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REMOTE CONTROLLED CONTINUOUS RADON GAS MONITOR

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ABSTRACT

NITON Corporation has developed resident software for the RAD7 continuous radon gas monitor that enables the remote control of all measurement and data functions through the instrument's RS-232 serial communication port. This paper will outline the operation of the new software and describe the broad range of applications it makes possible. Potential applications include, but are not limited to, two-way communication by way of telephone line or radio link for instrument control and data retrieval, centralized data logging from multiple instruments, automated multiple point sampling, microcomputer controlled laboratory experiments, ventilation and alarm control systems, and actively stabilized radon chambers.

INTRODUCTION

A variety of applications for continuous radon monitors require automated communication with microcomputers, often as part of a large data collection or control system. The RADLINK remote control package allows the RAD7 to converse with other microcomputers through the RAD7's RS-232 serial port, allowing for the complete remote operation of the instrument, including control of the measurement parameters and data. A RADLINK equipped RAD7 will remotely recognize all of the standard RAD7 keypad commands plus several special commands designed to enhance remote operation.

INSTALLATION

Installing RADLINK on the newest RAD7's is very simple since these already contain the circuits and firmware for remote control. RAD7 instruments built or upgraded since September 1991 already contain the necessary electronic circuits, but may require a firmware upgrade involving the installation of a new EPROM program module (version 2.4 or higher). Older RAD7s that were built before September 1991 and never upgraded will require the Real Time Clock/Non-Volatile memory (RTC/NVRAM) upgrade. Remote control software resides in non-volatile memory (NVRAM), but does not decrease the amount of radon data that the instrument can store.

TECHNICAL DATA

The RAD7 serial port follows RS-232 convention for voltages and signalling. The connector is the standard 9-pin male D-subminiature, with a pinout matching that of the IBM PC-AT. The RAD7 uses the ASCII character set for all transactions, and recognises XON/XOFF flow control. With the RADLINK package, the user may set the serial data rate to any standard rate from 300 to 19,200 baud. The port uses 8 data bits, no parity, and one stop bit.

The remote control dialog follows a typical command line pattern, where the instrument issues a prompt, waits for a command followed by a carriage return, then responds according to the command. The command names are identical to those used on the keypad interface, with several additonal commands. In commands, RADLINK does not recognize character case (uppercase or lowercase) as significant. If an unrecognized command occurs, for example due to misspelling, then the instrument responds with an error message followed by a list of allowed commands. RADLINK ignores modem result codes such as "OK", "CONNECT", and "NO CARRIER" to avoid error message bickering between the RAD7 and a modem.

The Control-C character serves to break or interrupt a process, and generate a new prompt. Control-H serves as a backstop for the backspace/delete key to cancel the last character. Several ANSI escape codes corresponding to the function keys F1 through F4 serve as a remote RAD7 keypad emulator.

Of particular interest among the additional commands is "Special SPrOn", which re-directs all subsequent output designated for the printer to the serial port.

DIRECT LINK

The most simple remote control arrangement is a direct wire serial port to serial port link from the RAD7 to a personal computer or terminal (figure 1a). This arrangement requires a serial null-modem cable from the RAD7 to the serial port connector on the computer or terminal. We prefer shielded cables, but unshielded cables perform adequately in most cases.

A direct wire link may be used for applications where distances are relatively short. Potential applications include data downloading, long term continuous data logging, a remote display terminal, an alarm system, a ventilation control system, an active control system for a radon chamber, a data acquisition system for a laboratory experiment, or a multiplexed sampling system.

EXTENDED RANGE POINT TO POINT COMMUNICATION

The official RS-232 standard limits the range of a direct cable link to 50 feet (15 meters), although some researchers have reported maximum distances of 1000 feet (300 meters) or more for shielded cables running at 2400 baud or less. Options for extending the range include RS-232 line boosters (up to 100 feet / 30 meters), current-loop interfaces, RS-485 or RS-422 interface converters (up to 4000 feet / 1200 meters), asynchronous line drivers (up to 2-4 miles / 3000-6000 meters), short-haul modems (up to 5-10 miles / 8-16 kilometers), leased-line modems, and radio modems (figure 1).

Spread-spectrum radio modems offer particular convenience in the 500 to 1000 foot range (150 to 300 meters), since these do not require a government license to operate. Longer range radio modems offer ranges of more than 15 miles (24 kilometers), but require a license.

LONG DISTANCE COMMUNICATION AND NETWORKS

You may use standard data modems to communicate over the telephone system to one or more remote RAD7 monitors, so that when you want to get some data or start a new run, just "dial up" the instrument of your choice. One can easily imagine a large network of radon monitors linked to a central data collection point through the telephone system (figure 2a).

On a smaller scale, special local area network (LAN) adapters or node adapters can link a number of instruments to a computer for centralized data collection or control (figure 2b). RS-485 based adapters use standard telephone cable for flexible and inexpensive installation, have a range of at least 4000 feet (1200 meters), and exhibit immunity to electrical noise.

SPECIAL COMMANDS

A series of special commands have been added to the ordinary RAD7 commands to provide functions of special interest to remote control users:

Special Ident - Output the RAD7 identification sequence, including firmware version, hardware model number, unit serial number, and last calibration date.

Special SPrOn - Re-direct subsequent output from the infra-red printer to the serial port. In other words, everthing that would ordinarily be printed will shoot out the serial port, but nothing will be printed, even when you say "Print". One reason to use this might be to move the data very quickly into a computer without waiting for the (slow) infra-red printer link. You can cancel the re-direction order with the "Special SPrOff" command. When you turn off the RAD7 and turn it on again, it goes back to the original, normal printer state.

Special SPrOff - Cancel the printer to serial port re-direction, so that output can go to the printer again.

Special SetBaud - Set the serial port bit rate. The following standard speeds are available: 300, 600, 1200, 2400, 4800, 9600, and 19,200 bps. The RAD7 remembers the serial port speed when you power down.

Special Status - Gives a snapshot of the RAD7 status page, including run and cycle numbers, countdown timer, last reading, temperature, humidity, and so on. This is basically the same information that you can get with "Test Status", but it gives the data in one shot and does not continue to update every second.

Special Start - Same as "Test Start", but does not go into a continuously updating status display.

Special Stop - Same as "Test Start".

Special S-Load - Used to load special software into the RAD7 through the serial port.

Special Version - Output the special extension version number.

Special Model - Output the RAD7 hardware version number.

Special Serial - Output the RAD7 unit serial number.

Special Beep - The RAD7 gives an audible beep tone. Does not make any sound if the tone setting is "Off".

APPLICATION EXAMPLES

Several projects are using the RAD7 as a remote control device, and other projects have been proposed. A simple use of the remote controlled radon monitor as part of a laboratory experiment was discussed in a companion paper "A Study of Radon Adsorption on Activated Carbon as a Function of Temperature" (Shefsky et al., 1993).

Figure 3 shows a remote waste site monitoring station that incorporates radon measurement at several different soil depths. Seven of these stations have been built by Reynolds Electrical Engineering Co. (Mercury, NV) for use at a Nevada waste site, and are currently being put into operation. The use of soil probes, radio modems, self generated power supply, and environmental enclosures suggests potential uses in geology research, hydrogeology, or earthquake prediction.

Figure 4 shows a simplified plan for an actively stabilized radon calibration chamber we are experimenting with at NITON. Several other small projects of this kind have been built or are being planned. One project in the planning stages is an interactive display for the Boston Museum of Science.

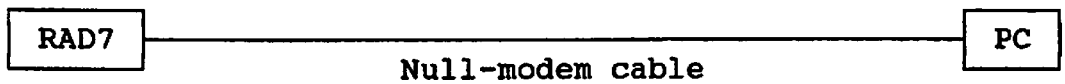
Several groups have proposed and are awaiting funding for projects to link multiple radon monitors into networks for the study of radon in large buildings, campuses, or neighborhoods.

REFERENCE

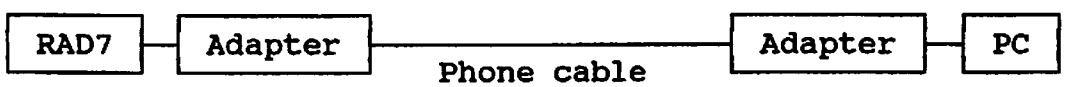
Shefsky, S.I., D. Rose, and C.G. Parsons. "A Study of Radon Adsorption on Activated Carbon as a Function of Temperature". AARST International Radon Conference, Denver, CO; Sept. 1993.

Figure 1: Methods for point to point communication.

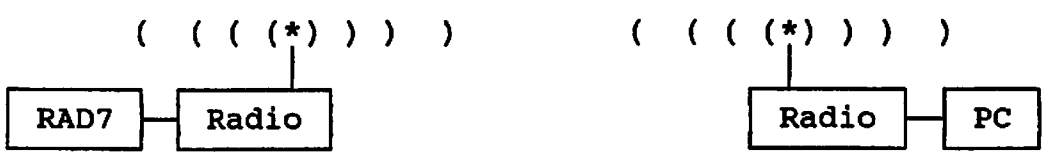
1a: Direct link from RAD7 to personal computer.



1b: Use of interface adapter, booster, driver, or short-haul modem to extend range.



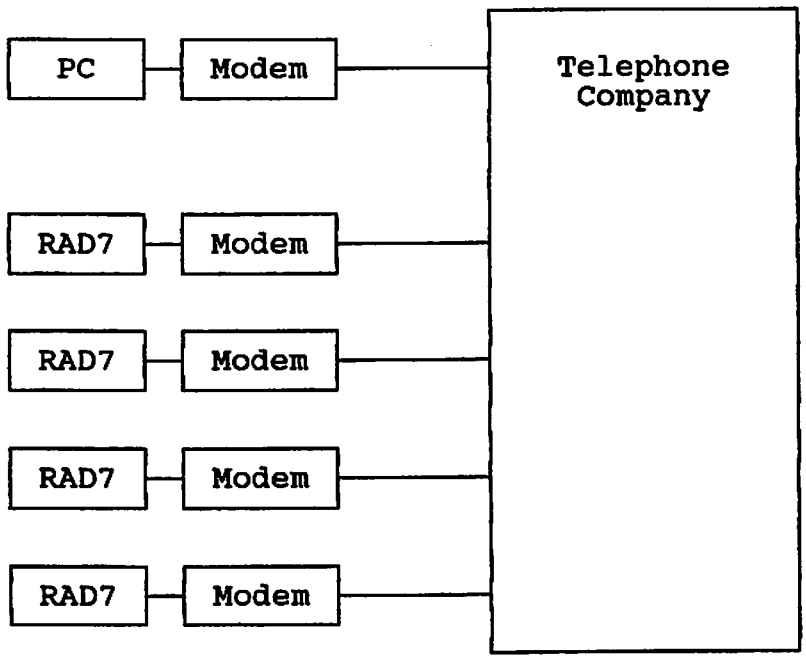
1c: Use of radio modems.



1d: Use of data modems on telephone system.

Figure 2: Network configurations.

2a: Use of telephone system.



2b: Local Area Network (LAN)

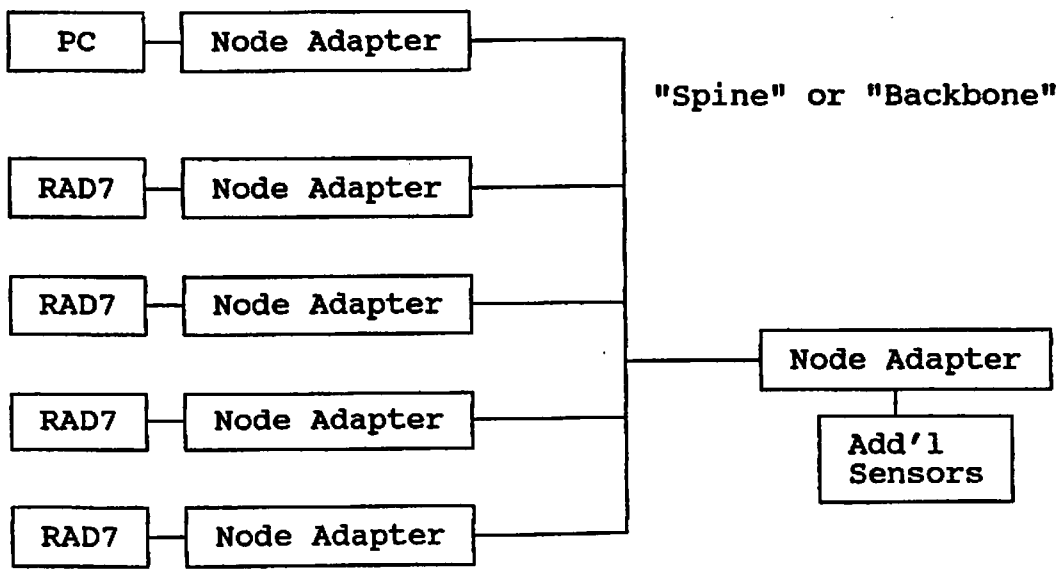


Figure 3: Remote waste site monitoring station (Reynolds Electrical Engineering Co., Mercury, NV). This figure represents one of 7 monitoring stations in communication with a central data logging computer. A weather-tight, ventilated enclosure protects the electronics from the desert environment.

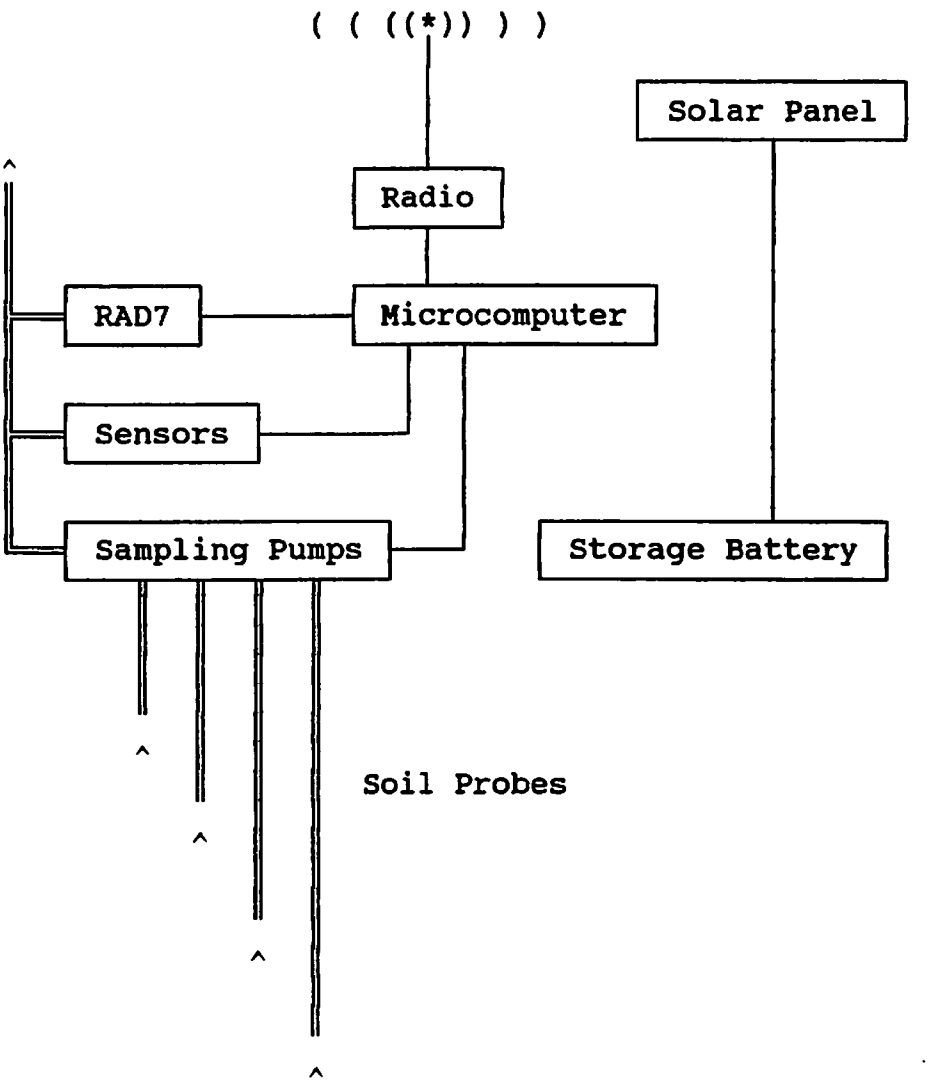


Figure 4: Actively controlled radon chamber.