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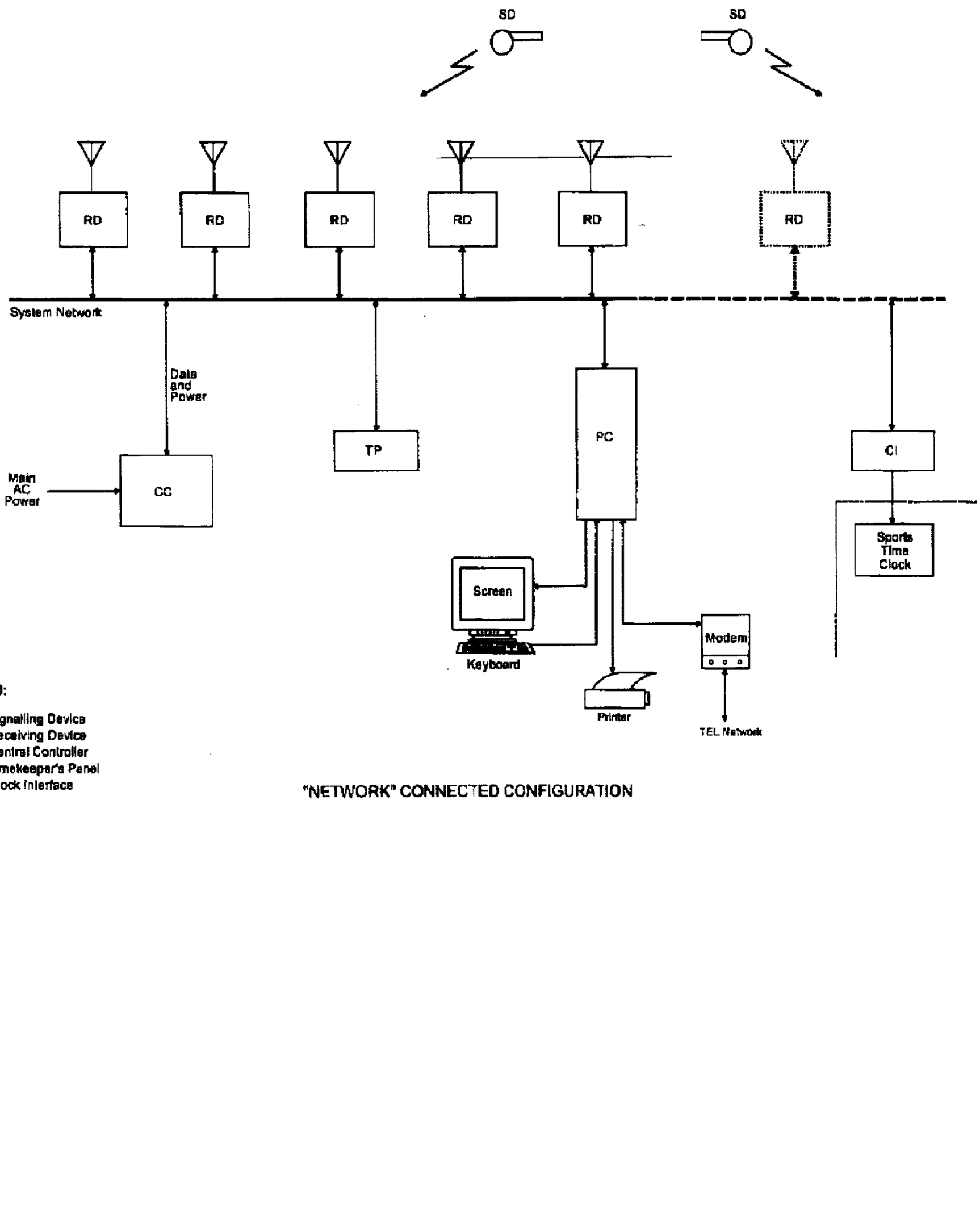
(54) **SYSTEME DE COMPTABILISATION DU TEMPS DANS DES ACTIVITES SPORTIVES**

(54) **SPORTS TIMEKEEPING SYSTEM**



"NETWORK" CONNECTED CONFIGURATION

SPORTS TIMEKEEPING SYSTEM

Signaling Device(s)

- whistle
- detector
- processor/controller
- data modulator
- radio transmitter
- antenna
- power source

Receiving Device(s)

- antenna
- radio receiver
- level detector
- data demodulator
- processor/controller
- communication controller
- power system regulator

Central Controller

- processor/controller
- communication controller
- external device communication interfaces
  - timeclock interface
  - timekeeper panel
  - computer
  - electronic whistle generator
- system power supply

System Configuration and Monitoring Computer

conventional PC

application software

communication controller

serial data link

Timekeeper Panel

processor/controller

timing display

system adjustment controls

communication controller

Electronic Whistle Generator

processor/controller

digital sound generator

ambient sensitive level control

PA system interface

communication controller

SYSTEM DESCRIPTION

The system consists of one or more self-contained portable signaling devices, each capable of causing radio transmissions to be sent for reliable interception by one or more radio receivers which in turn signal a central controller of events to occur on demand, such as stopping and starting a sports timeclock or display of appropriate timing information and other optional ancillary devices. The non portable devices of the system are interconnected as appropriate with a wired or wireless signaling or communication network so as to facilitate the exchange of commands or information among the individual devices for the proper execution of the system functions.

The interchange of data among the devices is orchestrated by a central controller which is the nerve center of the system. The various devices may be interconnected with that controller by means of a direct wired method or by means of a networked method, as appropriate for the particular installation. The networked method may take the form of a cabled network or wireless network. In certain cases a combination of direct wired, cabled network and wireless network may be employed.

The system may include ancillary devices such as local interactive controls and timing displays for the timekeeper, a variable level simulated electronic whistle for connection through a PA system, a PC with appropriate application software for the local or remote configuration, monitoring, recording, analyzing, communication and printing of game statistics and general proper operation of the whole system, and a suitable local area network for interconnecting the various devices.

DESCRIPTION OF SYSTEM COMPONENTS

The Signaling Device is a small, self-contained, physical integration of a conventional whistle as usually carried by a referee, and electronic circuitry consisting of a sensor to determine that a signalable event has been detected, a controller to confirm the validity of the detection, to orchestrate the coding of a secure data stream, to time and synchronize an actual data transmission and to monitor and transmit the proper operating status of the device, to monitor and manage the power requirement of the device, a radio transmitter to generate an RF carrier and to modulate that carrier with the data stream to be transmitted, and an antenna to properly emit the radio signals generated.

The Receiving Device consists of a suitable antenna for interception of the transmitted RF signal, a radio receiver to convert the intercepted RF signal to levels compatible with a demodulator, a demodulator to extract the signaling stream from the

modulated RF signal, a controller to interpret the extracted data stream, to determine the course of action to be taken according to the content of the data stream received, to pass the appropriate information to a communication controller, to receive commands and cause action according to those commands from other devices connected to the receiver whether wired directly to the receiver or via a network, a wire or communication controller to pass the information to and receive other communication from other devices connected directly or indirectly to the receiver(s), and a power regulator for adapting the power to levels suitable for proper operation of the receiver.

The Central Controller is the device which controls the interaction of the various elements of the system, and consists of a power supply for its own use as well as for the distribution of power to other devices connected to the system network, an embedded processor programmed to act as a system controller, a communication controller to interchange information with a system monitoring computer and other devices connected to the system network, display and diagnostic indicators for the convenient confirmation of proper operation, and signal interfaces for control of other devices such as a time clock, timekeeper controls, and electronic whistle generator in the case when those devices are not connected to the system network.

The System Configuration and Monitoring Computer is a conventional PC with appropriate application software, and its purpose is to monitor the proper operation of the system and record detailed statistical information about the timekeeping issues during a sporting event. It connects either directly to the Central Controller via an appropriate serial data link, or to the system network in those cases when such is employed. It is used to activate specific signaling devices for the sporting event at hand, to configure certain elements of the system and will gather operational information for storage, analysis and remote reporting.

The Timekeeper Panel consists of a power regulator, a system communication controller, a timing display to indicate the duration of the current play

in progress and electronic circuitry to effect the proper interaction among those elements.

The Electronic Whistle Generator simulates the sound of a whistle electronically and presents that signal at varying levels as determined by ambient noise level conditions to the PA system of the facility where the system is installed. It consists of a communication controller to interact with the system Central Controller to which it communicates its operational status, and from which it takes its commands such as the triggering of the simulated whistle signal to the PA system ant the adjustment of operational parameters such as duration, level ranges, ambient noise sensitivity and tone selection of the whistle sound.

DETAILED COMPONENT DESCRIPTION

Signaling Device

The signaling device is the complete integrated unit of a normal whistle and electronic circuitry to rapidly transmit the fact that the whistle has been blown to the rest of the system by wireless means.

A sensor determines the fact that the whistle has been blown. The methods to effect this determination can be various, and may depend on the particular application being addressed. It could be by means of a thermal dissipation sensor by which the voltage across an element in the air stream of the whistle changes with the amount of air passing the element, or by means of a pressure sensor which senses a change of air pressure in a passage or chamber of the whistle, or by means of a microphone embedded in the device, or by a vibration sensor directly coupled to the wall of the whistle.

Depending on the sensing technique used, the sensed signal may need to be amplified, and is then fed to processing circuitry to verify that the sensed signal has the correct attributes to be considered a valid event. These determinations are best performed digitally by means of an embedded microprocessor utilizing software algorithms appropriate to the sensing method used. Valid signal signature parameters will include the level, duration and frequency components making up the signal. In this manner, false signal determinations are minimized.

Once a valid whistle signal has been determined, the device circuitry will assemble an appropriately coded communication data packet for dissemination by the wireless circuitry. Again, this coding is best performed by the microprocessor, and includes such data as the packet serial number, device serial number, the identification of the type of transmission, and security information to guard against communication errors occurring during the transmission. Although many choices of bit length and bit timing of each packet is possible, a length of 32 bits at a rate of 4800 bits per second for four iterations is preferred as a balance between speed and reliability. For improved reliability and simultaneous transmissions from multiple signaling devices, each packet is sent numerous times. The types of transmission could be simply "housekeeping" information such as battery voltage, synchronization messages, other performance related data, or, of course, the sensing of the whistle event.

When the appropriate data packet has been assembled, it is handed over serially to the radio circuit for RF transmission. The radio circuit utilizes high frequency transmission consistent with available and authorized bands as determined by the appropriate Federal Agencies. Within the boundaries specified by those agencies, the methods of RF signaling could be by means of one or a combination of on/off keying, amplitude shift keying, frequency shift keying or phase shift keying. and could also take the form of broad spectrum transmission. Narrow band transmissions are more subject to intentional and accidental interference from other RF sources in the band proximity of the signal of interest than are broad spectrum transmissions. The

requirement to be able to separately and reliably receive and identify data packets from more than one whistle simultaneously poses a problem for narrow band transmissions if they are performed at the same RF frequency. As a result, the preferred method of implementing the data transmission is by means of binary phase shift keying in a broad spectrum mode, allowing multiple data transmissions to occur at the same time and at the same RF frequency. Although other bands are possible, the permissible band selected is the 902 to 928 MHz ISM band. The broad spectrum can generated by means of direct sequence, frequency hopping, chirp or possibly other means, with the direct sequence approach favoured for reasons of simplicity in implementation as compared to other methods. Naturally, the receivers need to be compatible and capable of reception of such simultaneous broad spectrum transmissions.

Although other choices could be used, a small patch antenna is integrated into the signaling device, and is designed to provide an effective match to the RF amplifier of the broad spectrum transmitter.

To confirm proper operation of each signaling device, it transmits idle status confirmation data packets at preset intervals. Failure of reception of such packets will therefor signify the system of a failure of the device with the affected serial number, and appropriate notification can be given to the game officials.

The signaling device incorporates a small battery to power the various circuit elements, and the voltage of this battery is monitored by the circuitry, causing appropriate alarm data packets to be transmitted in the case of low voltages.

Receiving Device

The receiving device is responsible for intercepting, decoding and validating the RF signals transmitted from one or more transmitting devices, perhaps simultaneously, and passing the validated data on to the Central System Controller.

An antenna intercepts the signals emanating from the signaling devices in use. Depending on the physical constraints and requirements of the particular installation, a suitable antenna must be selected from the plethora of models available to provide an appropriate signal for the application.

The antenna connects to the receiver which matches the frequency, modulation mode and broad (or narrow as the case may be) transmission mode of the signaling device. The receiver is controlled by an embedded microprocessor with appropriate software to effect the sequencing of simultaneous transmissions from multiple signaling devices.

When validated data packets have been received, this event and the data contents are coded by the embedded microprocessor into a data packet for transmission to the central controller. The receiving device is continually polled by the system Central Controller via the local communication system. The system can be directly wired from the Central Controller to each Receiving Device, or indirectly as in a local area network, or even in a wireless RF, infrared, or optical manner. For convenience and cost, certain applications will favor one approach over the others, but all are possible. In each case the required data is retrieved from all receiving devices in the system by each receiving device responding to an inquiry poll with its specific device address from the Central Controller. Regardless of the communication method chosen, receptions and transmissions of data packets on the system cables or network are serial in nature at data rates commensurate with the length and type of transmission medium selected. Although many data coding methods are possible the preferred implementation in all cases is Manchester coding with packet lengths as required to convey the data to be communicated. Security data is included in the packets to ensure the reliable conveyance of the data.

The receiving device does not generally interpret the content of the data in the packet received from the signaling device. It does however monitor the strength of the RF signal received from each signaling device, and when polled, passes this information on to the Central Controller for analysis and recording.

For convenience and certainty of supply, the receiving device draws its power from the Central Controller via the connected cables when connected directly to the Central Controller, or when connected to a wired local area network. The Receiving Device may of course be supplied with power from other sources if appropriate for the particular installation. The Receiving Device includes electronic circuitry to properly extract and regulate as necessary the power from the wired cables or network.

Central Controller

The Central Controller is the nerve center of the system. It is able to communicate, over channels as appropriate, with each of the other elements in the system, and orchestrates the collection of all data available and required for proper operation of the system, including its own functions. A local display is provided to indicate the proper or abnormal operation of the whole system or any device in the system.

The device contains of a power system for its own consumption as well as for distribution to other system devices wired to it, either directly or via a local area network. The proper operation of the power system is monitored by the unit's embedded microprocessor.

It embodies an embedded microprocessor with appropriate software to effect the various system functions desired.

The unit also includes one or more communication controllers to interchange data with other devices in the system. This data communication is exchanged in serial format, and at varying data rates and various message lengths as appropriate for the particular installation. All messages include message serial numbers, structure and security data so as to ensure the integrity of the data interchange. The physical medium for data interchange can be in the form of one or more of directly connected wires to the other system elements, of a local area network, of fiber optical nature, of wireless infra-red , of wireless laser link, or of wireless radio link.

The embedded microprocessor sequentially assembles data packets for transmission to each of the other devices in the system. The packets are coded to contain instructions to the addressed device to respond in some manner.

In the case of addressing the Receiving Devices in the system, these instructions include those which will cause the Receiving Device to respond with data packet transmissions passing back the data packets it received from the Signaling Devices in the system. It also will include those which cause the Receiving Device to make adjustments to its own settings affecting the operation of the Receiving Device. Also included will be those instructions which cause the Receiving Device to respond with status and alarm information about its own operation and integrity, including the performance and quality of the communication network. On receipt of data from the Receiving Devices that the signaling device has transmitted the occurrence of an event intended to stop the sports timeclock, the unit analyzes the information, and determines that if at least a specified number Receiving Devices indicate this occurrence, then the occurrence is deemed to be valid, and a signal is immediately communicated to the timeclock, and subsequently to the other interested devices connected to the network, that a valid stoppage in play has occurred, and for each device to react in the manner it is programmed to do in the case of such an event. Conversely, the signal might also be

the occurrence of an event to commence timing of play, and starting or resumption of timing by the sports timeclock.

Failure of the Central Controller to receive idle status data packets for a predetermined period of time from any of the Receiving Devices in the system, or major operational, status or alarm information from any device in the system will cause an appropriate alarm indication to be posted on the Timekeeper's Panel.

Other determinations for actions may also be made by the Central Controller according to the data received from other devices in the system and features implemented for the particular facility. On detection of the occurrence of such conditions, the Central Controller will address the required devices in the system to take the appropriate action.

In the case of addressing the sports timeclock ancillary device, the instructions include those to stop, start or otherwise adjust the clock. Instructions to retrieve status and alarm information relating to the proper operation of or adjustment to the operation of the Timeclock Interface ancillary device are also included.

In the case of addressing the timekeeper's panel, instructions include the setting of values on the timekeeper's time display as well as setting alarm and status displays on the timekeeper's panel, and retrieving operational commands from the switches and pushbuttons of the timekeeper's panel when so fitted. Instructions to retrieve status and alarm information relating to the proper operation of or adjustment to the operation of the ancillary Timekeeper's Panel device are also included.

In the case of addressing the System Configuration and Monitoring Computer, the instructions include the storing away in that computer the relevant operational, statistical, alarm and status information gathered by the Central Controller from the other devices in the system, including those of itself. The instructions also

include the retrieval from that computer those serial numbers of the devices which are permitted to be connected to the system network, including those of the signaling devices. In this manner unauthorized devices intentionally or accidentally connected to the communication network will not be permitted to affect the proper operation of the system.

In the case of addressing the Electronic Whistle Generator ancillary device, the instructions will include those to trigger an electronic whistle to the PA system. Instructions to retrieve status and alarm information relating to the proper operation of or adjustment to the operation of the ancillary Electronic Whistle Generator device are also included.

System Configuration and Monitoring Computer

The System Configuration and Monitoring Computer consists of a conventional PC with appropriate software to effect the data recording, retrieval, analysis, display, printing and configuration of the system.

The device has the capability for communication with the Central Controller via direct connection or via a local area network.

The unit communicates with the Central Controller and stores all data as instructed by the Central Controller. The system as a whole is configured by means of human intervention through the computer's keyboard and display, and stores information as to legitimate devices which are permitted to interact in the system. Unauthorized devices will be ignored from operational activities but are recorded, alarmed and printed when detected. This aids to eliminate tampering with the system.

Timekeeper Panel

The Timekeeper Panel provides the game's timekeeper with limited operational data and the ability to effect changes to the operation of the system at game time.

The unit has the capability for communication with the Central Controller via direct connection or via a local area network In the case of direct or network connection, the device draws its power form the connected cables. Otherwise the device may be separately powered. In each case the device has a power regulator to ensure the supply of proper power levels.

An embedded microprocessor with appropriate software permit the unit to display to the timekeeper the running duration of clock time since the resumption of timing since the last stop in timing. This permits the convenient adjustment of the sports timeclock in those cases where adjustment need be made due to false starts of play. The panel will also provide the game officials with urgent system alarm and status information such as the failure or gross mis-operation of devices in the system, including failure or low battery condition of the signaling devices. In this manner, urgent issues can be dealt with in a timely and appropriate manner thereby eliminating or minimizing disruption of normal play.

The embedded processor also monitors the proper operation of the unit, including the power supply, and this data is passed on to the Central Controller when the device is polled by the Central Controller.

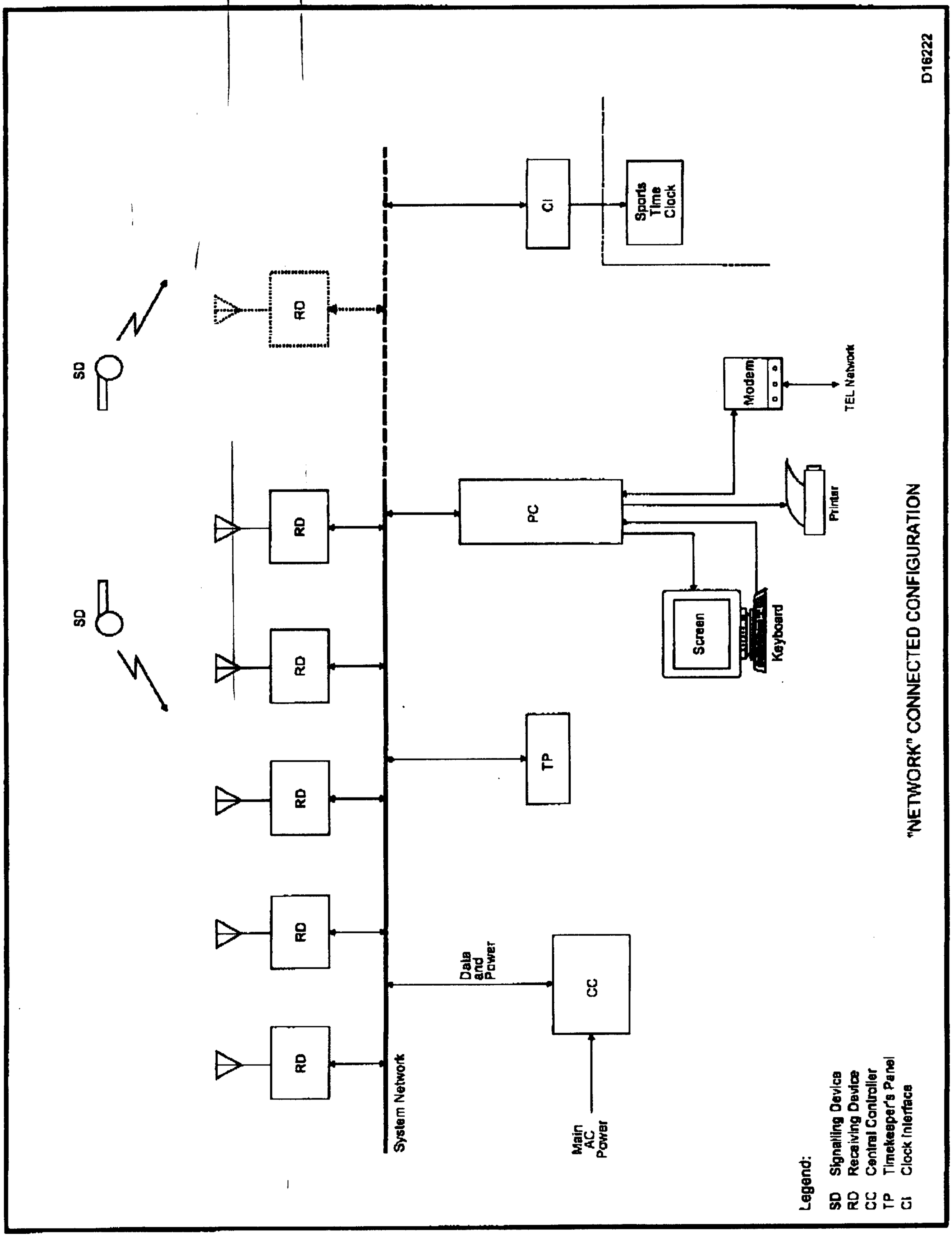
Electronic Whistle Generator

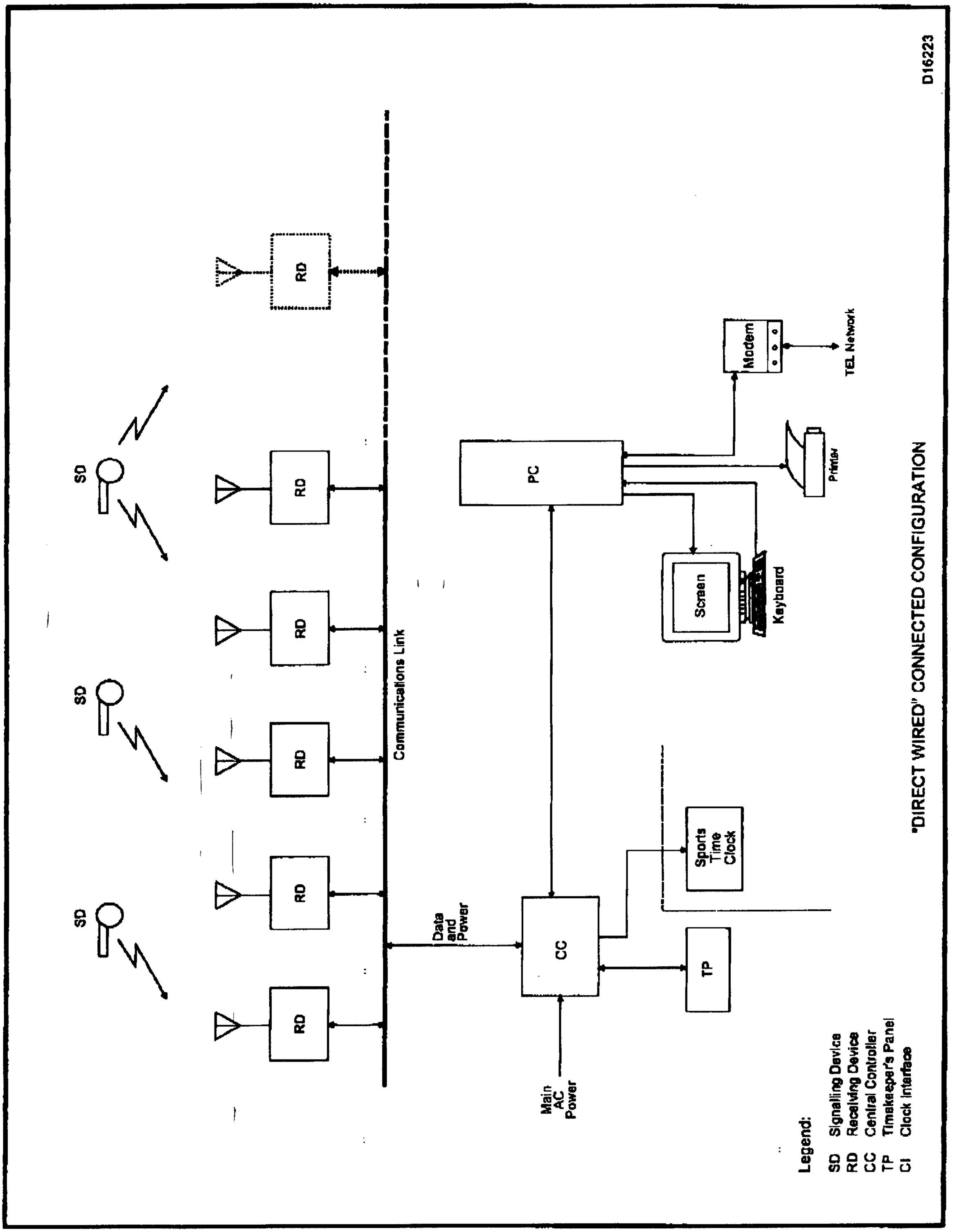
The Electronic Whistle Generator provides a means for a simulated whistle to be put onto the building or facility PA system.

The unit has the capability for communication with the Central Controller via direct connection or via a local area network In the case of direct or network connection, the device draws its power form the connected cables. Otherwise the device may be separately powered. In each case the device has a power regulator to ensure the supply of proper power levels.

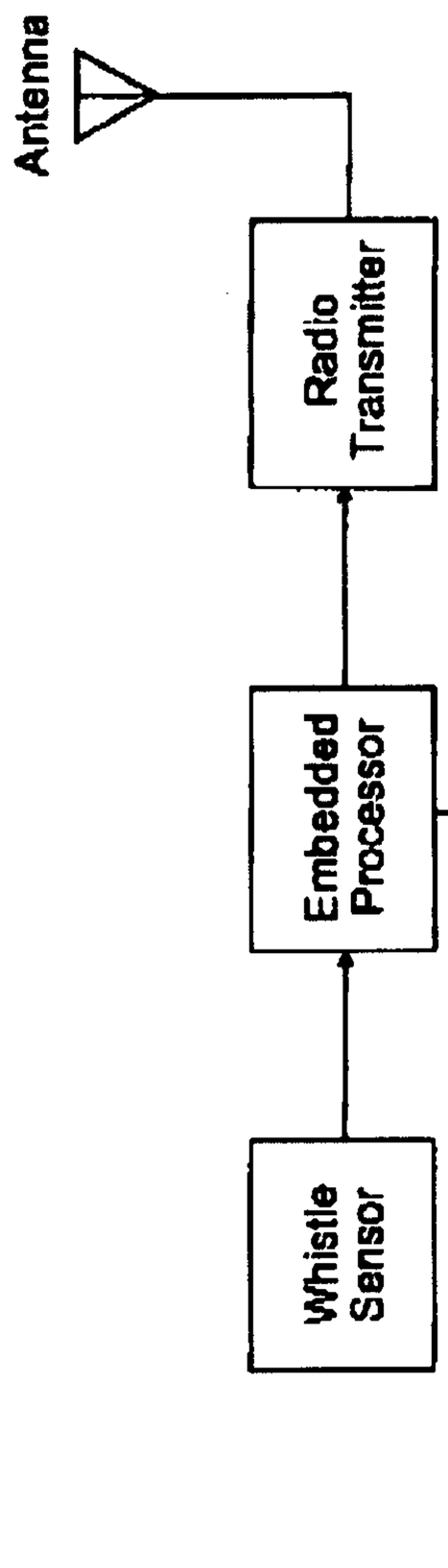
An embedded microprocessor with appropriate software permit the unit to retrieve from its memory a synthesized digital representation of a desired whistle, or other sound if so equipped. The digitized signal is converted to analog form, filtered and amplified to levels specified by the Central Controller, and fed to the PA system of the facility. A sensing mechanism utilizing a microphone will sense the ambient noise level at the facility, and adjust the level presented to the PA system accordingly. In this manner, as crowd noise increases, the referee whistle, via data transmissions from the signaling device, receivers, and central controller have a greater likelihood of being heard by the players.

The microprocessor also monitors the proper operation of the device, and accordingly communicates improper operation to the Central Controller.

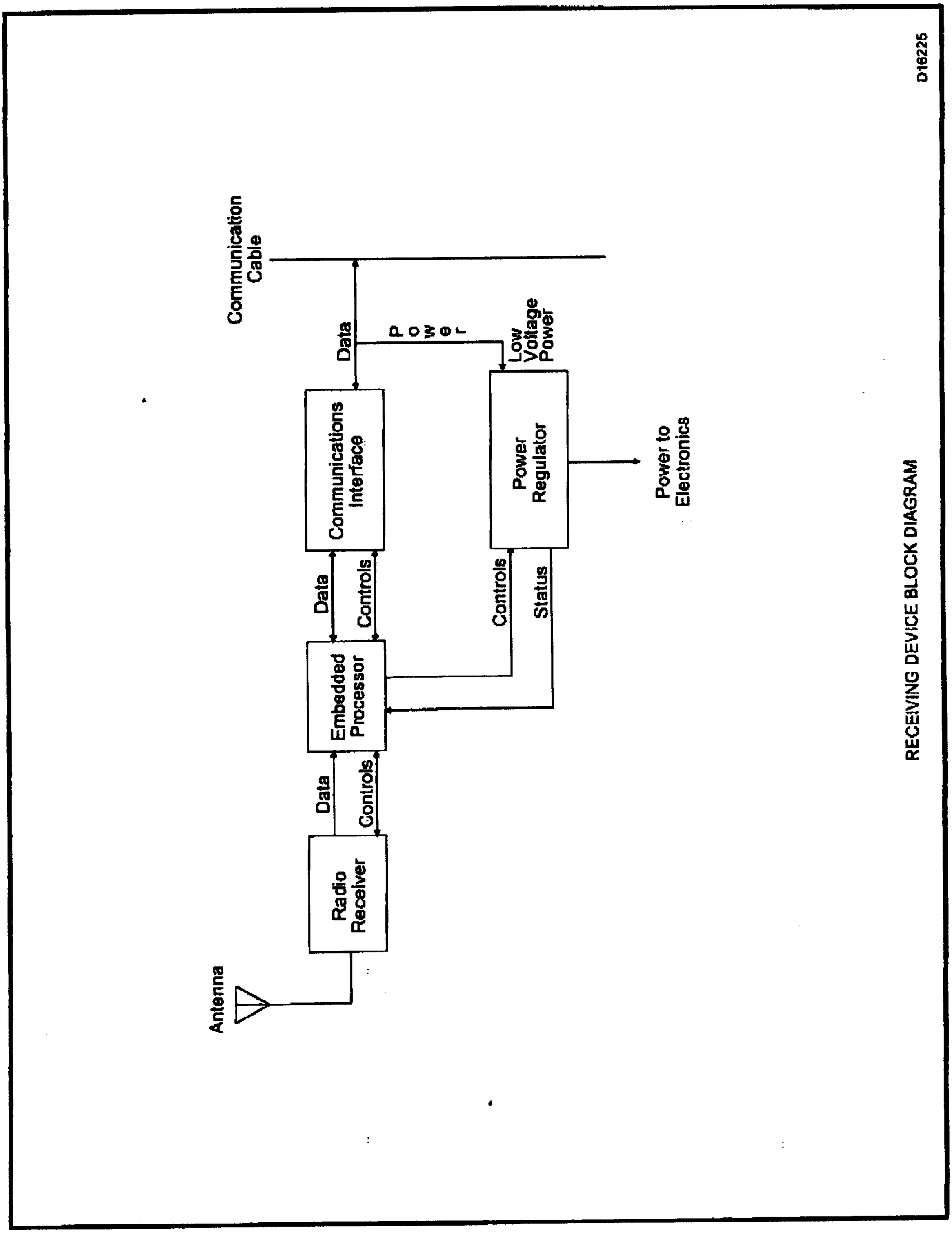

D16222
CI
Sports Time Clock
SD
SD
SD
RD
RD
RD
RD
RD
RD
RD
PC
Modem
TEL Network
Printer
Screen
Keyboard
TP
Data and Power
CC
System Network
Main AC Power
"NETWORK" CONNECTED CONFIGURATION
Legend:
SD Signalling Device
RD Receiving Device
CC Central Controller
TP Timekeeper's Panel
CI Clock Interface

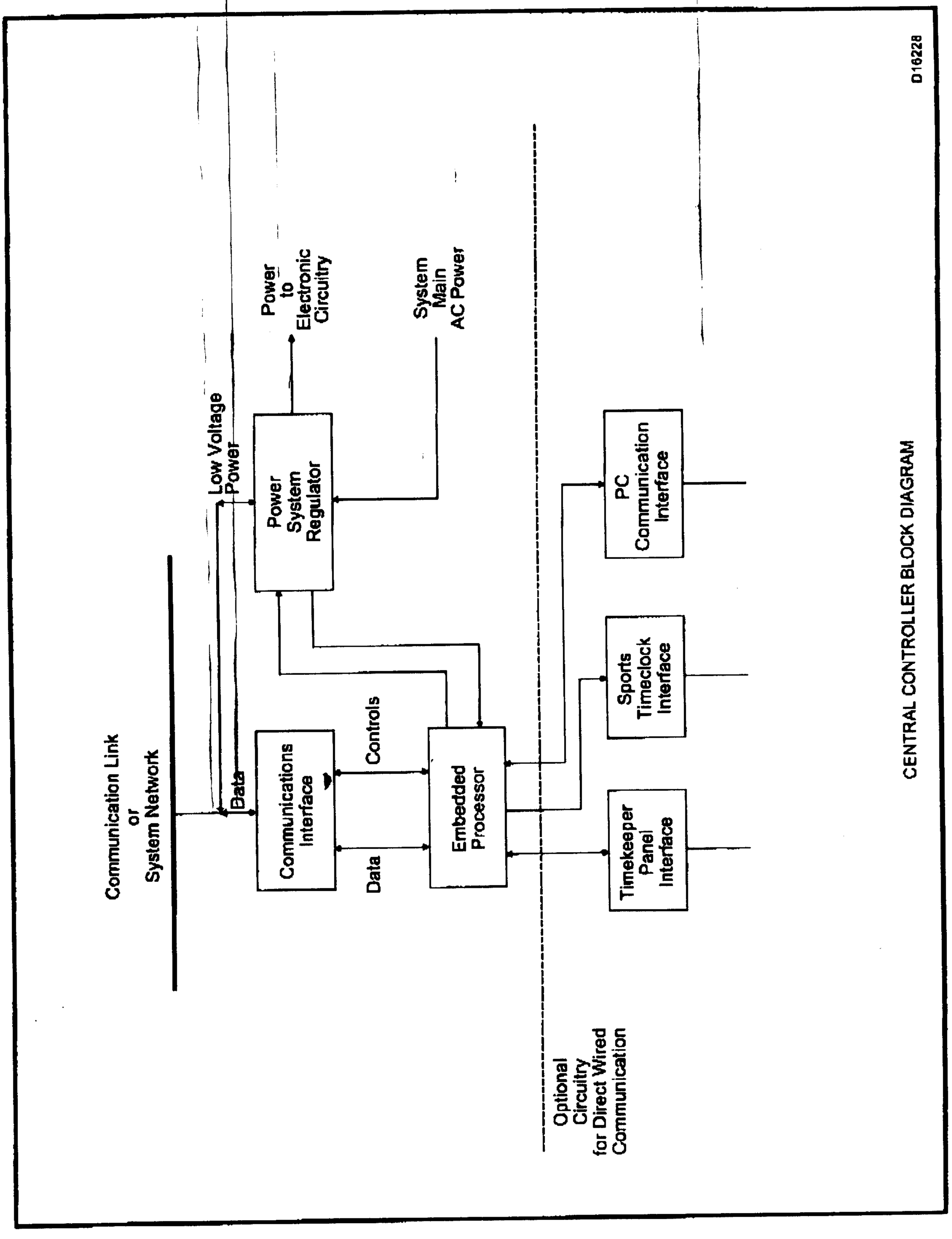

D16223
SD
RD
Communications Link
Data and Power
Main AC Power
CC
TP
Sports Time Clock
PC
Modem
TEL Network
Printer
Screen
Keyboard
"DIRECT WIRED" CONNECTED CONFIGURATION
Legend:
SD Signalling Device
RD Receiving Device
CC Central Controller
TP Timekeeper's Panel
CI Clock Interface

D16224

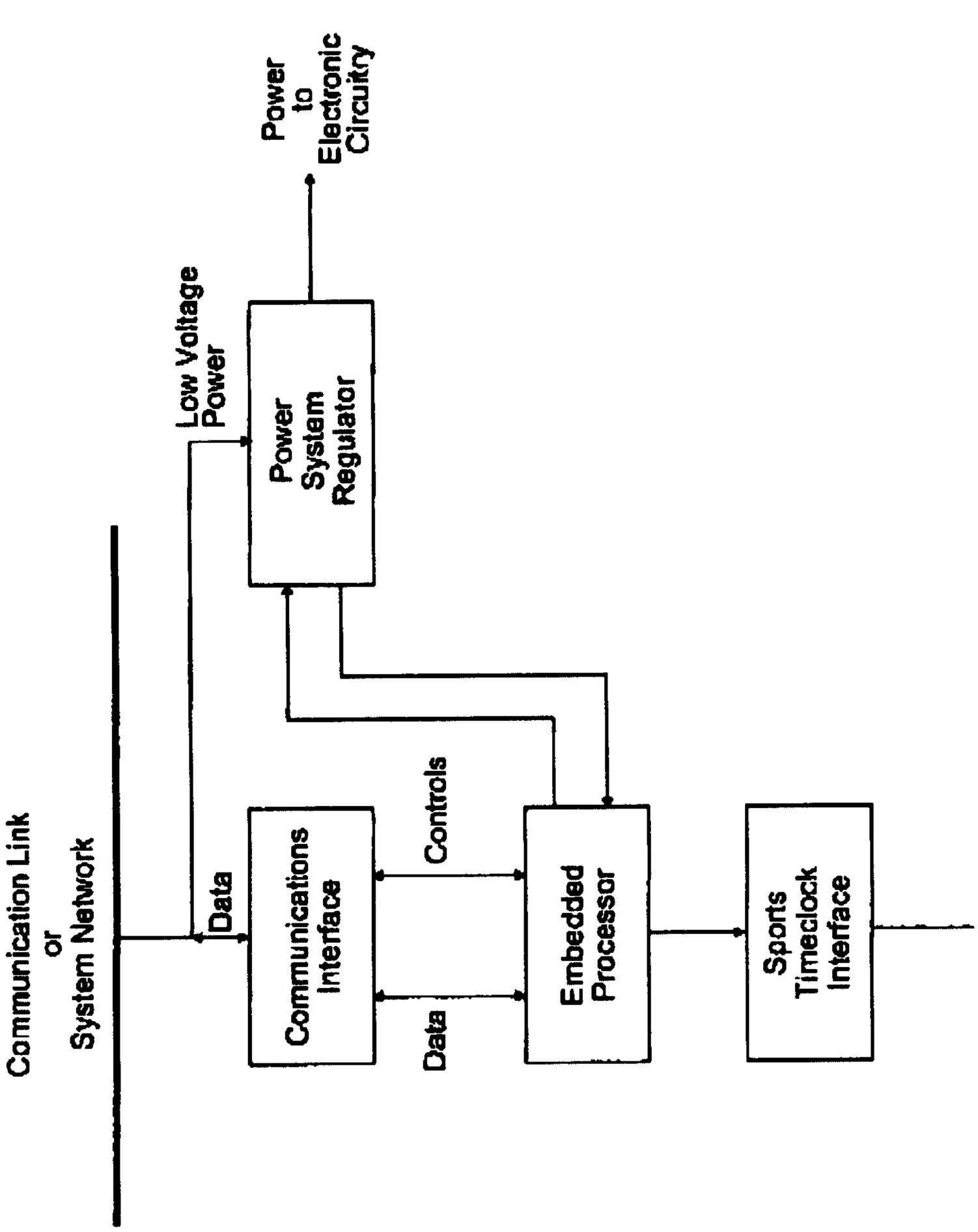


SIGNALLING DEVICE BLOCK DIAGRAM


D16225
Communication Cable
Data
Power
Low Voltage Power
Communications Interface
Power Regulator
Power to Electronics
Data
Controls
Controls
Status
Embedded Processor
Data
Controls
Radio Receiver
Antenna
RECEIVING DEVICE BLOCK DIAGRAM

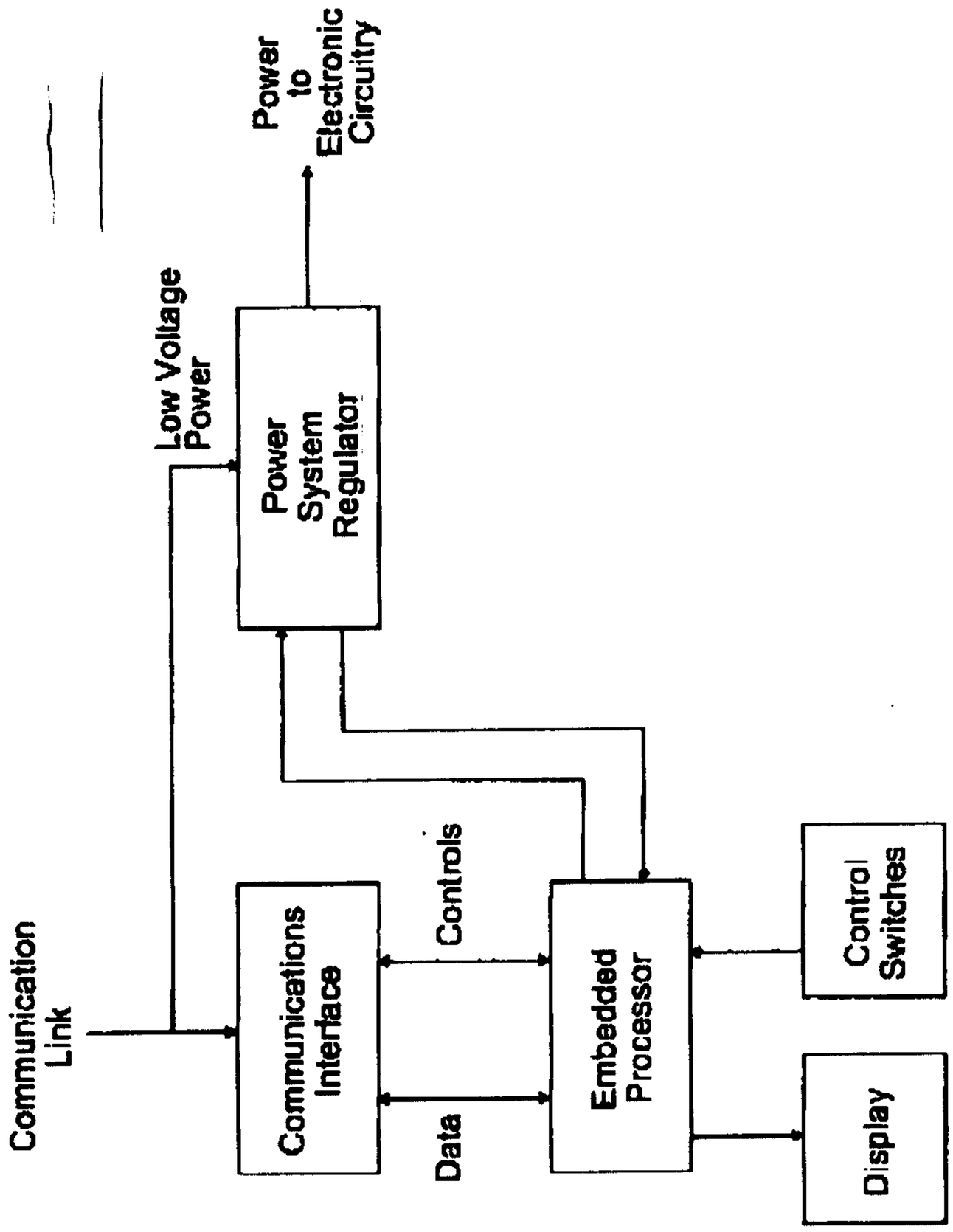

D16228
CENTRAL CONTROLLER BLOCK DIAGRAM
Communication Link
or
System Network
Low Voltage
Power
Power
System
Regulator
Power
to
Electronic
Circuitry
System
Main
AC Power
Data
Communications
Interface
Controls
Data
Embedded
Processor
PC
Communication
Interface
Sports
Timeclock
Interface
Timekeeper
Panel
Interface
Optional
Circuitry
for Direct Wired
Communication

D16227

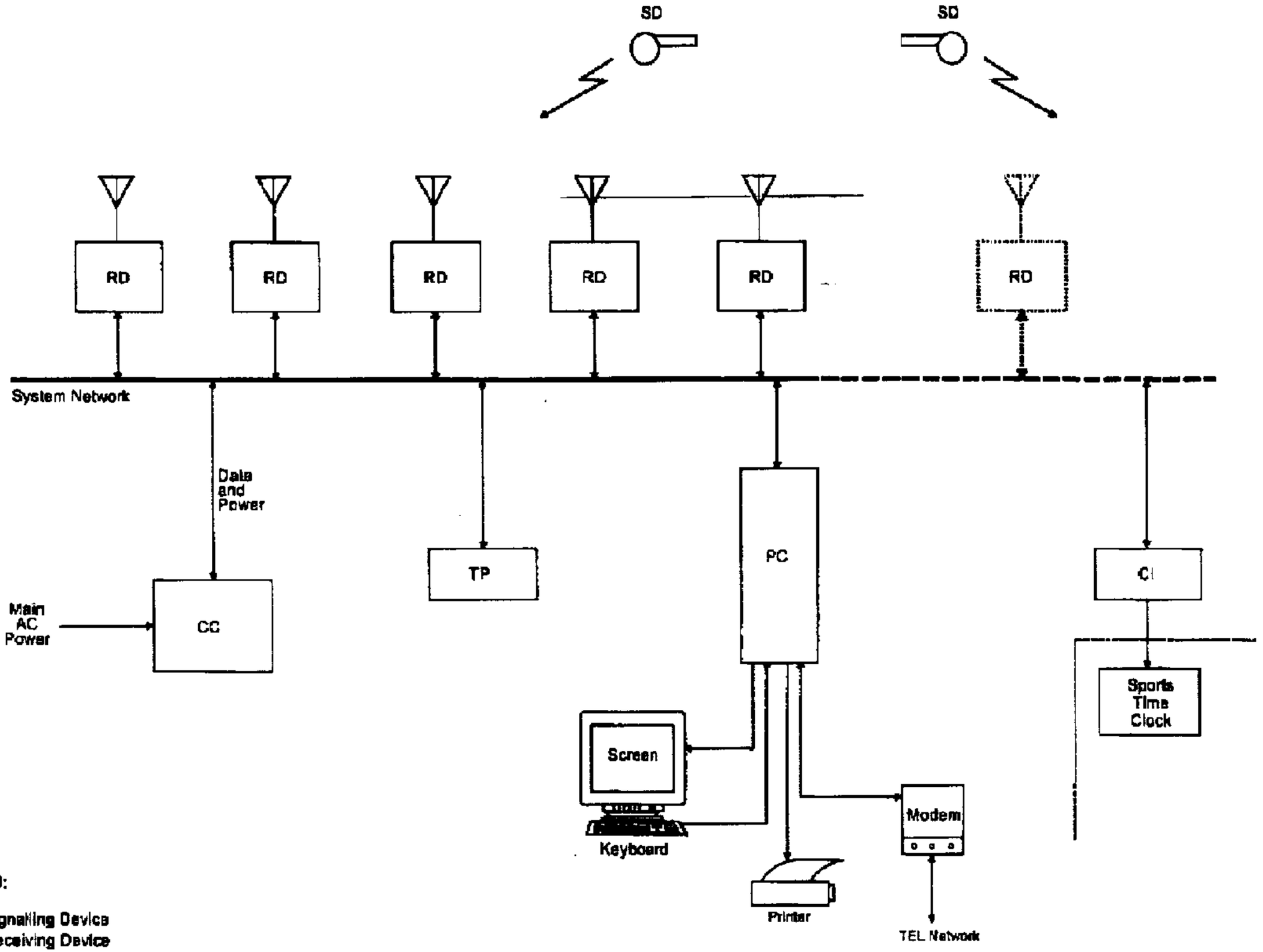


CLOCK INTERFACE BLOCK DIAGRAM

D16226



TIMEKEEPER'S PANEL BLOCK DIAGRAM



Legend:

SD Signalling Device
RD Receiving Device
CC Central Controller
TP Timekeeper's Panel
CI Clock Interface

"NETWORK" CONNECTED CONFIGURATION