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THE FUNDAMENTALS

Serial bus technology is employed in every area of modern telecommunication and data transmission in order to cope with the continuing increase in the quantities of data which must be handled. The most important feature of a serial bus system is that it requires only one cable, which supplies both energy and information to multiple devices. In terms of model aircraft, the most obvious feature of this method of connecting servos is not very suitable for large-scale models, because it offers no security features of any kind.

An enhancement in security is the redundancy of the receivers and serial connections between the receivers and the backer.

CONVENIENT, SIMPLE, AND SAFE

PowerBox Systems has a history of enhancing safety in flying large, valuable model aircraft. PowerBox’s latest product — the PowerBus — builds on this design philosophy.

The technology is not new; bus systems represent the state-of-the-art in the RC industry. In basic terms, the servo data is transmitted serially at high speed using a single cable — a bus. Current model airplanes carry a great deal of extremely sophisticated equipment, so it was really only a matter of time before bus systems were introduced into model aircraft.

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POWERBOX BUS SYSTEM

is encoded. The data carries an address code in addition to the pure information for the servos’ positions. The servos connected to the PowerBus or the bus adapters understand this code, and only process the information intended for them — they ignore the remainder of the data stream. In practice, this works as follows: the rudder servo knows its own encoded address, and extracts from the data stream only that information which is addressed to it. It utilizes this information to carry out the required rudder movements.

If the PowerBox system is used, the connection between the transmitter and the servos is digital from start to finish. The transmitter generates digital, high-resolution signals in accordance with the current positions of the transmitter’s controls. These data are then passed serially to the receiver at high data rates; modern systems mean a 2.4-GHz radio connection. It makes no sense for the receiver to convert these data into quasi-analogue PWM (Pulse Width Modulation) signals and pass them to the various servos in radial form via individual cables, only to have the signals be converted back into digital form if the model is fitted with digital servos. This multiple data conversion processes takes time. There is, however, another fundamental problem, the danger of errors creeping into the conversion process. Modern technology uses a completely digital connection, as it offers maximum security and speed. You only need to think of the efficiency of USB connections, as mentioned earlier.

SAFETY FIRST

The individual airborne components required for the control of a model aircraft may be arranged in various ways, and their positions play an important part in operational safety. Fig. 1 shows the simplest arrangement, which is still employed today in many models. The various servos for the two wing panels, the two elevator servos, one rudder servo, and the throttle servo are connected directly to the appropriate receiver outputs. Each servo is connected using a separate three-core lead which carries both positional information and electrical energy. Data density on the individual data wires is very low; all that passes along the signal wire is a chain of PWM signals. This arrangement of the airborne electronics offers far too little security, especially when we are dealing with large-scale models. There is absolutely no redundancy, and this is a particularly glaring omission in the case of the power supply. The arrangement shown in Fig. 2 solves this gap in security. The PowerBox Professional incorporates a battery backer, which provides for redundancy in the power supply. The airborne electronic system is powered by two independent batteries, and this represents a significant improvement in safety in the power supply. In addition to a constant, stabilized voltage, the use of a backer of this type provides further safety-relevant advantages. The servos signals are amplified and interference signals are suppressed. The individual servos are de-coupled from each other. The unit also features an integrated Servo Match function, which is more than just convenient; it is vital if a single control surface is actuated by multiple servos. Servo matching is used to fine-tune the servos’ travels and avoid them working against each other. Unfortunately, a backer of this type involves further complication in the wiring arrangement, since additional patch-leads are required between the receiver outputs and the backer inputs. These are needed because the signals transferred at the input and output are PWM signals, so the data density on these cables is also low. Moreover, there is less than optimal in terms of reception redundancy — there is none, since the system only incorporates one receiver.

The wiring system typified by Fig. 4 solves this problem, since it is based on two independent receivers. However, it is no longer possible to wire both receivers individually, so a serial bus system is required, as shown in the diagram. Modern 2.4-GHz receivers are fitted with serial output sockets for precisely this purpose. The data density in this circuit is high, and the information is passed from the receivers to the backer in serial form. In this case, the signals transferred are digitally encoded, i.e., they contain both positional data and addresses. This is useful for data transmission. However, even with the arrangement shown in this diagram there is a drawback: the data passed from the backer to the servos is still quasi-analogue in nature. In other words, they take the form of PWM signals, so there is still room for improvement.

PowerBox Systems has now tackled this drawback with the PowerBus. Fig. 4 shows a typical circuit in diagrammatic form: serial signal chains for all the servos are generated by a bus-enabled backer — such as the PowerBox Champion — and passed along three-core cables of adequate size. The bus cable also carries the power supply to the servos. Data density is high both at the input and output side of the backer. This arrangement greatly reduces the complexity of the wiring and creates a digital flow of information from the transmitter right through to the servos. Data transfer operates in accordance with a protocol. The information is encoded and carries an address code as well as positional information for each servo. Each of the servos connected to the bus understands this code, and only processes the information intended specifically for it. The servos simply ignore all other data. In simplified form, the system works like this: the rudder servo knows its own encoded address. From the data stream, it extracts just the information addressed to itself and uses that information to generate the movement of the rudder. Considerable weight is saved through the elimination of individual servo leads. This method of controlling servos reflects the current state of data transmission technology.

POWERBUS SYSTEM DESIGN FEATURES

The PowerBus transfers data from a maximum of sixteen proportional channels and two switched channels. The bus can therefore control the corresponding number of servos. It is not uncommon for the two bus outputs fitted to the PowerBox backer to be insufficient in such cases, a distributor — known as a PowerBox splitter — must be employed. These units feature one output and two outputs and provide a convenient means of creating one bus branch for each wing panel, and a third for the tail surfaces, as shown in Fig. 4. The advantage is obvious: a single three-way connector is used at each wing root to connect the wing-mounted servos. The splitter is housed in a very small, lightweight plastic case, while the connections take the form of the familiar heavy-duty MPX connector system. PowerBox Systems can supply ready-made cable sets for the bus wiring. They are available in various lengths, and are manufactured according to high standards of quality. However, the modeler can also make their own bus leads for the exact length required, as the cable is available ‘off the roll’, and the plugs and sockets are widely available.

The servos are actually connected to adapters, of which PowerBox Systems can supply two different types. The PowerBus-to-PWM adapter is used for servos that do not feature a bus-enabled backer. The hub of the system is a modern RS232 backer with bus outputs such as the PowerBox Champion SE5, with satellite ports.

Components like these are used to assemble a PowerBus system. The connections are simple and quick to make.
signal is decoded in the adapter, which converts it into a standard PWM signal. It is extremely simple to configure the correct channel. All you need to do is to position the bus leads quickly and reliably to follow the operating instructions. Hold down the SET button, then connect the bus lead to the adapter's input. The LEDs assigned to the servo outputs will light in sequence. When the output you wish to program is active, release the button and the corresponding LED will continue to glow, but much less brightly. Repeatly press the SET button to select the channel whose signal is to be generated at this socket, and the settings are stored. To program a different port, simply disconnect the adapter briefly from the bus. Modern analogue servos can be used with the PowerBus-to-PWM adapter, as well as digital servos.

The PowerBus-to-Bus adapter does not feature an integral decoder, and is designed to be used in combination with servos that already contain their own decoder. This type of servos can be configured independently in order to assign the channel you require. Such servos are available; the PowerBus is fully compatible with 5-Bus servos made by Robbe/Futaba, which means they promise complete normal operation of the servos. They continued to function completely normally, so our verdict is that the electronic fuses do exactly what they promise. Once the short-circuit was removed, the affected servo immediately reverted to normal operation. You must not underestimate the importance of this feature of the PowerBus system. It is also important to know that there was no heat build-up in the servo lead when a short-circuit was deliberately provoked, so a "servo short" will not cause a cable to catch fire.

Another interesting point about the PowerBus system is that the level of the current at which the electronic fuses are triggered. It is clearly vital that a fuse is not tripped simply because a servo must cope with a momentary severe current load. This is clearly not the case with this system. We established that a current up to 7.0 amps could be applied to the power supply leads at the output of an adapter before the fuse responded, and currents of this magnitude do not occur even in extreme pull-out maneuvers. If a servo should ever draw such a high current, it is an absolutely clear indication of a fault, and this will not influence the system as a whole thanks to the presence of the electronic fuses.

SUMMARY

The introduction of the PowerBus system is a notch in terms of operational security. The new, simple method of wiring servos has a significant reducing effect: everything becomes simpler and lighter. At the same time, the system does not exclude the possibility of current fault to use existing high-quality servos equipped with PWM adapters. In our laboratory session, the system easily passed every test. It represents the current state of technology, and even offers protection from the effects of operational faults. Anyone planning to outfit a new large-scale model should seriously consider the adoption of this new technology.