



Bruce Technologies Inc.

18 Esquire Road, North Billerica, MA 01862

APEX (UNIX) PROCESS MANAGEMENT SYSTEM

PRODUCT DESCRIPTION VERSION 2 MARCH 2002

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DESCRIPTION

APEX is a diffusion furnace, process management system, which supports the Bruce Technologies's (BRUCE) family of controllers. It provides the necessary tools for all aspects of both process and equipment management. APEX is based on workstations running the powerful UNIX operating system, distributed via a local area network. It incorporates the sophisticated data analysis tools required by the engineering community, while utilizing a very simple user interface that is required by the production personnel.

The APEX family of products is segmented into a series of compatible software applications. Each application is designed to provide varying degrees of functionality which includes furnace process monitoring, engineering analysis tools, furnace automation control and statistical process control.

APEX SYSTEM ARCHITECTURE

APEX is based on workstations distributed via a local or factory network. The system has three basic building blocks which are:

Workstation: The Workstation which is the basic building block of the APEX system. It combines the display node features and communications to BRUCE controllers. It is a user interface that allows information retrieval from the furnace controllers it is directly

communicating with or any others on a network.

Multiplexor: The multiplexer is the required link to allow communications from the furnaces to the Workstation. BRUCE utilizes both SCSI terminal multiplexers (local to the node) and Etherlite Terminal Servers (local to the furnace) to achieve this function.

X-Term: 'X' Terminal display used as an additional method for graphical display/interface to the APEX system.

The workstations may be connected on an ethernet network. There is virtually no practical limit to the number of workstations and X-terminals which can be connected to the network.

USER INTERFACE

The APEX User Interface is simple to use, reduces errors and assures data security, while allowing for maximum flexibility and consistency across the APEX family. On-screen "buttons" and a pointing device, provides easy transition from screen to screen (i.e. function to function). The keyboard is used to enter alpha/numeric values.

A privilege scheme for all commands has been implemented for the security of data and function. On-line help is available from every screen at any time by selecting the designated "button" labeled "HELP". From an APEX display station anywhere on the network, the privileged user has full access to all furnace tube controllers. This access includes real time status and the many other functions as described below.

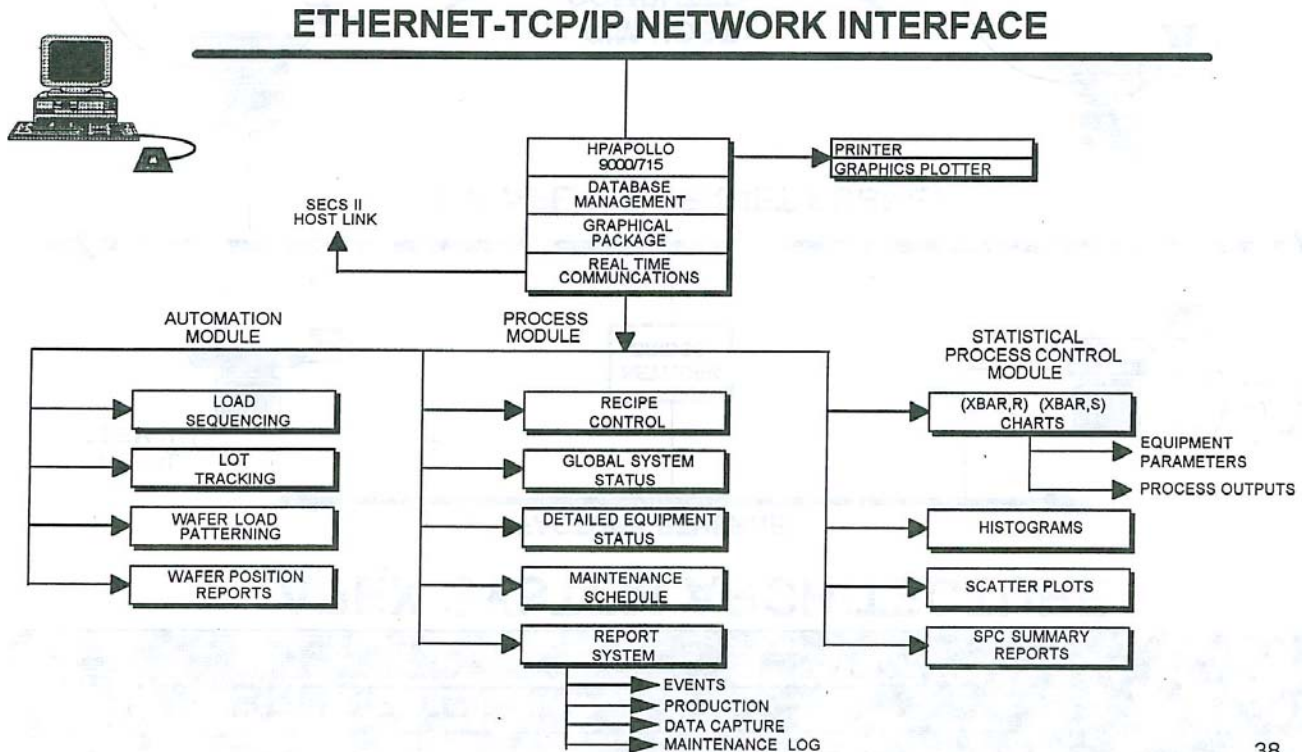




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APEX FEATURES

Real Time Data Monitoring

APEX provides real time access to furnace data which is displayed in both graphical and tabular format. This data is organized hierarchically starting with a system overview, continuing with subsequent levels that show more detailed process data. A description of these features is outlined below.

Systems Status Summary

The System Status Summary displays the current activity of all individual furnaces included in the network. The information includes: Machine name, description, cycle state summary (in cycle, idle,...); Alarm/Alert status, Recipe number, and estimated time of recipe completion. From this page, the user can easily select any tube controller for more detailed information about that tube.

Tube Status Display

The Tube Status Display shows what is currently happening at an individual tube. By dividing the screen into windows, diverse information is presented simultaneously. Overall the screen is split into six (6) sections: One for an overview of the tube and process, one for monitoring of the wafer position, and the remaining four (4) can be selected by a privileged user or pre-established for certain users (i.e., operators). Therefore, the status display can be tailored for each individual user's needs.

Window selection is noted in memory when exiting and redisplayed when that user invokes the Tube Status Display again. The following are the Tube Status Display window selections:





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- Process Status
- Temperature Setpoints vs. Actuals (graphic)
- Temperature Deviations (graphics)
- Temperature Detail (tabular)
- Gas Deviations (graphic)
- Gas Status Detail (tabular)
- Programmable Output Status
- Module Status (diagnostic data)
- Tube Load Status
- Alarm and Alert Summary
- Remote Tube Commands (detailed below)
- Maintenance Status

By selecting the "History Plot" button, the user can review the current status in a graphical format. Temperature, gas and boatloader data is displayed, in real time, in a format resembling an electronic strip chart recorder. Selected variables can be displayed and the real time base can be varied with the zoom function.

In addition, extensive alert/alarm information and the active process tube controller information can be reviewed.

REMOTE TUBE COMMANDS

APEX allows users to execute tube commands remotely (i.e., from any APEX display terminal anywhere on the network) if they have the necessary privileges. To execute a command, a two stage commit is required to invoke the command. APEX offers the following remote commands:

- Start or abort a furnace process
- Hold the current process or release the hold
- Acknowledge an alarm
- Turn the horn off
- Continue a process
- Upload of dependent recipe data
- Start processing and tracking lots entered into system

Each time a remote command is executed it is logged into the "event log". This "event" can

then be selectively retrieved to reconstruct a sequence of events.

RECIPE DOWNLOAD

Recipe Downloading transfers a recipe from the APEX system to the tube controller. Validation is performed by the APEX system prior to downloading the recipe in order to check: compatibility, tube (or recipe) restrictions and need for variable interval time and availability of the tube controller.

FURNACE RECIPE MANAGEMENT

Furnace recipes contain all of the steps necessary for the furnace controller to perform an operation. This information includes interval definitions (i.e., length of time for a ramp, soak, etc.), temperature and gas setpoints, programmable functions, alarm/alert limits and controlling parameters. APEX presents this data using both tabular and graphic displays. APEX can store up to 9999 recipes for each of the 26 libraries (each letter of the alphabet denotes a new library)

Recipe Editor and Directory

The editor allows creation of new recipes and modification of old ones. All recipe data and controlling parameters are available for edit; that is, if it can be created or changed at the tube controller, it can be edited at the APEX Workstation. A function to copy a dependent or independent recipe part is also provided. APEX uses windowing to present multiple tables on one screen, reducing recipe programming time. Interval and setpoint groups may be named in order to document the recipe in more detail. Comments may be associated with each recipe which can serve as an on-line engineering notebook. APEX also records the time, date and person responsible for edit changes of the recipe. The function of deleting recipes is also available.

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APEX provides the ability to review a recipe. This allows access to a recipe without being able to change it, preventing unauthorized personnel from accidentally altering its contents. Recipes can be reviewed on a display station or sent to a printer for creation of hard copy printouts

A directory of all recipes can be obtained for review. Recipes may be stored in various libraries as defined by the user. The recipe directory may be sorted for review by many criteria.

Data Capture Definition and Reporting

Data Capture collects data from a furnace tube during a recipe run, including temperature, gas and boatloader information. APEX either collects data during a designated interval or initiates collection on the occurrence of specified alerts and alarms. APEX also maintains historical data prior to that specified event. Data Capture parameters are pre-defined for each recipe. APEX offers the flexibility of having numerous levels of data capture for a single recipe. Each level is defined to collect varying amounts and/or types of data. These levels are user defined and selected at the time of recipe execution.

Reports may be generated for each Data Capture session. The user can selectively search and view all data collected for a particular furnace run, which can be displayed either in tabular or graphical form. Once the desired screen has been configured, a hard copy report can be created from a printer.

LOAD CONTROL

A collection of one or more "lots" of wafers can be "batched" together for processing at the furnace. "Load Control" is the APEX function

used for introducing these materials to the furnace system.

The furnace processes "lots" in "batches", henceforth, referred to as "**LOADS**". For convenience a unique identifier, called a "**LOAD ID**", is assigned to each furnace run and its associated **LOTS** (if any). Normally this **LOAD ID** is assigned by the APEX system every time a run is initiated. (The **LOAD ID** generated by the controller is supported for the locally created load.)

Load functions give the operator ability to:

- Enter all information pertaining to a new load in the absence of a host system;
- Edit information regarding to the existing load;
- Initiate processing of the load.

Before the operator initiates processing of the load he/she reviews the **LOAD** information and enters the furnace data capture type and recipe name. Machine availability and proper quartz pattern (if required) are verified. This operation should be performed when the **LOT**'s are ready for arrival into the furnace complex. Though this condition is not necessary, it provides a logical flow for the operator and avoids confusion. Finally, a command is issued to start processing and a load can then be processed through the furnace complex without further interaction with the operator.

LOAD STATUS REPORTING

Available at an APEX terminal, is an overview of the loads in the furnace. This information conveniently summarizes the activity of the furnace and automation system. Additional information, if required, is available at the controller front panel.





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POSITION OF THE WAFERS (Automated Furnace Systems)

A detailed report of the position of each wafer in plastic carrier as well as position in the quartz for each load is available from the APEX report system, for loads configured with this detail. This report will give the process engineer an ability to establish a correlation between production and test wafers.

QUARTZ EDITOR (Automated Furnace Systems)

Part of the powerful user interface tools provided with the APEX product, is the wafer load pattern editor. It allows graphical and text editing of wafer patterns. The user is able to set up libraries of quartz patterns, currently performed with furnace recipes, that are utilized by the controllers for loading the quartz boats prior to the furnace process.

The **QUARTZ PATTERN** determines the type of wafer which occupy the various positions (slots) in the quartz carrier. Possible types are:

- Production
- Test
- Baffle
- Space

FURNACE PROCESS DATA MANAGEMENT

Machine Management provides configuration definition and historic information for each defined furnace tube.

Machine Configuration

Machine definition and its configuration parameters include: Machine name, description (i.e., gate ox, nitride, etc.); Gas description; Alarm input description and Programmable output description. These parameters are reflected at the APEX Workstation.

Maintenance Scheduling

Preventative Maintenance is available for each process tube. Maintenance tasks can be scheduled on a per tube basis or days between maintenance. For each scheduled task a warning limit and a disable limit may be defined. The system status display indicates the maintenance status of each tube. In addition to the scheduled maintenance, unscheduled maintenance tasks performed can be logged into the system for tracking. An on-line notebook function is available for each furnace tube and can be generated showing scheduled and unscheduled tasks, actual down time and the maintenance technician who performed the work.

Event Logging and Routing

When a significant action occurs at the local furnace controller, it is known as an "event" to the APEX system. These events include such actions as recipe starts, completes, aborts as well as alarms and alerts. The user may selectively view a compiled list of event occurrences for any furnace tube at any time, by specifying search criteria including Recipe, Date Range, Tube ID, Lot ID and Load ID.

PRODUCTION TRACKING AND REPORTS

APEX can produce production reports for each furnace step performed. Each time a furnace load is prepared, the lot ID's, the process recipe and the data capture specification can be grouped into a "load" page. Once this is done, the system will assign a unique "Load ID". As the load is processed all significant events are logged and made available for production reports. Production reports can be generated based upon load ID's (collection of Lot ID's), Lot ID's, furnace tube, process recipe of data range. The associated data capture reports are also easily retrieved.





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SYSTEM MANAGEMENT UTILITIES

Many features to assist in managing the APEX system are provided. Included utilities are:

- Automatic data backlog
- System error logging
- Data archival/restoration
- Error recovery procedures
- Mail utility
- General operating system utilities provided by the UNIX based APEX
- Relational data base utilities

HARDWARE PLATFORM

The APEX Process Management Systems operates on the Hewlett Packard B Class workstations. A typical workstation configuration would include:

- PA-RISC Processor
- 512MB memory
- 19" 1600 X 1200 Color Display
- Two, 18GB Hard Drives
- DDS3 DAT Drive Tape Backup (External)
- Ethernet Interface

An HP 4550 Laser color printer can be used for hard copy reports.

NOTE: The components described are the basic building blocks of the hardware system. The actual components and their configuration are based upon system requirements such as number of tubes supported, location of equipment and number of user display stations.

TYPICAL B CLASS WORKSTATION DATA

HARDWARE

Central Processor	PA-RISC 8600
Clock Frequency	500 MHZ
Memory	256- 2GB RAM
I/O Ports	(1) Ultra SCSI WSE, (2)RS232, (1) Parallel Port
Keyboard	HP-USB, 3 Button Mouse

COLORS DISPLAYS

Display	19"/18.3" Viewable, Visually Flat
Resolution	Up To 1600x1200

MASS STORAGE

Internal Drive	Two (2), 18GB LVD SCSI 10K RPM Disk, Low Profile
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REMOVABLE MEDIA

Digital Audio Tape Drive	One (1), External DDS3 DAT
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NETWORK OPTIONS

Ethernet	IEEE 802.3
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PHYSICAL DIMENSIONS AND WEIGHTS

CPU Electronics Unit	(12.71cm)H, (40.64cm)W, (45.69cm)D
19 inch Color Monitor	(471mm)H, (470mm)W, (464mm)D

OPERATING ENVIRONMENT

Temperature	5°C to 35°C
Humidity	15% to 80%, non-condensing

