generate the program (standstill / operation) applicable to the sequence control and the effective program is provided for the further functions.

The “interaction” between the command block and the step blocks is coordinated for the operating mode section and for the program section in the organization section. It is therefore not necessary to plan the connections between the command and step blocks.

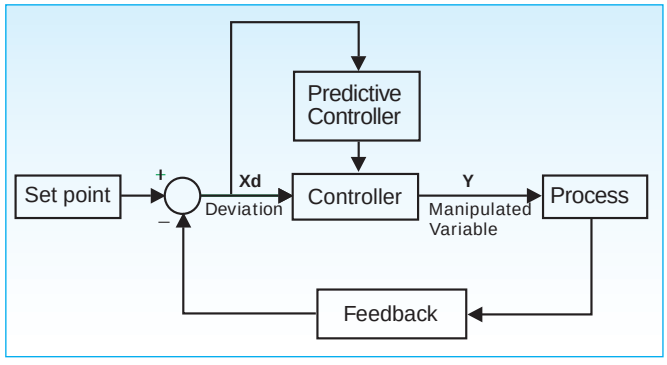
The statuses of the command block and the step blocks are monitored, the fault signals for alarm purposes are generated and the display signals produced in the monitoring alarm and display section.

Plant performance enhancement functions

SoftAS provides the following advanced control functions:

- Predictive control
- Fuzzy logic
- Unit coordination control including load prediction
- State feedback control

Predictive control

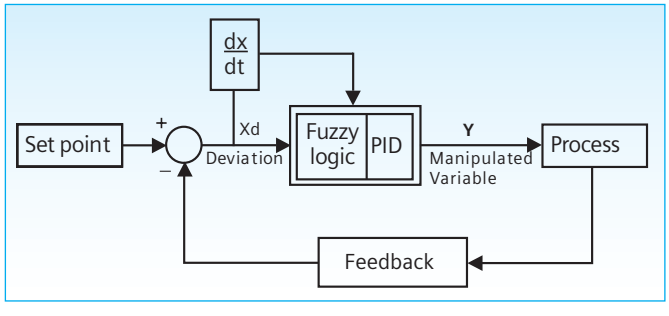


Predictive control

In plant process control, the controlled variables are often very slow in reacting to the control element changes. To provide stable primary and secondary control, the principal factors affecting the process are measured and along with the set point, are used in computing the correct output to meet current process conditions. In this manner, whenever a disturbance occurs, corrective action starts immediately, to nullify the disturbance before it affects the controlled variable.

Fuzzy logic control

Fuzzy logic is required when conventional control does not provide satisfactory results, process measurements are not directly possible and all the process facts can not be reduced to values 0 and 1 as required by any system.



Fuzzy logic control

In Fuzzy logic, undefined quantities are inter-linked as input variables according to IF-THEN rules. In this logic, the experience & knowledge is combined with open loop control strategies.

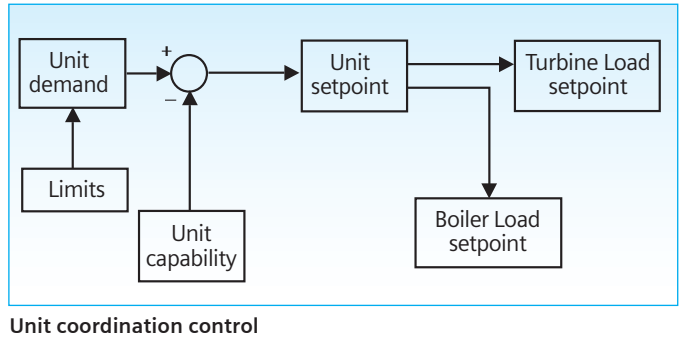
Interdependencies in the process & disturbances in variables are integrated into fuzzy control design.

Fuzzy logic controls are primarily used for the non-linear processes, which cannot be exactly represented in mathematical models.

Unit coordination control including load prediction

The unit coordination control is provided with sufficient fuzziness and supplemented by the prediction of the load reserves. Its application is primarily useful for power plant automation.

The unit can be controlled in coordinated control mode. The unit demand is transferred to turbine control system as set point for electric load generation. The same set point is used as feed forward signal to the boiler firing rate control. A correcting signal is added to or subtracted from the feed forward signal to maintain steam pressure at its set point. On frequency related load variations, the set point is modified only if the frequency deviation is more than the recommended limits. Provisions for plant runback/run up depending on unit capability are also present. This results in a simple & stable control system. Primary controllability is ensured by model based steam generator control (control variable: thermal output) and turbine control (control variable: throttle pressure set point).



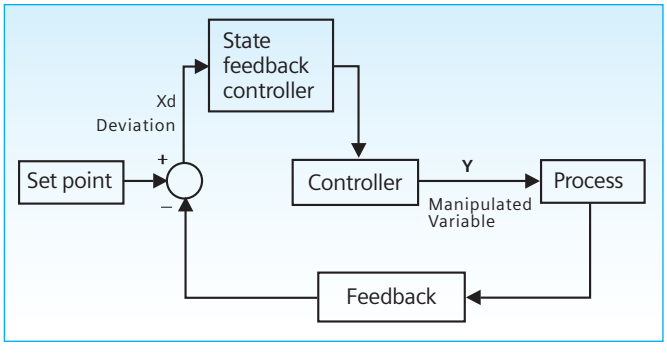
Unit coordination control

State feedback controllers

The function of state feedback controller is to optimize closed loop control for higher order systems. This is a mathematical model supported control algorithm. The state feedback controller control

is much better as compared to the conventional controllers as it reacts faster to the disturbances located at the beginning of the process.

A number of first order delay elements are set up and their outputs are connected to the controller as intermediate variables of the process. These intermediate output variables are compared to the process output variable.



State feedback controllers

Thus the model is continuously matched to the process. Therefore, in this type of control, not only the output variables but also the intermediate statuses of the process are used for closed loop control. Thus systems with short delay time are created which can be corrected faster. This type of control is primarily used for sluggish systems.

The application of the above control blocks enables users to control highly complex loops effectively and efficiently, for example:

- Combustion control
- Furnace supervisory and safety system
- Burner management system
- Secondary air damper control
- Superheat/Reheat steam temperature control

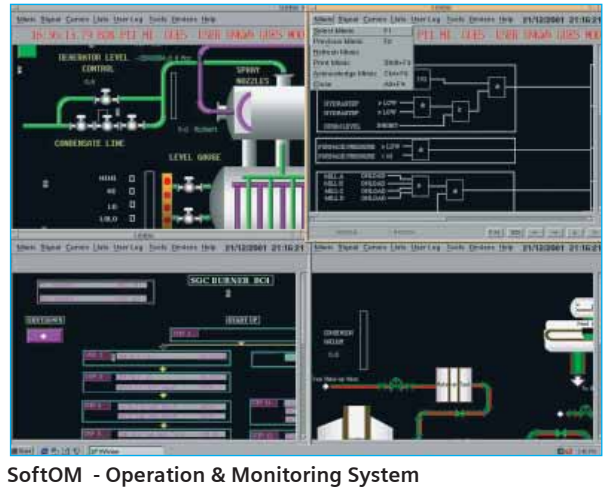
SoftOM - Operation & Monitoring System

The SoftOM is an intelligent, open and decentralized system. It is based on universal workstations and provides the user the choice of Windows, LINUX or UNIX operating systems. It uses latest industry software and standards such as Ethernet, TCP/IP, OSF Motif, OPC connectivity, web-enabling and multiple gateways.

SoftOM enables both client server architecture as well as direct HMI connectivity to the system bus.

The trend-setting features of SoftOM symbolize an important step in the long line of I&C innovations from Siemens.

SoftOM incorporates customer's requirements, namely ergonomical displays, operator comfort, open communication and scalable level of redundancy. It has very powerful functional features like plant operation, events monitoring, HSR, mimics, parameter and trend displays, report generation, performance calculations, etc.



SoftOM - Operation & Monitoring System

The high degree of processing capability, short response time, complete modularity, flexibility and online system engineering of SoftOM are ideally suited for both greenfield and modernizing projects.

SoftTurbo – Turbine Control System

The SoftTurbo is based upon the SoftAS configuration and has been exclusively designed to serve the automation and control needs of all types of turbines and turbo-compressors. It has special software blocks/algorithms to achieve very fast processing speeds. It has a powerful, versatile and modular structure to

ensure highest degrees of safety and availability.

The SoftTurbo provides flexibility to choose the configuration and the extent of redundancy in the most cost effective manner.

SoftFS - Fail Safe System

SoftFS is a unique Triple Modular Redundent (TMR) System. It is designed to provide independent and physical 3 channel redundancy not only at all levels but for the hardware and software as well. The main applications of SoftFS automation system are to be found in power plant control, e.g. burner control for steam boilers, including boiler protection, equipment protection and process automation with simultaneous demands of high safety and high availability.

SoftBuzz - Bus system & interfaces

Bus system

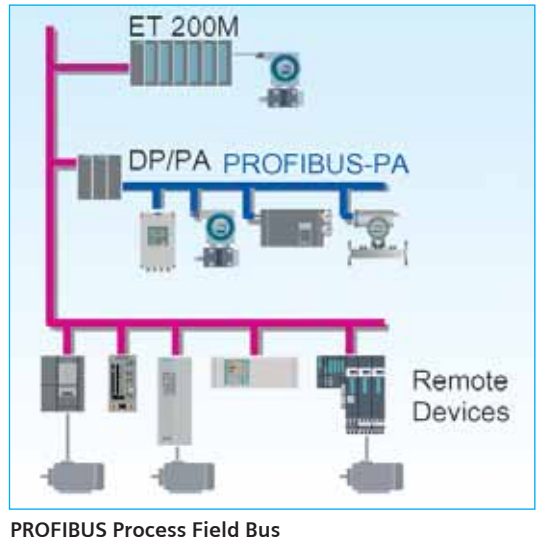
The SoftBuzz communication system consists of the following in a fully integrated network, which provides high-speed deterministic responses under even the most severe conditions:

- PROFIBUS
- System bus
- Terminal bus

PROFIBUS

Universally accepted Process Field Bus (PROFIBUS), technology is used for field communication. Other field bus systems can be offered optionally. PROFIBUS offers an extensive range of components for electrical and optical transmission with speed up to 12Mbps. With PROFIBUS, it is possible to exchange data between devices from different vendors without special interface adapters. Online pluggable remote or local I/O stations acting as PROFIBUS slaves are used for interfacing with the field via redundant interface modules. These interface modules are in master standby mode. The modules themselves decide the mastership role.

The transmission of the process data is cyclic, while alarms and diagnostic data are transmitted acyclically. Parallel redundant PROFIBUS provides a fault tolerant system with high reliability and availability. PROFIBUS provides several other benefits such as scalability, ease of expansion, reduced capital, simple engineering, practically no maintenance, low operating costs and DDL support for multi vendors.



PROFIBUS Process Field Bus

SoftAS incorporates a fault tolerant data acquisition system. In case of failure of the communication module of a slave or the communication processor card, the field data is not lost. Data acquisition by polling method on a continuous basis leads to high throughput. There is a dedicated acquisition module for each bus, which makes the acquisition system very fast. Diagnostic information is also available, which simplifies troubleshooting.
The essential characteristics of the PROFIBUS are :

Speed : upto 12Mbps
Protocol : DP (Distributed Periphery)
Redundancy : Available
Changeover : Since the PROFIBUS is parallel redundant, the data is acquired in both the Central Controllers through the PROFIBUS via the interface modules. In case one bus or interface module becomes faulty, the other interface module connected to the other PROFIBUS takes over the master role.

System Bus

This bus is used for communication between the individual participants. The participants on this bus can be:

- SoftOM Servers/HMI
- Central Controllers (CC)
- GUES+ Server/Client
- Diagnostic Systems
- Gateway Servers
- OPC interfaces

The essential characteristics of the system bus are:

Type : Ethernet
Speed : 100 Mbps
Protocol : TCP/IP
Redundancy : Available
Changeover : The bus monitoring programs run in all the nodes detecting any failure and initiating smooth bumpless switchovers when required.

Terminal Bus

This bus is applicable where the SoftOM configuration is client-server architecture. The data transfer between the HMI and OM servers takes place through the terminal bus and also the printers are connected on this bus. It has the following essential characteristics :

Type : Ethernet
Speed : 100 Mbps
Redundancy : Available
Changeover : The bus monitoring programs run in all the nodes detecting any failure and initiating smooth bumpless switchovers when required.

A standard windows tool is available to monitor the network traffic. It can be used to monitor the network load on various nodes. It detects and trouble shoots the problem occurring on the system bus. The network monitor tracks the network data stream, which consists of all the information, transferred over a network at any given time. Thus, percentage network utilization, data bytes transferred per second etc. are available.

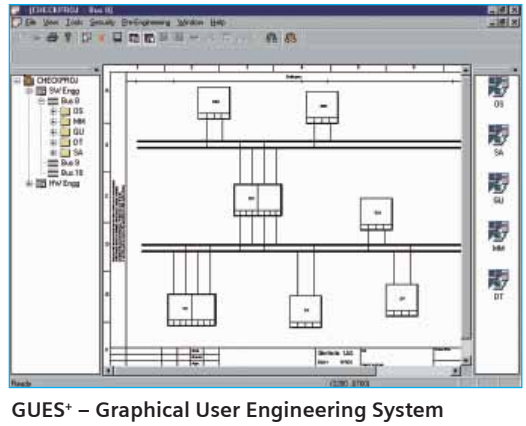
Interfaces

Communication with various external networks is supported by a number of features within SPPA-T1000, which include open interfaces to international standards.

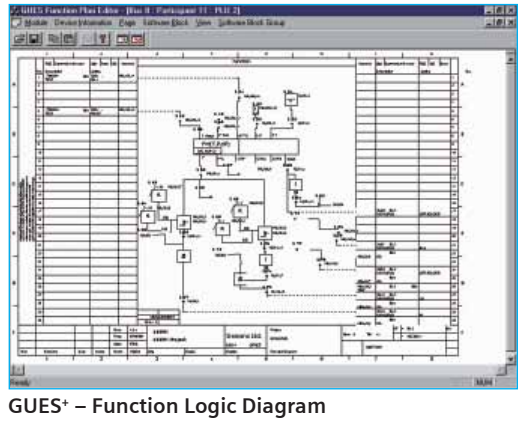
- OPC DA interface
- Serial gateways
- Radio/VSAT communication
- GSM mobile communication

GUES+ – Graphical User Engineering System

GUI based Engineering System (GUES+) is used for configuring the system as well as building process



GUES+ – Graphical User Engineering System



GUES+ – Function Logic Diagram

logics. It also integrates the entire hardware engineering of the I&C system.

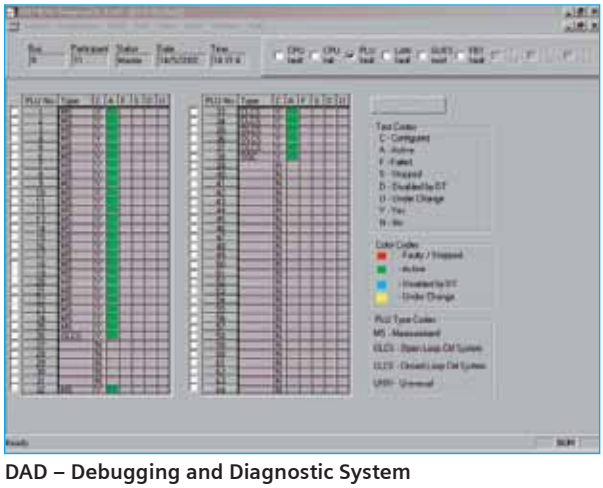
GUES+ is a multi-user window-based engineering and commissioning tool. It provides a comprehensive technology environment right from project planning to the commissioning of the plant and thereafter.

GUES+ offers extremely easy and flexible engineering through interactive GUI based graphics editor. It includes features such as generating graphical assembly of logic using standard and predefined set of symbols, resource management, signal exchange and automatic generation of software code.

GUES+ automatically generates reports such as cable schedules, loop diagrams, termination plans etc. once hardware connection drawings are built in it. By using simple and standard guidelines GUES+ ensures huge reductions in engineering times and perfection in quality documentation and commissioning. GUES+ can be used online such that modifications can be done at any stage with automatic and simultaneous updation of documentation.

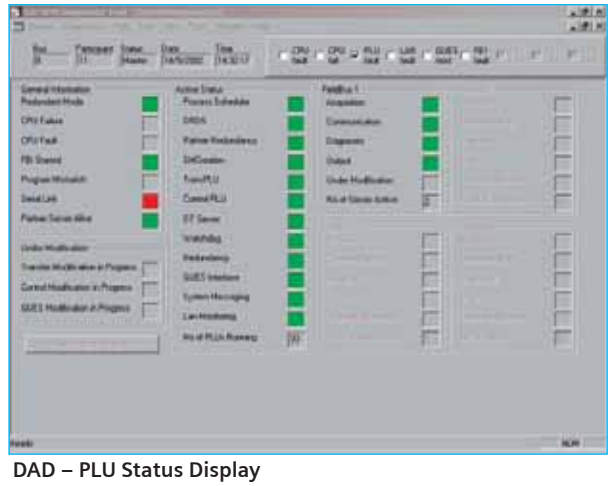
DAD – Debugging and Diagnostic System

User friendly, menu driven DAD system is available for diagnostic purposes. It provides both local as well as remote access.



DAD – Debugging and Diagnostic System

It is designed on hierarchical fault guidance principles enabling the user to locate the actual cause of fault in very short time. Different levels of access authorization are provided for security. User and supervisor logins are separate for control of critical operations.



DAD – PLU Status Display

The user can view process values, real time trends, logic and wiring diagrams, system status, field status etc. Manual simulation of process variables and operation is also possible. The user can also do system administration functions like PLU termination, PLU activation, viewing of system log file and LAN status using this tool.

Field Interface Module – FIM

These are interface units used for interfacing the field signals with Input/Output modules of the Control System. Each unit has a multi-channel, compact design and is dedicated to each I/O module. FIMs are suitable for universal mounting on DIN rails. Applications include:

- Providing protection against field faults.
- Fast traceability of field faults through LED indications.
- Independent power supplies for Field and I/O modules.
- Elimination of pin-to-pin wiring and to a

large extent, the pre-commissioning checks. Connection between the FIM and I/O module is through a prefab plug-in cable. This reduces Installation and Commissioning times.

- Possibility to interface higher voltage digital signals (e.g. 110V / 220V AC or DC) through optical isolation.
- Multiplication of field signals to achieve dual or triple redundancy.
- Conversion of non-standard temperature signals to industry standard 4-20mA signals.
- Capability to withstand surges up to 2KV.

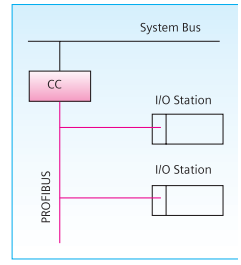
In summary, FIMs make the entire Control System very reliable and robust. Moreover, they simplify system packaging, reduce installation and commissioning times and ease trouble shooting and maintenance. At the same time, they help to make system configurations flexible and user-oriented.

Redundancy

SPPA-T1000 can be designed with a plannable redundancy of 0-100 %. The redundant configurations use the hot-standby principle.

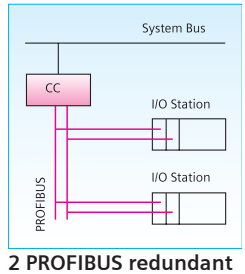
The redundancy is explained by the following examples:

Example 1 : It is the simple configuration with no redundancy at any level.



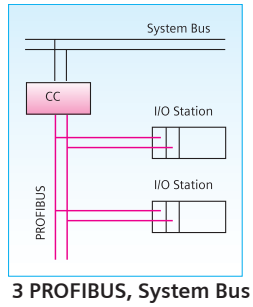
1 Non redundant system

Example 2 : It is the configuration in which PROFIBUS is redundant.



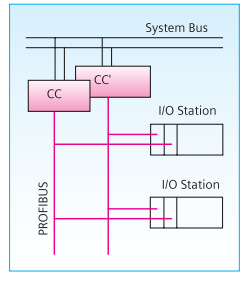
2 PROFIBUS redundant

Example 3 : It is the configuration in which the PROFIBUS and the system bus are redundant.



3 PROFIBUS, System Bus redundant

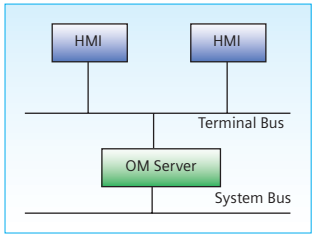
Example 4 : It is the configuration in which the redundancy is at all levels i.e. CC redundancy, PROFIBUS redundancy and the system bus redundancy. This is most frequently used in power plant controls.



4 Fully redundant

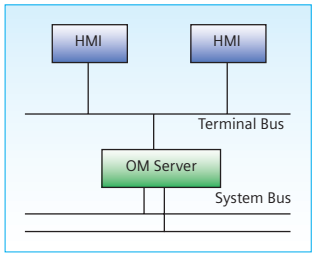
The SoftOM redundancy is explained as follows:

Example 1 : It is the simple configuration with no redundancy at any level.



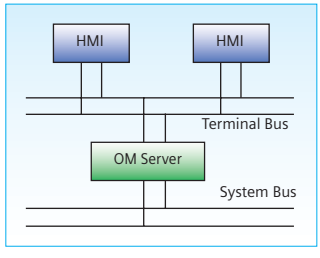
1 Non redundant

Example 2 : It is the configuration in which only system bus is redundant and terminal bus and OM server are non-redundant.



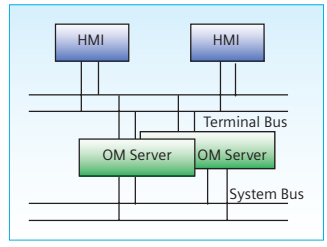
2 System Bus redundant

Example 3 : It is the configuration in which the system bus and the terminal bus are redundant but the OM server is non-redundant.



3 System Bus, Terminal Bus redundant

Example 4 : It is the configuration in which redundancy is at all levels i.e. terminal bus redundant, system bus redundant and OM server redundant.

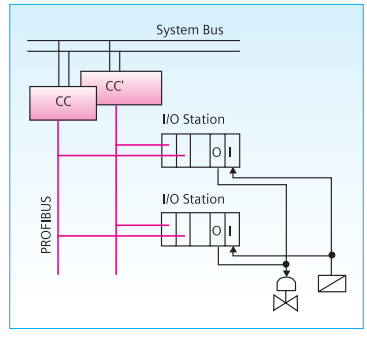


4 Fully redundant

Further, if the user desires, he has the option of selecting a configuration where the HMIs of the SoftOM are directly connected to the system bus, instead of the client-server architecture.

I/O redundancy class is explained as follows:

Apart from the above-mentioned redundancy examples, the user can choose the extent of redundancy required for Inputs/Outputs on a free scale of 0 to 100 %. An example of the I/O redundancy is shown below :



I/O redundancy

Total Service Concept

Timely and qualified service is among the most critical inputs for customers satisfaction. Siemens has therefore increased its emphasis in this vital area by creating a special service team dedicated to automation of power plants. This team provides round the clock accessibility to all customers.

Highly trained and experienced professionals address the customer's needs and problems. Depending upon the nature of problem, the service team provides either immediate solutions on phone/Fax/e-mail or deputes specialist to the plant in the shortest possible time. In addition, comprehensive remote service by actual viewing the complete plant on a monitor in the Siemens Service Centre (TELEGAZE) can be provided. The various services offered include :

- Solution on Hotline (Telephone/FAX/E-mail)
- TELEGAZE
- Annual maintenance contracts
- Service on demand
- Customer Training
- Compact Training Unit-SIWIZ

System salient features

- Fast and powerful Central Controller with local/remote I/O stations
- Plannable and flexible redundancy (0 100%) at all levels
- Universally accepted PROFIBUS for field communication
- Possibility of connectivity with smart field devices
- GUI based Engineering
- Fast Ethernet (100Mbps) bus
- Easy expandability
- Strong networking capabilities
- Powerful Field Interface Modules (FIMs) at I/O level.
- Universal hardware at OM level
- Obsolescence proof, seamless upgradation to future technologies
- Choice of OM operating system (Unix, Linux, Windows)
- Integral SOE with 1ms resolution
- Comprehensive remote service through TELEGAZE.

Customer benefits

Green Megawatts

SPPA-T1000 sets the benchmark in meeting the global concerns towards the environment improvement. The green manufacturing processes, use of energy efficient devices, trend towards paperless communication and engineering and a continuous drive to use environment friendly components are net contributors to a better environment. The use of sophisticated process control techniques ensures more efficient usage of primary fuels/natural resources and significant reduction in discharge levels of toxic pollutants to the atmosphere and water basins.
SPPA-T1000 is a major value added contributor to our customer's strive in ensuring a better environment as a global citizen.

Uniformity of hardware & software

SPPA-T1000 provides a single window comprehensive solution to the total automation needs of the plant. The customer is thereby able to save costs related to coordination and interfacing among many suppliers. Economy also results through the elimination of gateway interfaces and the need to match different protocols. Therefore, uniform systems based on common hardware and software platforms not only ensure that initial investments are lower but also ensures that the recurring costs related to logistics, software, documentation, spares inventory and training are kept to the bare minimum.

Secure investments

SPPA-T1000 ensures that the investments on a Distributed Control System are secured against obsolescence of both hardware and software. The system can be seamlessly integrated into future technologies without the necessity of any major revamp.

By using open and universal protocols, the system has the inherent capability to absorb and adapt to the latest concepts in both control and information technologies.

Energy savings

The use of software based technologies, optimized and innovative process control concepts, advanced and complex algorithms as well as on-line simulation through mathematical models ensure that the process is regulated within very strict tolerances. The resultant benefits are increased efficiency, fuel savings, rapid yet safe ramp-ups & downs and a seamless co-ordination with the grid.

Availability & safety

SPPA-T1000 incorporates an all embracing concept to ensure a very high degree of availability and safety. The availability and safety of the system are attributable to a very high degree of distribution, plannable redundancy, latest yet proven information technologies, very fast reaction times, unique isolation and earthing concepts, reliable and decentralized power supplies, extensive diagnostics, comprehensive fault guidance and active noise suppression networks. These features and measures ensure long and trouble free plant operation. They also lead to very low downtimes of the plant with practically no outages.

Low wear

SPPA-T1000 incorporates fast cycle times for measurement, control, interlocks, safety and protection trips. The safety check routines are accorded the highest priority over other functions. Thereby equipment damages and consequential maintenance/repair costs and plant outages are minimized. The result : Longer and trouble-free equipment life ensuring continuous economic savings.

Engineering comfort

The use of latest IT tools in the engineering process provides both flexibility and accuracy. The facilities of the automatic code generation and forward documentation ensure quality and error-free documentation, which is always at the updated i.e. “As- built” status. The customer does not need to keep documentation in paper form any longer.

Space savings

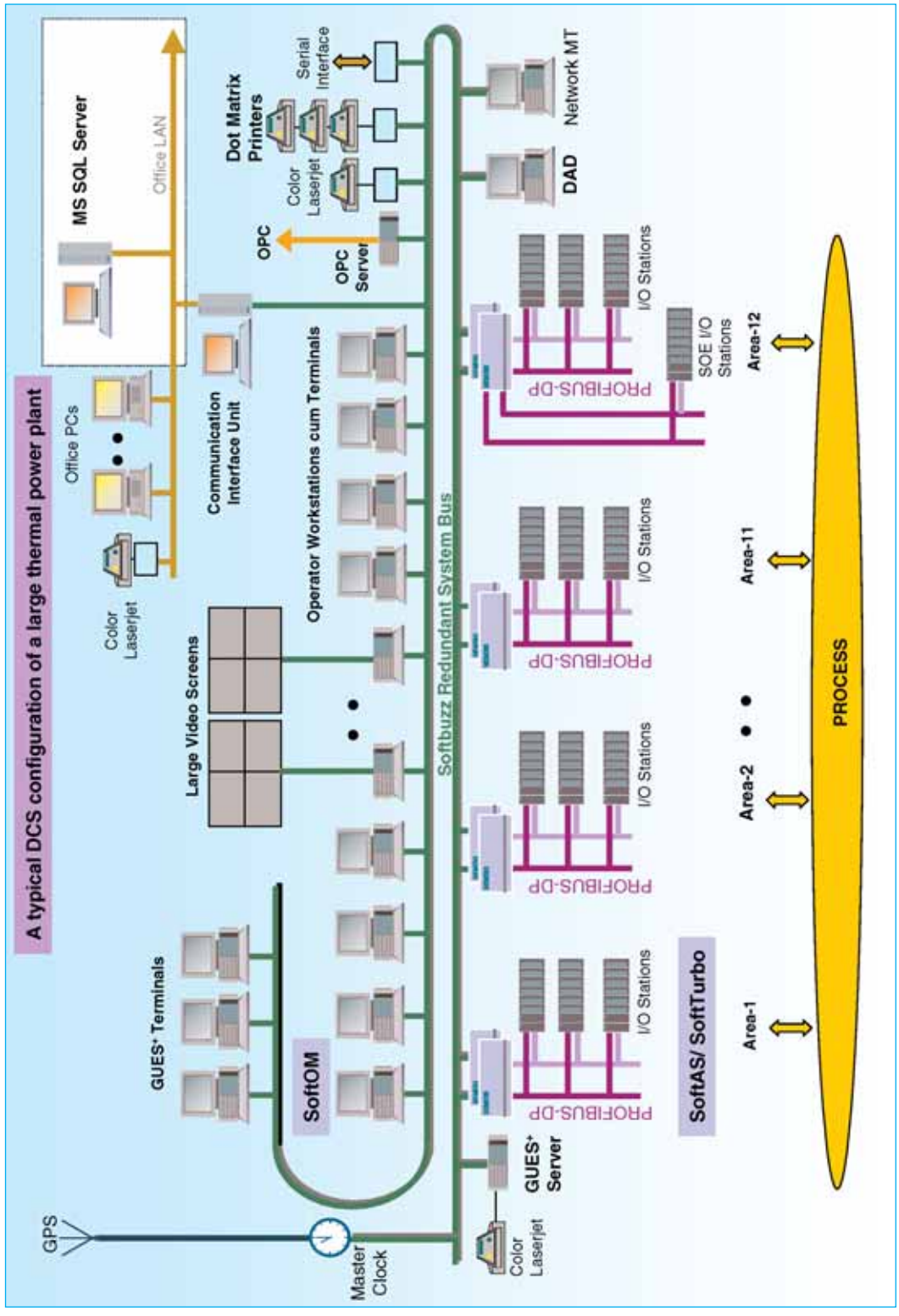
SPPA-T1000 is equipped with features which make optimum and efficient use of the system internal resources. Specific embedded software utilities allow increase in capacity utilization without the need of increasing the hardware. Moreover, a judicious mix of geographical and functional distribution leads to direct space savings in the climate-controlled rooms as well as a reduction of input power requirements. Paperless documentation results in further saving of storage spaces.

Excellent Service (24x7)

The Total Service Concept of SPPA-T1000 ensures that trained and qualified service is always available to Siemens customers locally and round the clock every day of the year. Powerful features such as the 24x7 hotline and ‘TELEGAZE’ enable rapid expert intervention such that any unforeseen problem can be solved expeditiously. The Service Hotline can also be used to obtain information on latest upgrades and features.

SPPA-T1000 is thereby provided with a vast array of unique features which translate into tangible customer benefits. These features ensure that the payback period of SPPA-T1000 is much shorter than any other concurrent distributed control system.

Typical system configuration



SPPA-T1000 System Configuration