

PC-10 Process Control System

Semiconductor Productivity Network

Technical Data

The PC-10 Process Control System is one of a series of integrated application software products which provide a solution for the manufacturing, administration, and marketing information needs of semiconductor producers. Together these software packages form the HP Semiconductor Productivity Network (SPN), Figure 1. PC-10 resides in a network consisting of both an HP 3000 system and one or more HP 1000 systems.

The major function of PC-10 is to provide a host process control computer which interfaces intelligent semiconductor processing equipment to the SPN. It does this by conforming to the SEMI Equipment Communication Standard (SECS). By intelligent equipment we mean equipment with a built-in microprocessor or minicomputer. PC-10 is designed to connect with processing equipment (such as diffusion furnaces and epi reactors) and metrology instruments (such as film thickness and line width measurement systems).

PC-10 integrates four categories of features into the SPN.

- Equipment Supervision
- Equipment Monitoring
- Enhanced Lot Tracking
- Documentation Management

Equipment supervision

Recipe Downloading Integrated With IC-10's Lot Tracking

Recipes consisting of both equipment recipe steps and operator instructions can be downloaded from PC-10 to intelligent equipment and operator terminals, respectively. Downloading of the correct recipe steps to the proper piece of equipment occurs automatically at a user-specified point

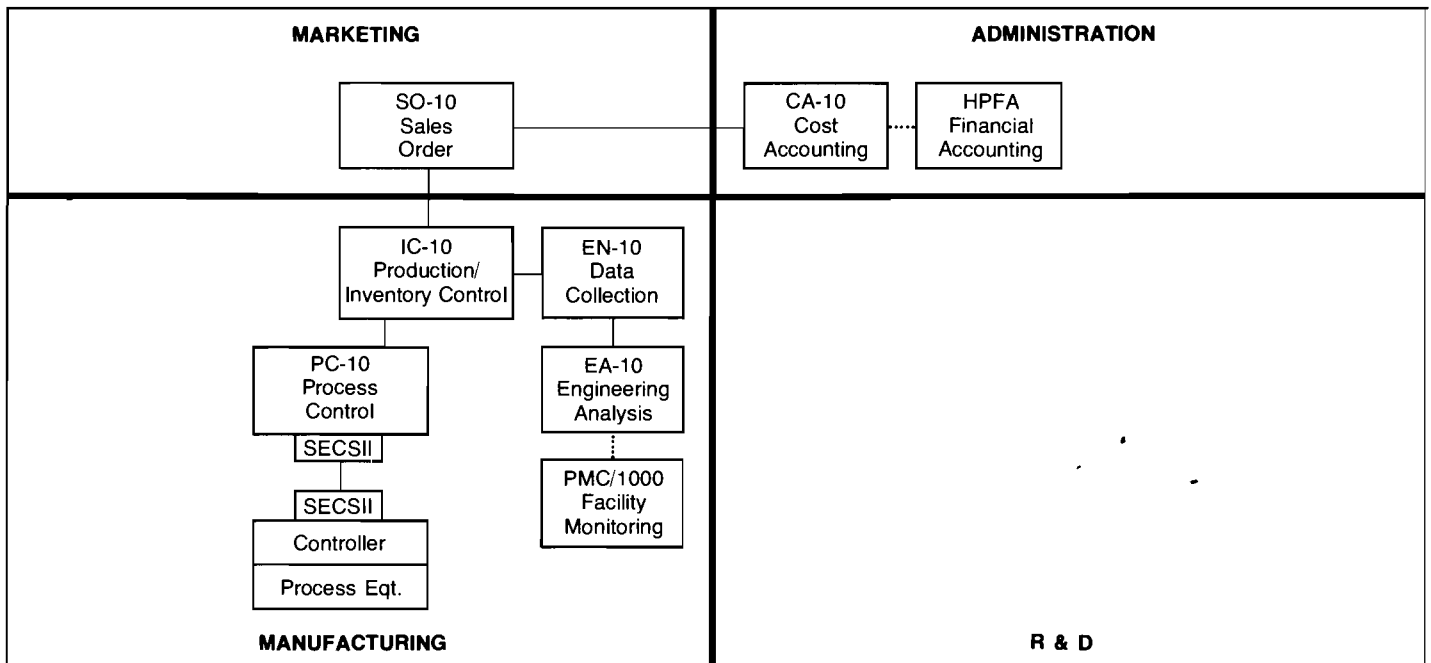


Figure 1. Semiconductor Productivity Network (SPN)

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in the overall recipe. The correct operator instructions are sent automatically to the operator's terminal once a lot is tracked into or out of an operation.

- Improves process repeatability by eliminating use of incorrect recipes.
- Insures that steps are not skipped.
- Eliminates time-consuming, error-generating retyping of recipes into equipment. This retyping is frequently necessary when power failures cause equipment to go down.
- Permits running large numbers of recipes, even when microprocessor-controlled equipment has limited memory.
- Revision capability insures that latest revision of recipe is used, thereby improving process repeatability.
- Saves time needed to manually key in recipe names or to load in floppy discs containing recipes.

Uploading of Equipment Recipe Steps Integrated With IC-10's Lot Tracking

Equipment recipe steps developed using equipment recipe editors can be uploaded to PC-10 and incorporated as part of an overall recipe.

- Allows use of equipment recipe editors with which users are already familiar.
- No need to recreate equipment recipe steps which have already been developed on equipment recipe editors and which are currently in use.

Equipment Enable/Disable

Equipment can be logically turned off or on, regardless of whether it actually (physically) runs. By disabling equipment, you inform PC-10 that the equipment is not to be used for processing. If an operator attempted to use the equipment, PC-10 would not download the recipe and would present an error message to the operator.

- Prevents operators from erroneously using equipment on hold.
- No need for engineers to write notes or tell all operators about engineering holds.

Remote Equipment Control

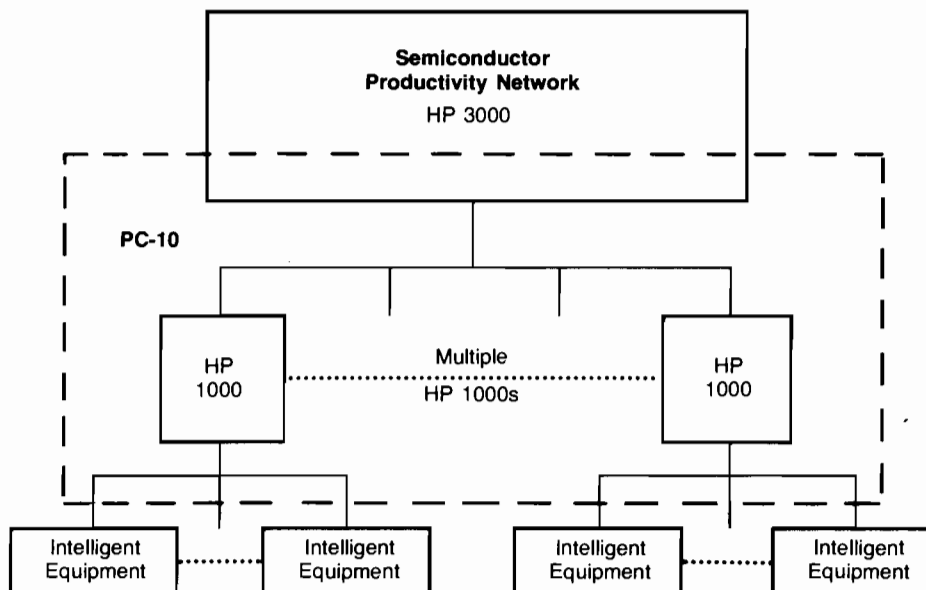
Any equipment function the equipment controller can perform in a stand-alone mode can be performed from PC-10. (This assumes that equipment vendors support the appropriate SECS streams and functions.)

- Technicians can perform preventative maintenance or troubleshoot equipment from service areas without entering clean rooms. This reduces particle contamination and saves technicians' time.

Equipment Calibration

Equipment calibration tables (such as tables converting thermocouple millivolts to temperature in degrees Centigrade) can be stored and retrieved.

- Equipment can be recalibrated without re-editing recipes. (Due to equipment drift, periodic recalibration of sensors and other equipment components is necessary. For example, the number of millivolts read from a thermocouple at 1000 degrees Centigrade may vary over time. Recalibration would be required to keep the temperature constant.)
- Recipes can be written in engineering terms (such as degrees Centigrade), rather than in machine terms (such as millivolts).



PC-10 – Foundation for the Automated Fab of the Future

Equipment monitoring

Equipment Alarms

Equipment alarms are automatically stored in the equipment history data base.

- Allows capture of data which would be very difficult to key in manually.

Equipment History Reporting

PC-10 lists all activities, including equipment alarms, that occurred at user-specified pieces of equipment within a user-specified time period.

- Helps engineers to analyze process problems and identify potential root causes.
- When power failures cause equipment to go down, users know exactly where in the recipe processing should be restarted. Thus, there is no need to guess how far along the material progressed.
- Allows quick, accurate determination of how many lots are affected by specific process problems.

On-Line Equipment Status

On-line equipment status, showing whether a process is in use and how well it is running, is taken from the equipment controller and displayed unchanged by PC-10.

- Offers engineers their own "personal window" into the fab. They are able to monitor processes more frequently and completely, and thus identify problems faster.

Enhanced lot tracking

In addition to applications where equipment is interfaced directly to PC-10, these enhanced lot tracking features can be used for operations involving equipment not interfaced to the software.

Operation-Level Lot Tracking

In addition to the **location level** lot tracking (i.e., oxidation, first mask, etch, etc.) provided by the IC-10 Integrated Circuit Manufacturing Information System, PC-10 offers **operation level** lot tracking (i.e., spin, bake, align, etc.).

- Allows the flexibility of choosing summarized reports at the location level and/or detailed reports at the operation level.
- Helps management identify production bottlenecks. Users can spend their time solving problems rather than locating them.
- Prevents out-of-sequence processing of lots.
- Allows yields to be analyzed at the lowest possible level (the operation), rather than at one level higher (the location).
- Allows collection of operator and machine IDs at operation level.

Two-Step Move

Users can differentiate between lots actually being processed and lots in queue.

- Users can determine where queues and cycle times can be reduced.

On-Line Queue Reporting

Given a specific piece of equipment, lots available for processing are listed by **a)** priority (from 0 to 9), **b)** due date, and **c)** lot number. Given a specific lot, pieces of equipment available for processing are listed.

- Operators can choose the highest priority lots to work on from all lots in queue.
- Operators can determine all equipment on which a given lot can be processed.

Documentation management

In addition to applications where equipment is interfaced directly to PC-10, these documentation management features can be used for operations involving equipment not interfaced to the software.

On-Line Operator Instructions and Process Routings Are Integrated With IC-10's Lot Tracking

- Improves process repeatability by insuring that correct routing is followed.
- Improves process repeatability by insuring that correct instructions are downloaded with the routing step.
- Reduces need for paper in fab, thereby reducing particle contamination.

On-Line Recipe Editor For Operator Instructions

This line-by-line editor allows engineers to add, delete, modify, and create operator instructions. These instructions can appear automatically (at track IN or track OUT) or upon operator request only. For each equipment recipe, up to 9,999 lines are allowed for the recipe steps and operator instructions.

- Even long and complex instructions can be stored and downloaded.
- Recent changes or additions to operator instructions can be "starred," allowing operators to easily spot them.

Product specifications

Interface With IC-10 Integrated Circuit Manufacturing Information System and EN-10 Engineering Data Collection System

The PC-10 software running on the HP 3000 shares parameter and production data bases with the IC-10 Integrated Circuit Manufacturing Information System and the EN-10 Engineering Data Collection System.

Interfaces With Intelligent Equipment

PC-10 conforms to a subset of the SEMI Equipment Communication Standard, Parts 1 and 2 (known as SECS I and SECS II, respectively). SECS I defines the hand shaking and message protocol used between the intelligent

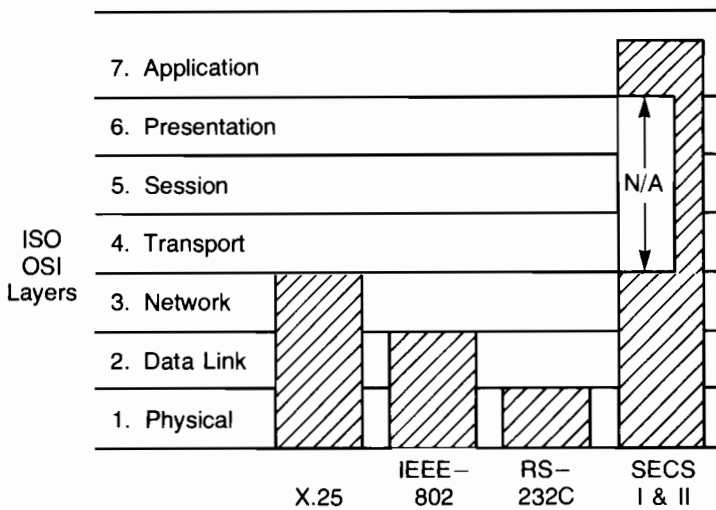


Figure 2. Communication Standards for Factories

equipment and the host computer. SECS II defines the form and meaning of data exchanged on SECS I lines between the host computer and the intelligent equipment.

The Open Systems Interconnection (OSI) model of the International Standards Organization (ISO) states that for any two processors to communicate effectively, seven layers of hardware and software must be implemented on both processors. Figure 2 shows that SECS I and II cover virtually all of these layers. Only a small amount of equipment-specific code must be developed to allow a "turnkey" connection. HP has developed and will sell and support the equipment-specific code required to interface PC-10 with intelligent equipment from two major vendors. HP was able to do this after certifying that the vendors' equipment incorporates SECS I and II. With these interfaces, customers will not have to develop any additional code to interface PC-10 with the specified equipment. Specifically, these software interfaces are available for:

- **Thermco TMX-9001 Diffusion Furnace System, and the Combination of the Thermco TMX-9010 Diffusion Furnace System and Thermco Master Mux Controller (TMMC)** from Thermco Products Corporation, Orange, California.
- **Tylan Tycom 9900 Diffusion Furnace Control System,** software Model 6, from Tylan Corporation, Carson, California.

These software interfaces, along with HP's implementation of SECS I and II, will reside on the HP 1000.

In addition, HP is working with other major equipment vendors to certify incorporation of SECS I and II and to provide similar software equipment interfaces.

Internal Operation of PC-10

Programming languages are high level (Pascal on the HP 1000 and COBOL on the HP 3000). Two data bases on the HP 3000 are managed using Image/3000: the IC-10/EN-10/PC-10 parametric data base and the IC-10/EN-10/PC-10 production data base. Two data bases on the HP 1000 are managed by Image/1000: the parametric data base (a subset of the HP 3000 parametric data base) and the production data base, which is station-oriented, rather than lot-oriented. Inter-CPU communication is implemented using DS/1000-3000.

System requirements

HP 3000

The minimum configuration required for the HP 3000 is as follows:

- HP 3000 with Fundamental Operating Software (FOS), including Image/3000.
- IC-10 Integrated Circuit Manufacturing Information System (33900A).
- TD-10 Transaction and Display Processor (33902A).
- Two megabytes of memory. (This includes what is required for IC-10 and TD-10.)
- Two 7925M 120 Megabyte Disc Drives or one 7935H 404 Megabyte Disc Drive. (This includes what is required for IC-10 and TD-10.)
- Two 30020B Intelligent Network Processors (INPs), one for connection to one HP 1000 and one for remote dial-up support.
- One 2635B 180 cps Printing Terminal for use as system console.
- One 2608A 400 lpm Printer.
- One 7970E 1600 bpi/45 ips Magnetic Tape Subsystem.
- 32190A DSN/DS Distributed Systems Software.

In addition, the EN-10 Engineering Data Collection System (33903A) is recommended.

For specific customer applications, an appropriate HP 3000 configuration will be recommended by an HP Manufacturing Application Specialist.

HP 1000

The following HP 1000 models will support PC-10:

- HP 1000 A600
- HP 1000 A700
- HP 1000 A900

The minimum HP 1000 configuration is as follows:

- HP 1000 A600.
- One megabyte of memory.
- One 7912P 65.6 Megabyte Disc Drive.
- One 2622A Display Terminal for use as system console.
- One 12040B 8-channel Asynchronous Multiplexer with Connector Panel.
- One 12082A DS/1000-IV BISYNC Direct Connect Interface to HP 3000.
- 91750A DS/1000-IV Software.
- 92069A Image/1000 Data Base Management System.
- 93697H SECS I Firmware.

In addition, one 2631B 180 cps Printer is recommended.

For specific customer applications, an appropriate HP 1000 configuration will be recommended by an HP Manufacturing Application Specialist.

Ordering information

Application Software Products

The PC-10 Process Control System consists of the following five application software products:

- 33920A PC-10 Software running on the HP 3000 providing operation-level lot tracking and documentation management.
- 33921A PC-10 Software running on the HP 3000 providing equipment supervision and monitoring.
- 33922A PC-10 Software running on the HP 1000 providing equipment supervision and monitoring.
- 33923A PC-10 Interface for Thermco TMX-9001 Diffusion Furnace System, and for the combination of Thermco TMX-9010 Diffusion Furnace System and Thermco Master Mux Controller (TMMC). This interface runs on the HP 1000.
- 33925A PC-10 Interface for Tylan Tycom 9900 Diffusion Process Control System, software Model 6. This interface runs on the HP 1000.

Customers requiring only operation-level lot tracking and documentation management may order the 33920A product only, once the HP 3000 system requirements have been met.

Customers requiring equipment supervision and monitoring as well as operation-level lot tracking and documentation management must order the 33920A, 33921A, 33922A, and either the 33923A or 33925A.

Documentation

Each Hewlett-Packard SPN system includes two sets of documentation for reference and training purposes. All documentation is periodically updated to reflect software enhancements. The PC-10 Process Control System includes the following manuals:

- PC-10 User Manual
- PC-10 Operations Manual

Implementation Assistance

HP provides a number of consulting services including analysis, planning, and training to assist customers in implementing PC-10. A local HP Sales Representative or Manufacturing Application Specialist can discuss these services in detail.

Software Support Services

To help ensure a customer's success with PC-10 after installation, Hewlett-Packard provides a variety of standard support services. These HP software services can be discussed in detail with a local HP Sales Representative or Manufacturing Applications Specialist.

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