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DATA ENTRY APPARATUS

This invention relates to data entry apparatus for a computer more particularly, but not exclusively, to a keyboard.

Keyboards for computer data entry are well-known and typically consists of a key pad matrix connected to a microcontroller which performs the functions of the keyboard such as keyscan, typematic control and bi-directional communication with the computer.

Control of various keyboard modes is possible either via the computer or via certain keys of the keyboard. Bi-directional communication with the computer is via a cable, with the power supply derived from the computer. Since the keyboard must perform multiple functions and yet be able to response to rapid key strokes from the user, the microcontroller firmware code needs to cater for many concurrent tasks and need to be active at all times, drawing power from the computer.

While the amount of power drawn from the computer is small, if this is provided by a portable power source, for example dry cells, the power drain is sufficient to discharge such cells rapidly. Where it is desired to provide a wireless connection to the keyboard, this becomes a significant difficulty, since power requirements increase due to the need to provide a transmitter and receiver and for these components to have sufficient sensitivity and power to cope with the inherently noisy and unreliable nature of the wireless channel.

It is an object of the invention to provide improved wireless data entry apparatus.

According to the invention there is provided data entry apparatus for a computer comprising data entry means connected to a transmitter for sending data entry signals via a wireless link, a receiver connected to data processing means for processing data entry signals received from the data entry means and data control signals received from a said computer and for sending data to the said computer in accordance with both said signals.

With the described embodiment of data entry apparatus of the invention, the data entry means, for example a keyboard and transmitter, sends data entry signals over a wireless link to the receiver and data processing means for processing the data entry signals into a form for sending to the computer and for processing data control signals received from the computer. Such data control signals may include, for example, typematic instructions affecting data flow rate and such like. Such signals are not sent over the wireless link but are directly interpreted. The signals are then combined with the data entry signals from the data entry means and data is sent to the computer in accordance with both signals.

With such an arrangement it is possible to rely on a uni-directional wireless link with information being transferred from the data entry means to the data processing means and not vice-versa. This allows the data entry means and transmitter to be controlled in a simple way and only need to be responsive to the data entry means. Preferably, the data entry means includes control means for powering up the circuitry only upon depression of a key and for powering down after data representing the key pressed is sent to the receiver, thus requiring only little power in short bursts every time a key is pressed and negligible power at all other times.

Additional preferred features of the invention may be found in the appended claims.

An embodiment of the invention will now be described, by way of example, with reference to the accompanying drawings in which :

Figure 1 is a schematic view of an embodiment of the invention

Figure 2 is a flow chart illustrating the operation of the keyboard and associated circuitry of Figure 1.

Figure 3 illustrates a data signal packet sent from transmitter to receiver.

Figure 4 is a schematic diagram of the operation of the receiver and microcontroller of Figure 1.

Figure 5 is a flow chart further illustrating the operation of the receiver of Figure 1.

With reference to Figure 1, an embodiment of the invention is shown which comprises a wireless keyboard module 100 and a receiver module 200.

The module 100 includes a keyboard 110 which is provided with a plurality of switches forming a keyboard matrix 120, the keyboard matrix being connected to a microcontroller 130 which provides an output signal to a RF transmitter 140.

The receiver module comprises a RF receiver 210 connected to a microcontroller 220 which is connected via a bi-directional wire link 230 to a personal computer 300. The microcontroller 220 is provided with a read only memory 240 and has output to an LED array 250.

The transmitter 140 and receiver 210 are of standard construction including modular/demodulator, voltage controlled oscillator, prescaler and phase-locked loop circuitry.

Operation of the keyboard 100 is illustrated with reference to Figure 2 which is a flow chart illustrating operation of the microcontroller 130.

In normal operation, the controller 100 is in a "sleep" or shut-down condition drawing almost no power at all (step 400). The only element of the controller in an active state is interrupt-driven circuitry to determine if any key is pressed at step 410. Upon activation of any key, the microcontroller wakes up at step 420, starts up its oscillator (not shown) and at step 430 checks for the key pressed by using a standard key-scanning algorithm. Upon identification of the key pressed, the microcontroller 130 retrieves a corresponding code from memory and sends the code to the transmitter at step 440.

The controller then checks at step 450 to determine if a further key is pressed and if so loops to step 430. If not and on completion of the code transmission, the controller 130 shuts down all the electronics before shutting itself down so as to conserve power. The entire cycle, which takes only 20 milliseconds is repeated at every key press. No on/off switch is necessary as the keyboard is essentially off under a no activity condition. As the controller 130 only performs a simple sequential task, sending one byte of data when a key is pressed and one byte of data when the key is released, with no need to store any variable conditions, the data needed to be transferred is low and thus a lower frequency of transmission may be used reducing power consumption requirements further. Preferably, a UHF frequency band is chosen for transmitter 140 as this allows a simple and efficient transmission with low power consumption.

The data entry signal sent to the transmitter 140 by microcontroller 130 will now be described. The signal comprises four packet transmissions, the first being a Key Make transmission, which is then repeated, followed by a Key Break transmission, also repeated. An example of the Key Make transmission is shown in Figure 3 and this comprises a series of ten synchronisation pulses, of which three such pulses S1, S2 and S3 are shown, each of period X, followed by a 9 bit data stream, terminating in a parity bit (not shown) and a stop bit (not shown). The data, parity and stop bits are represented by "1"s and "0"s being pulses of different period, in the case of logical one, the period being 1.5X and for logical zero being 2X. In the example given, the first five bits of the data signal shown are "10110...".

For the Key Make instruction, the first data bit is always a logical "one" with the following 8 data bits providing the information as to which key has been pressed. The

Key Break transmission is exactly the same as the Key Make transmission except that the first data bit is a logical "zero".

The average transmission rate is approximately 3 Kbits per second, significantly lower than that of normal key boards. The slow bit rate allows the use of a UHF ASK transmitter which uses less power than the traditional FSK transmitter, thus conserving power at the transmitter side. However, the pulse rate is chosen such that it is still significantly faster than the ability of a person to type. The synchronisation pulses serve two functions. Firstly, they help the receiver to pick up the data entry signal from the random noise often encountered at the receiver input. Together with the parity bit, this enables a very robust and noise tolerant transmission method. Secondly, the synchronisation pulse are used by the receiver to calculate the average reference pulse width. A pulse width is defined as the time from a low to high transition, to the next low to high transition as seen at the receiver output. Since the receiver recalculates the reference pulse width at each data stream sent, frequency stability at the keyboard microcontroller is not important. This allows for the use of a cheap resistor to replace an expensive crystal, in the controller 130 thus saving cost further. Allowing this tolerance in synchronisation period also allows variation across different keyboards due to part tolerances, thus improving manufacturability at high volumes.

Operation of the receiver module 200 will now be described with reference to the flow chart of Figure 4.

Unlike the keyboard module 100, since the receiver module 200 is permanently connected to the computer 300, it is possible to provide this with a direct power link and, thus,

power saving requirements are not a factor.

As shown in Figure 4, the receiver module has several functions, the first in step 500 being to check for commands coming from PC 300 along data line 230. Such commands may be state commands determined by software such as NumLock, CapsLock, etc. Such commands are not sent to the keyboard module 100 (there is no bi-directional capability on the receiver-transmitter link 210-140) but the microcontroller 220 sends at step 510 acknowledgement to the PC 300 as if the command had been sent to the keyboard. If the state command involves the illumination of an indicator light on the keyboard, as this cannot be instructed to the keyboard, instead the microcontroller 220 lights an appropriate indicate light 250 on the receiver module itself. In the alternative, the microcontroller 220 may send a command to the PC for display on screen of an icon or by using a TSR (Terminate but Stay Resident) program.

At step 520, RF input from the receiver 210 is checked to see if a data transmission has been initiated and, if so, this is interpreted and sent to the PC 300. The input line from the PC 300 is then monitored again at step 530 to determine if any typematic function command is or has been sent, relating to data flow, for example and the command is implemented. The program then loops to step 500 and the program operates continuously.

The step 520 is shown in more detail in Figure 5.

At step 600 the microcontroller 220 checks to see if a Key Make data signal has been received from receiver 210 and if not the program loops to step 530. If so, at step 610, it is determined if 100 characters or more have been sent and if not at step 630 the period X of the synchronisation pulses $S1 - S3$ of Figure 3 is determined and at step 640 the time periods of a logical 1 ($1.5X$) and logical 0 ($2X$) are calculated. The data packet is then decoded at step 650.

The first and second transmission of the Key Make instructions are then compared at step 660 and if the data is identical, the data is transmitted at step 670 to PC 300. At step 680, receipt of the Key Break instruction, (and its repetition) is awaited and once both are received this instruction is also sent to the PC 300 at step 690. Until the Key Break instruction is received, auto repeat characters, depending upon the auto repeat period instructed by the computer 300 will be sent at step 685. The program will break out of the Key Break loop after a time-out period or if the two Key Break instructions are not identical, sending an error message to PC 300 and looping to step 600.

After sending a Key Break data signal to the PC at step 690 the program loops to step 600.

Where more than 100 characters have been sent at block 610, the calculation period for "1" and "0" are assumed, based on an average and these periods are set at step 620 before the data is decoded at step 650.

While the invention has been described by way of example with reference to a keyboard system for a personal computer, this is not to be construed as limitative and use with any data entry means for example a mouse or joystick for a personal computer or for any digital data handling device is envisaged. Furthermore, while the wireless link has been described as a UHF link other wireless transmission links, for example infra-red, may be used.



CLAIMS

1. Data entry apparatus for a computer comprising
data entry means connected to a transmitter for sending data entry signals over a wireless link,
a receiver connected to data processing means for processing data entry signals received from the data entry means and data control signals received from a said computer and for sending data to the said computer in accordance with both said signals.
2. Apparatus as claimed in claim 1 wherein communication over the wireless link is uni-directional from the data entry means to the data processing means.
3. Apparatus as claimed in claim 1 or claim 2 wherein the receiver and transmitter are for UHF reception/transmission.
4. Apparatus as claimed in claim 1 or claim 2 wherein the receiver and transmitter use infra-red reception/transmission.
5. Apparatus as claimed in any one of the preceding claims wherein the data signals transmitted over the wireless link comprise at least one synchronisation pulse and a plurality of data bits represented by respective pulses each having a period which is a multiple of the period of the synchronisation bit.



6. Apparatus as claimed in claim 5 wherein the periods for a logical true and for a logical false differ by at least half the period of the synchronisation bit.
7. Apparatus as claimed in claims 5 or claim 6 wherein the data processing means includes means for adaptive determination of the period of synchronisation of the data signal and for computation of the bit period of logical true and false.
8. Apparatus as claimed in any one of the preceding claims wherein the data entry means comprises a keyboard connected to a microcontroller, the microcontroller being further connected to the transmitter.
9. Apparatus as claimed in claim 8 wherein the microcontroller is in a normally off state and is activated upon depression of a key of the keyboard.
10. Apparatus as claimed in any one of the preceding claims wherein the data processing means is further connected to means for indicating visually at least one data control signal received from the said computer.
11. Apparatus as claimed in any one of the preceding claims wherein the data entry signal representing a single key depression comprise a Key Make instruction defining the key pressed and a Key Break instruction defining when the said key is released.
12. Apparatus as claimed in claim 11 wherein the Key Make and Key Break instructions are repeated in the data entry signal.



13. Keyboard apparatus for a personal computer comprising:

a keyboard module having a key pad connected to a microcontroller for determining the key pressed and for sending a data entry signal to a transmitter, the module having a portable power source, and

a data processor, connected to a receiver for receiving a said data entry signal over a wireless link from said transmitter and connectable to a said personal computer over a wired link for receiving data control signals from the computer, and for sending keyboard data to the said computer in accordance with both said signals.