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Grider et al.

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[54] **TWO PROCESSOR COMMUNICATIONS SYSTEM WITH PROCESSOR CONTROLLED MODEM**

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[73] Assignee: **Dallas Semiconductor Corporation**, Dallas, Tex.

[21] Appl. No.: **282,702**

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[51] **Int. Cl.**[5] **G06F 9/00**; G06F 13/14

[52] **U.S. Cl.** **395/200**; 395/325; 364/229; 364/230; 364/238.5; 364/284; 364/286

[58] **Field of Search** .... 379/98, 97; 364/200 MS File, 900 MS File; 395/200, 325

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Primary Examiner—Lawrence E. Anderson
Attorney, Agent, or Firm—Worsham, Forsythe, Sampels & Wooldrige

[57] **ABSTRACT**

Preferred embodiments include systems with two processors and an interconnected modem, one processor functioning as a control for both the modem and the second processor. This permits remote communication with the second processor for test or reconfiguration purposes.

15 Claims, 2 Drawing Sheets

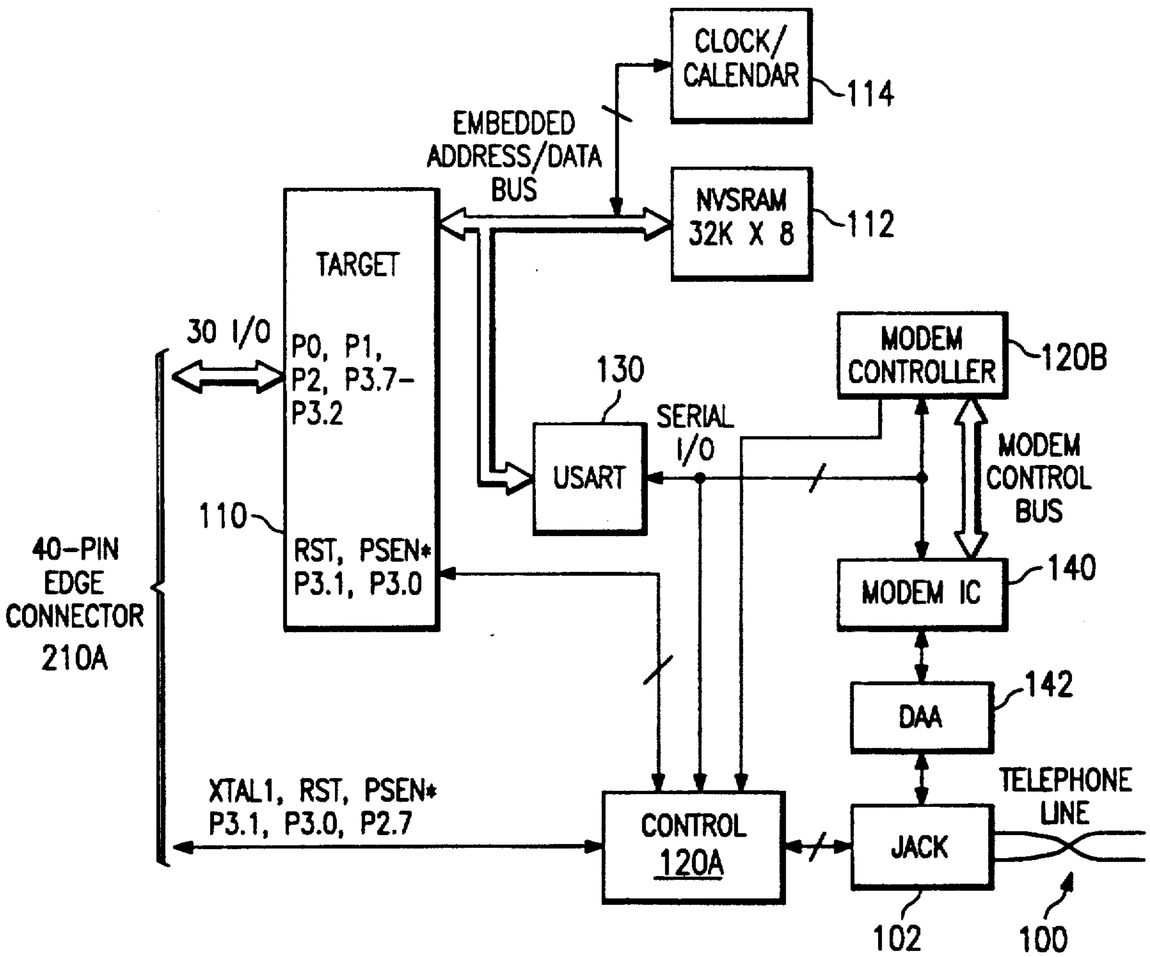
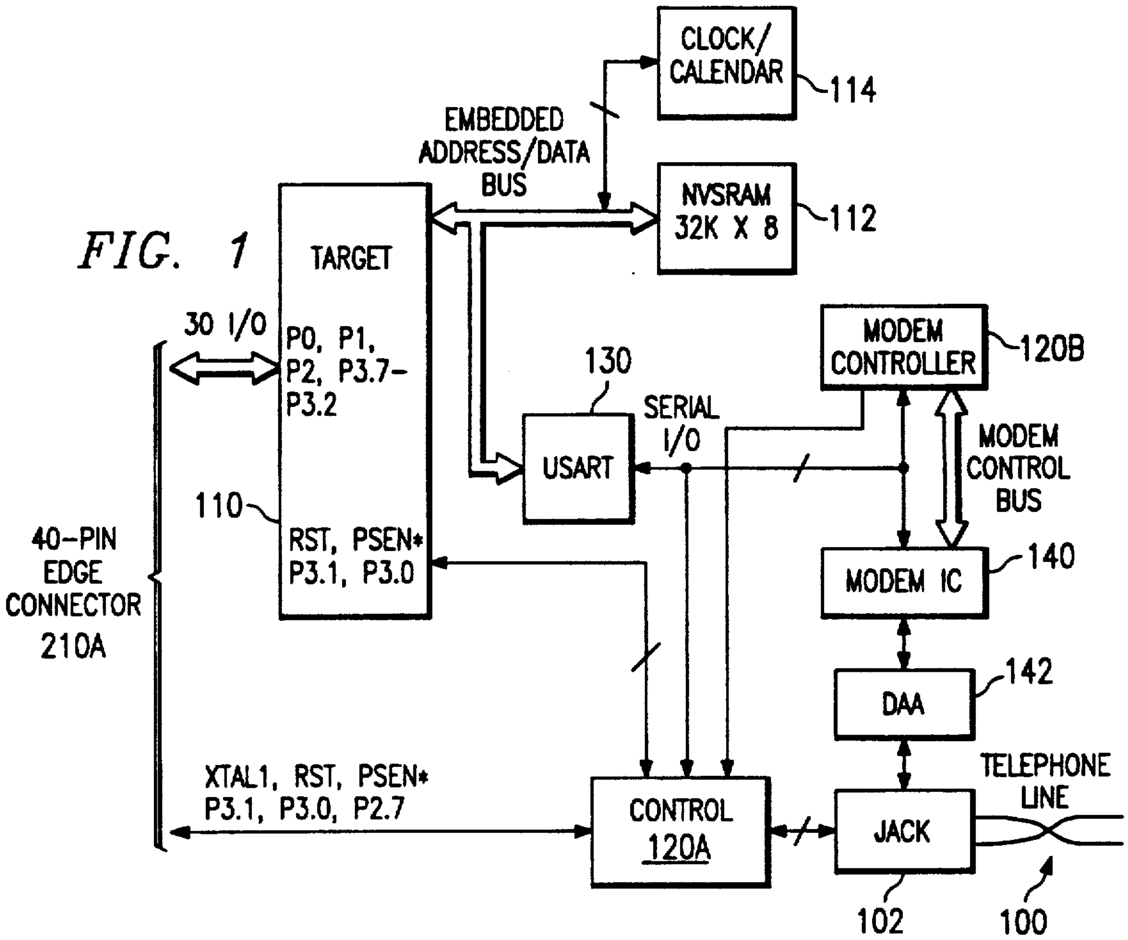
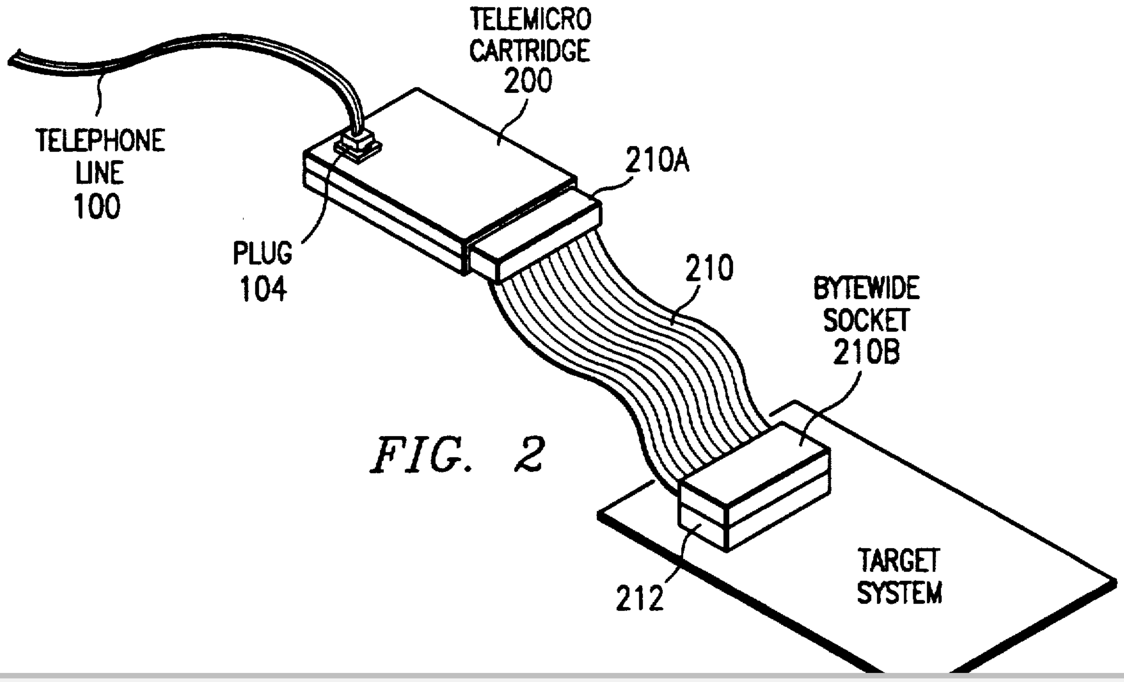


FIG. 1


CLOCK/ CALENDAR
114
EMBEDDED ADDRESS/DATA BUS
NVSRAM 32K X 8
112
TARGET
30 I/O
P0, P1, P2, P3.7-P3.2
MODEM CONTROLLER
120B
130
SERIAL I/O
USART
MODEM CONTROL BUS
110
RST, PSEN*
P3.1, P3.0
40-PIN EDGE CONNECTOR 210A
MODEM IC
140
142
DAA
XTAL1, RST, PSEN*
P3.1, P3.0, P2.7
CONTROL 120A
JACK
TELEPHONE LINE
102
100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TELEPHONE LINE 100
210A
PLUG 104
210
BYTEWIDE SOCKET 210B
212
TARGET SYSTEM

FIG. 2

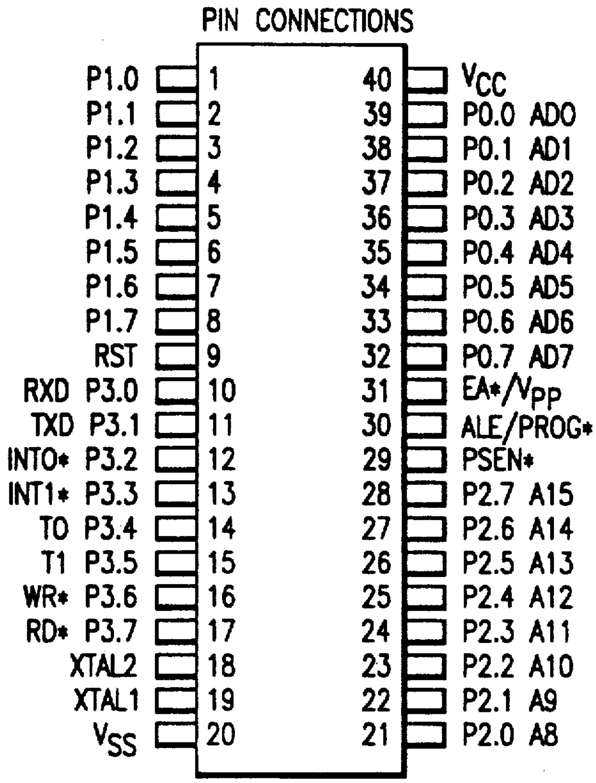


FIG. 3

FIG. 4a

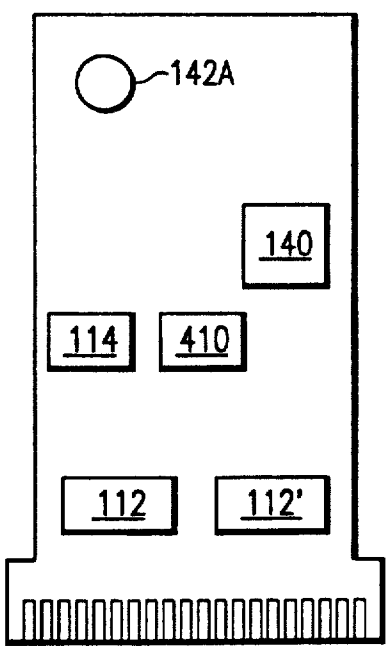
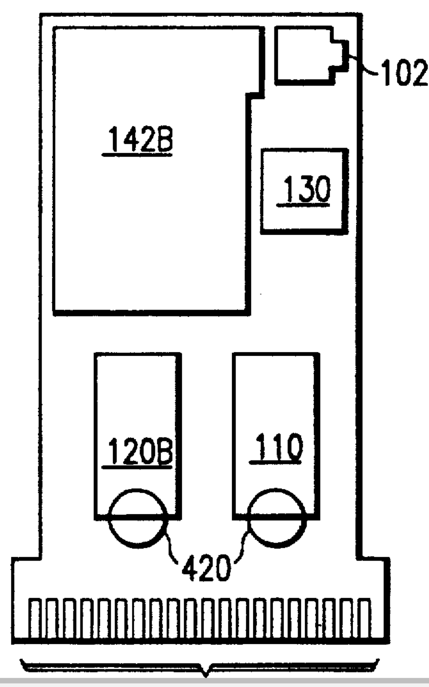


FIG. 4b



TWO PROCESSOR COMMUNICATIONS SYSTEM WITH PROCESSOR CONTROLLED MODEM

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BACKGROUND AND SUMMARY OF THE INVENTION

The present invention relates to computer systems, and particularly to small computer systems which can be connected to a telephone line.

The present invention provides a computer system which can be completely reprogrammed by telephone. This permits debugging, or software updating, to be performed by telephone. Since low-level access is possible, this system can be used for data-collection stations, for application-specific systems generally, or for other systems in which a high-level software environment is not present.

Some presently available software packages permit a computer to be accessed, through a modem, in "slave" mode. In this mode, the user can issue commands, through the process which is managing the communications link, to be passed on to the main operating system (software). However, since this connection occurs at a fairly high level, it is not suitable for low-level manipulation of a microprocessor's programming. This means that access of this kind cannot reliably be used for troubleshooting.

It should also be noted that, in presently available modem systems, an "escape sequence" is commonly used to identify modem commands within a stream of data. That is, in common modem systems for use with desktop computers, the computer will send commands directed to the modem (such as "hang up") on the same line as the data which is to be sent through the modem to a remote computer. To prevent confusion, the "escape sequence" is used to indicate that the modem must interpret (rather than transmit) the following bits. For example, one commonly used escape sequence is three plus signs (+ + +), preceded and followed by a certain minimum period of silence.

The ability to perform "teleservicing" can be a significant element of a userfriendly computer system. A tremendous amount of effort has been devoted to providing "friendly," easy-to-use computer systems and software. However, one of the weak points in this effort is that, when problems occur, the inexperienced user may rapidly become bewildered and unhappy, regardless of how friendly the system is when it is working. Moreover, physical transportation of computer systems is a large burden on the time of users and/or technicians. Thus, it would be a major forward step if an experienced repair technician could access a customer's system by telephone, even if a hardware failure had occurred, and reliably read the configuration and state of the system and software, and change stored programs if needed.

This ability is also advantageous in many large-scale system design contexts. For example, if a systems analyst is formulating solutions to a problem which requires periodic data collection from many points, he may consider using human monitors; or using physical recorders (such as strip charts) with analog sensors; or using simple microprocessor or microcontroller systems to collect data in digital records; or use higher-level microcomputer systems which can collect data, reduce it, and transmit via modem on demand. In considering system architectures of this scale, one of the key parameters is how "smart" the remote station is: can it implement a sophisticated algorithm to control sensors? Can it monitor data storage conditions? Can it recognize exception conditions? Another key parameter is robustness: a "smart" remote station which fails can be much worse than a simpler station, since the extraordinary measures which may be needed to retrieve the data may disrupt the efficiency and economy of data flow overall. From this point of view, it may be seen that the present invention provides a range of options which would not otherwise be available.

For example, the present invention can be particularly advantageous with systems using fairly low-level control systems. Major home appliances (such as washing machines, driers, microwave ovens, etc.) usually contain embedded microcontrollers; the present invention can be particularly advantageous in such systems, since, with only a small increase in the cost of the embedded electronics, it may be possible to perform remote diagnosis on such systems. Similarly, such architectures can be adapted for diagnosis of consumer electronics systems, or even to retrieve billing information from pay-per-view cable systems (or utility-metering systems).

A further area of capability provided by the present invention is in redundant systems. The ability to perform low-level remote access means that, wherever the hardware system has included sufficient redundant elements and (electronically) switchable elements to bypass the failure, teleservicing can be used to select or deselect those elements. For example, a precision timing circuit can be retrimmed to compensate for drift in the crystal frequency; or, where a line interface chip has been blown by a voltage spike, that chip can be disconnected and another one connected; or power transistors, protection diodes, electrolytic capacitors, disk drives, memory banks, etc., can be similarly switched. The capability to test and reconfigure a remote system may be particularly advantageous where high reliability and maintainability are needed.

The capabilities of the disclosed system can be advantageous in a wide variety of systems. A few examples—which do not by any means exhaust the range of applications of the disclosed innovative concepts—include private branch exchanges (PBXs); vending machines (including machines which can accept credit cards for payment); automated machine tools and robotic systems, where the compatibility provided by the present inventions may permit a large step to be taken toward an integrated manufacturing environment, without users to install a comprehensive new computer network; process controllers, for a wide variety of continuous processes, including chemical plants, oilfield production sites, food-processing operations, and others;

printing presses; information presentation systems; semiconductor manufacturing equipment (where systems according to the present invention are particularly advantageous in keeping humans out of the clean room).

Another class of applications uses a basic system, like that shown in FIG. 1, simply as an entry point to a more complex system. Thus, a configuration where the target microcontroller is connected to a further microprocessor (or other computer) can be used to provide low-level management functions (power-up, watchdog, kickstarter, clock, etc.) for a digital signal processor (DSP) system, or for a 32-bit microprocessor-based computer, or even for a minicomputer or mainframe. Alternatively, such a configuration can be used simply for system robustness; by permitting the nonvolatile target microprocessor to perform low-level tests on the more complex elements of the system (and, optionally, also permitting the nonvolatile microprocessor to control configuration switch settings), extensive teleservicing of even a complex system can become possible. A further alternative is to use the nonvolatile target microprocessor to monitor system activity, and to dial out and report hardware or software failures (or major events).

The presently preferred embodiment enables a telephone-programmable computer by providing a module which combines a DS5000T Time Microcontroller™ (which includes clock/calendar functions) with a 1200 bps or 2400 bps modem and another DS5000 microcontroller, and 32 Kbytes of nonvolatile SRAM (which can be used for program and/or data). A ribbon cable and connector is provided, so that this module can be connected to a standard DS5000/8051 socket on a circuit board.

The systems and subsystems provided by the present invention, and/or by alternative embodiments thereof, have at least the following advantages:

Teleservicing is possible, in new designs or existing systems;

Complete application software changes can be made with only telephoneline access;

capability to download and verify absolute object files (in Intel Hex);

All DS5000T I/O facilities available to the user, and familiar modem functions can also be exploited.

Requires no support circuit overhead on target system.

BRIEF DESCRIPTION OF THE DRAWING

The present invention will be described with reference to the accompanying drawings, which show important sample embodiments of the invention and which are incorporated in the specification hereof by reference, wherein:

FIG. 1 is a block diagram which illustrates the functional elements of the module which, in the presently preferred embodiment, provides telephone-line direct access to a computer system.

FIG. 2 shows the physical connection of the TeleMicro cartridge of the presently preferred embodiment into a socket on a board of a target computer system.

FIG. 3 shows the preferred pin allocation of the socket 212 in the target system.

FIGS. 4a and 4b show the general circuit board organization of the presently preferred embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The numerous innovative teachings of the present application will be described with particular reference to the presently preferred embodiment, wherein these innovative teachings are advantageously applied to a system using two DS5000 nonvolatile microprocessors. However, it should be understood that this embodiment is only one example of the many advantageous uses of the innovative teachings herein.

The presently preferred embodiment is particularly directed to systems which are based on the DS5000T Time Microcontroller. (This microcontroller is a modification of the DS5000 referred to above, which includes a real-time clock/calendar in addition to the other functions of the DS5000.) Teleservice refers to the ability to perform remote software upgrades and system diagnostics from a desktop computer over a telephone line. The major benefit to the end user is reduced operating costs by eliminating service calls to repair or upgrade equipment in the field.

A central part of the TeleMicro Cartridge is the DS5000T itself. Unlike rigid ROM or EPROM based microcontrollers, all of the Time Microcontroller's memory is high performance, read/write, and nonvolatile for more than 10 years. The DS5000T is equipped with 32K bytes of nonvolatile SRAM which can be dynamically partitioned to fit program and data storage requirements of a particular task. A major benefit resulting from its nonvolatility is that the Time Microcontroller allows Program Memory to be changed at any time, even after the device has been installed in the end system. Additionally, the size of the Program and Data Memory areas in the embedded RAM is variable and can be set when the application software is initially loaded or by the software itself during execution. Incorporated within the DS5000T is a permanently powered clock/calendar function which may be used for time stamping and scheduling of events. The DS5000T is instruction set and pin compatible with the industry standard 8051.

The TeleMicro Cartridge exploits this capability of the DS5000 with the addition of a complete modem subsystem which resides on the Embedded Address/Data bus of the DS5000T. The subsystem accepts the "AT" command set issued from the user's software for maximum customer familiarity during software development. The internal circuitry includes a Part 68 registered DAA function, eliminating potential delays for customers with a need to incorporate a modem function in their end system product. The microcontroller 110 is interfaced to the modem subsystem via its Embedded Address/Data bus, so that all of its 40 pins are available for use in the target application.

The TeleMicro Cartridge is housed in a rugged and durable package which is compact enough to fit into a wide variety of applications. Two connectors are provided on the cartridge. The first is an RJ45 female connector which interfaces directly to the telephone line terminated with a standard modular RJ11 male connector. The second is a 40-pin edge connector which brings out the signals associated with the footprint of a DS5000 or 8051. A standard 40-pin connector may be used for direct mount to a printed circuit board. Alternatively, remote mounting may be accomplished with a 40-conductor ribbon cable terminated with a 40-pin

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