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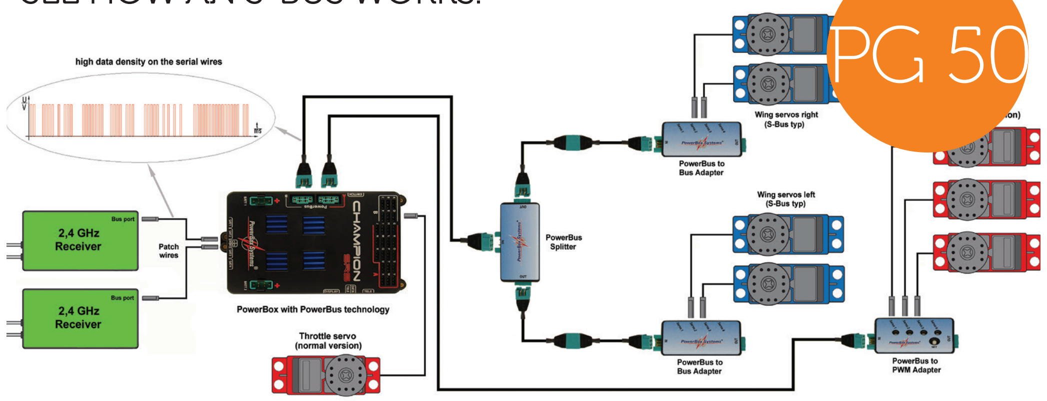
DEPARTMENTS

SEE HOW AN S-BUS WORKS.



PG 50

HOT PRODUCTS

PG 14

BUILD

PG 34

ROB SHOWS YOU HOW COMING BACK TO A NEGLECTED PROJECT AFTER YEARS CAN BE A REWARDING EXPERIENCE.

HOW TO

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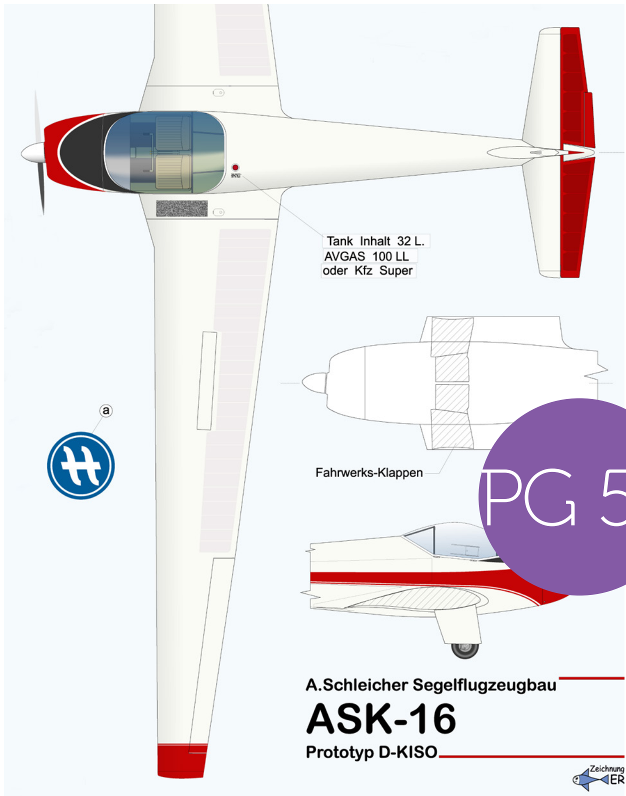

PG 56

3-VIEW

THE E-FLITE CARBON-Z YAK 54 3X MAKES 3D EASIER THAN EVER.

PG 64

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RIGHT OUT OF THE BOX, THIS HELICOPTER IS AN ADRENALINE RUSH!

REVIEWS

POWERBOX BUS SYSTEM

CONVENIENT, SIMPLE, AND SAFE

BY DIPL. ING. KARL-HEINZ KEUFNER

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 electronics, so it was really only a matter of time before bus systems were introduced into model aircraft.

PowerBox Systems is an innovative company that has now introduced such a system. This article will clarify how their system works. It will also convey some of the technical background relating to bus technology and outline its advantages as they apply to model aircraft. I'll share our laboratory tests on the components of the PowerBus system.

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 modern method of data transfer is that all servos are connected using a single cable; i.e., one bus branch. Naturally this means the bus cable has to handle data at a much higher sample rate than a conventional radial (hub-and-spoke) wiring arrangement, where each servo is connected separately to the receiver. Although this principle is a departure for the model aircraft world, it is a totally mature technology.

In our everyday lives we constantly use data transfer structures of this type, and they work very efficiently. For example, most peripheral devices — such as printers — are connected to a PC using a USB interface; i.e., as in the case of the Universal Serial Bus. Nowadays the best method of telephony involves the use of a digital data cable and Integrated Services Digital Network (ISDN) telephones or similar digital terminal devices. This arrangement allows several digital telephones to operate using a common bus. When it is necessary to use conventional analogue telephones, appropriate adapters are employed. This again is a serial bus: the ISDN bus. In the world of professional telecommunications technology, the ISDN bus is now a fundamental component. Connecting each telephone to a central hub using separate cables in a radial arrangement would be far too complex and prone to problems.

However, the radial method is exactly how we have always wired up the equipment in our model aircraft: all the servos are fed information via dedicated cables. One result is complex, confusing wiring in the model, combined with excessive weight. Anyone who has tried wiring a glider's servos that uses three control surfaces and an airbrake per wing panel is well aware of these problems. If that includes you, you will be delighted to find that the PowerBus enables the same system to be wired in a wing using just one cable.

Note that the data on the bus

FIG. 1

This method of connecting servos is not very suitable for large-scale models, because it offers no security features of any kind.

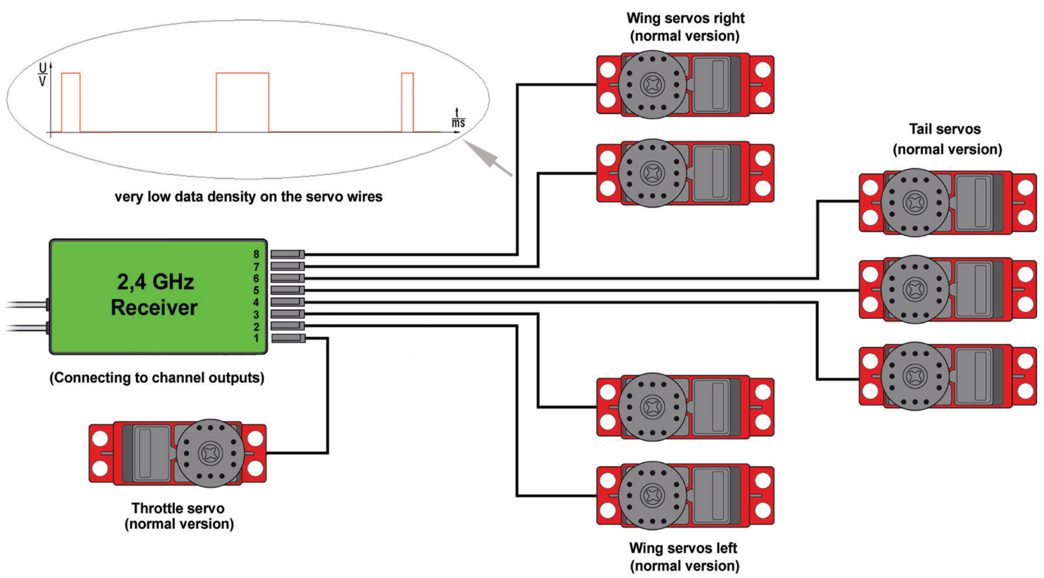


FIG. 2

Much better and safer, in this system the servos are connected using a high-performance battery backer.

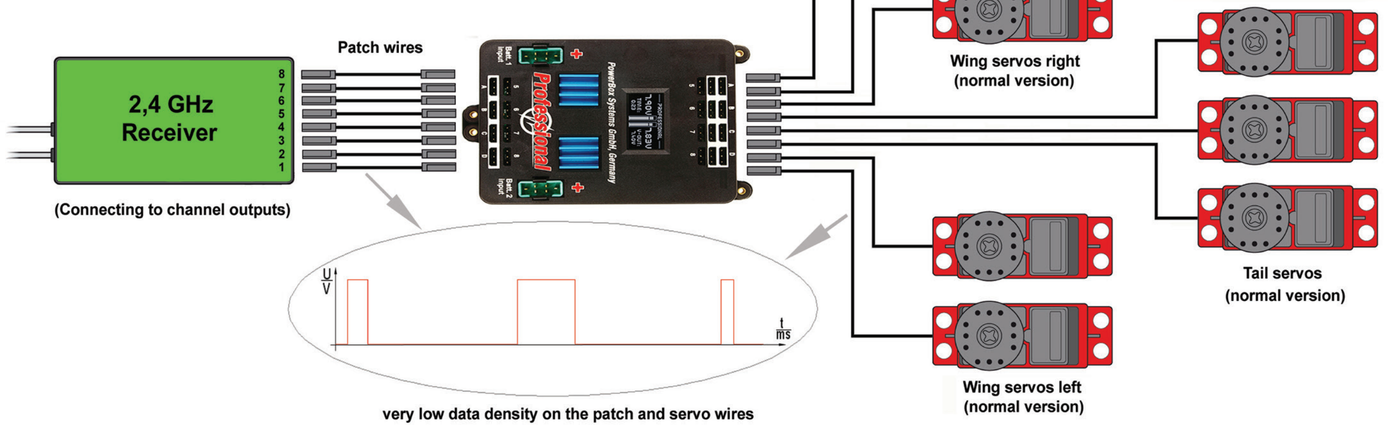
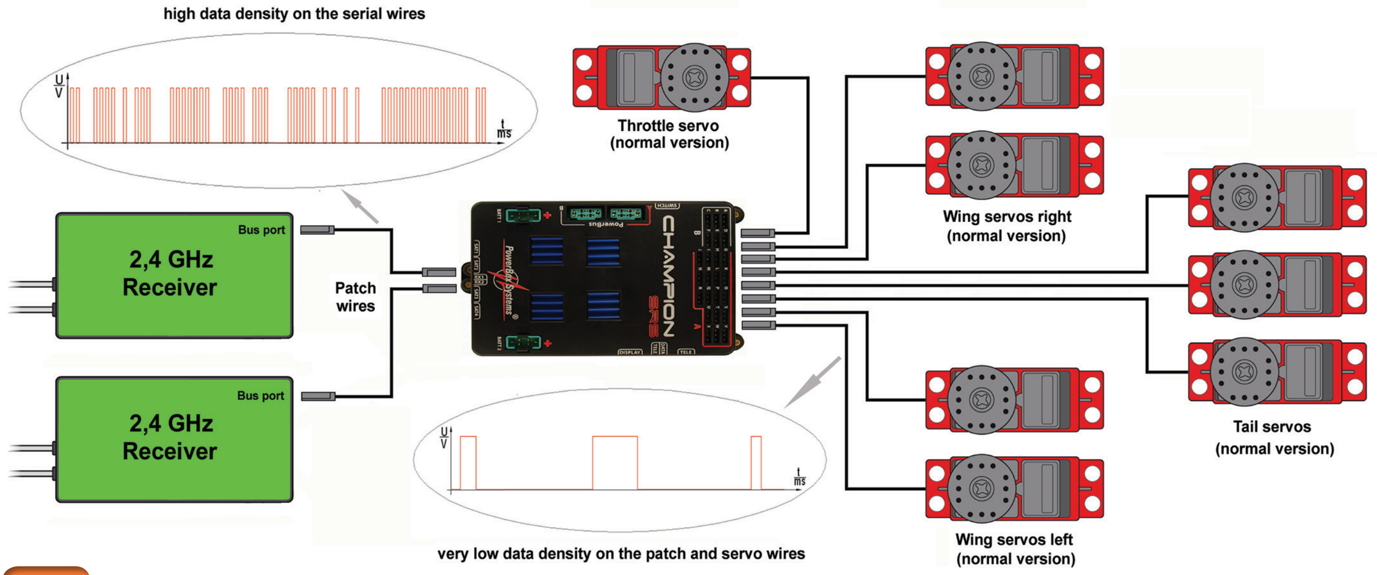


FIG. 3

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



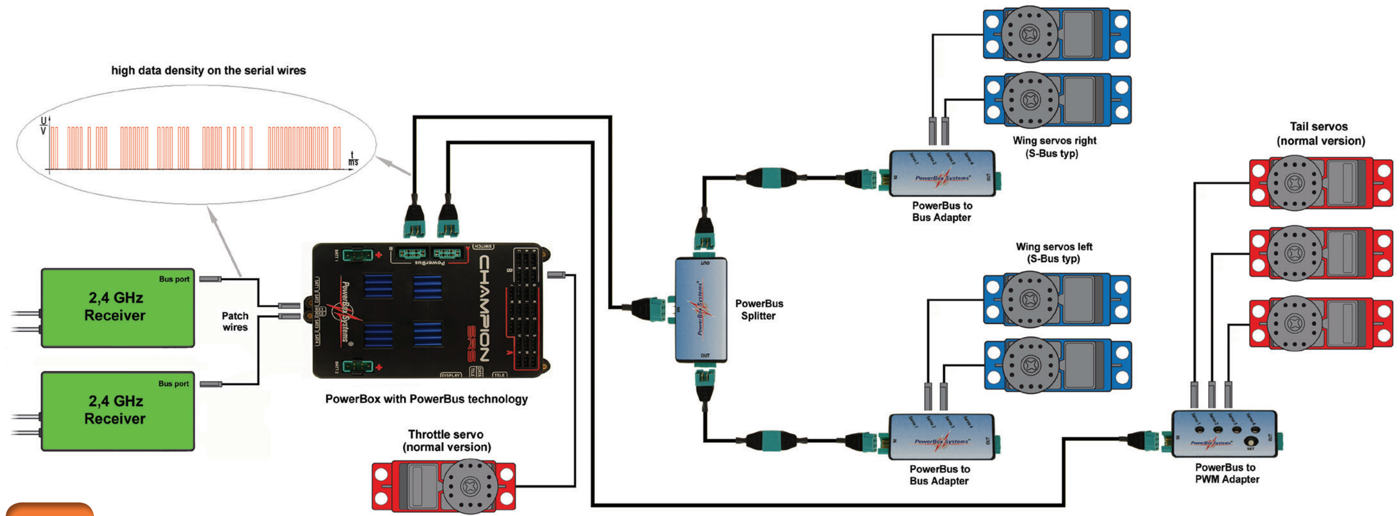


FIG. 4

This is the future. It provides ultra-safe, convenient serial servo connections to the receiver via a PowerBox backer.

» 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; nowadays, this means 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 for the signals to 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** closes 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 servo 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. This arrangement is also less than optimal in terms of reception redundancy — there is none, since the system only incorporates one receiver.

The wiring system typified by **Fig. 3** 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 professional 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.

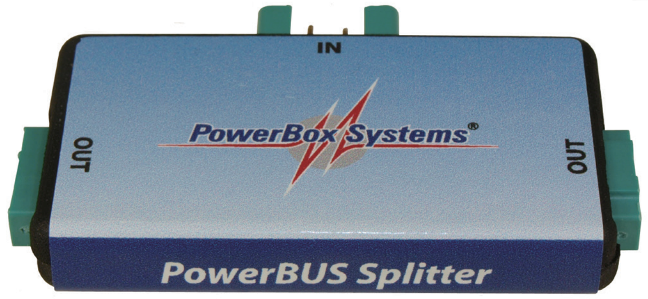
Components like these are used to assemble a PowerBUS system. The connections are simple and quick to make.

The hub of the system is a modern SRS backer with bus outputs, such as the PowerBox Champion SRS, with satellite ports.

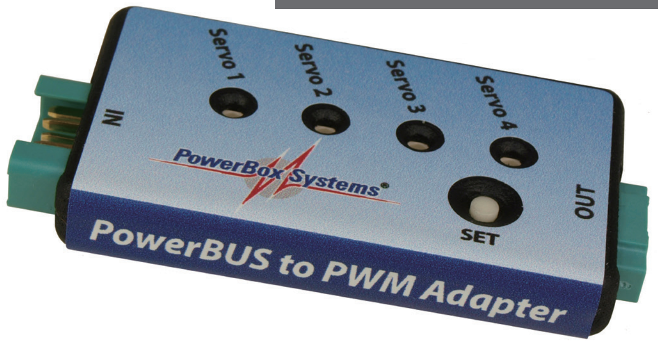
POWERBUS SYSTEM DESIGN FEATURES

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 PowerBus splitter — must be employed. These units feature one input 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.

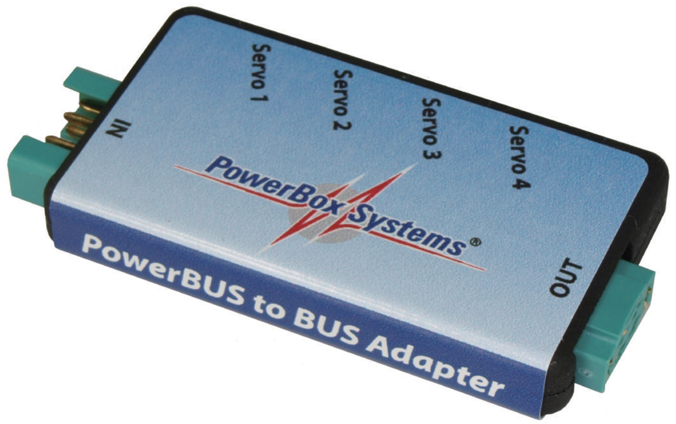
The servos are actually connected to adapters, of which PowerBox Systems can supply two different types. The PowerBus-to-PWM adapter is used for servos that do not feature an integral bus decoder. The bus »



A PowerBUS splitter is employed if additional bus cables are required. As you can see there is tone input and two outputs.



Conventional servos can be operated using a Bus-to-PWM adapter. It supports up to four servos on the output port.



The Bus-to-Bus adapter is used for connecting servos which feature an integral decoder. I explain this in the text of the article.

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 do to complete the task quickly and reliably is 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. Repeatedly 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.

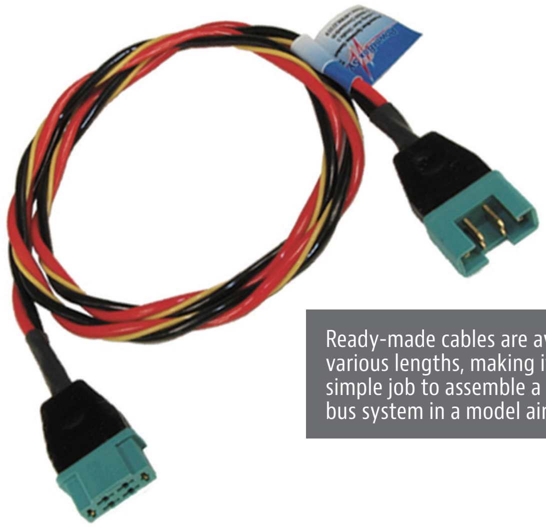
The PowerBus-to-Bus adapter does not feature an integral decoder, and is designed to be used in combination with servos that already contain their own decoder. This type of servo can be configured independently in order to assign the channel you require. Such servos are available; the PowerBus is fully compatible with S-Bus servos made by Robbe/Futaba, which means any S-Bus servo can be connected directly to the Bus-to-Bus adapter. There are various possible methods of configuring an S-Bus servo; i.e., of assigning the correct channel. You will find detailed information on this in the operating instructions supplied with all Robbe/Futaba S-Bus servos.

There is a another very important aspect of the PowerBus which should not be overlooked — integral short-circuit and overload protection. The outputs of the PowerBus-to-PWM adapter and the PowerBus-to-Bus adapter are protected against these situations. The protection takes the form of electronic fuses and applies both to the data wires and the power supply. It would clearly be disastrous if a single faulty servo were to affect all the other servos connected to the bus and prevent them from working. If a short-circuit suddenly occurs in a servo, and blocks the signal input, then the fuse switches off this port within a few micro-seconds, and the bus remains functional. All the other servos continue to operate entirely normally. The same applies to the servos' power supply. The electronic fuses immediately unlatch when the fault is corrected. Every adapter features integral signal amplifiers for all servo outputs and the bus output. This simply means the optimal signal is always fed to the servos, making it possible to wire multiple bus adapters in a series.

LABORATORY TESTS

The PowerBus components were subjected to a comprehensive test program in the laboratory. Our initial impressions: everything is very easy and convenient to handle, and can be inter-connected very quickly and securely. The essential programming of the PowerBox Champion backer is also a quick, painless procedure. For our purposes, the only important point is knowing which channel assignments are present. Unrestricted channel assignment facilities are provided in the backer's Output Mapping menu, so it is possible to assign the bus channels exactly as you wish. The programming of a PWM adapter turned out to be just as effortless using the procedure described above, resulting in four standard digital servos of different makes operating normally with the adapter and the PowerBus. Tests involving Robbe/Futaba S-Bus servos in conjunction with the Bus-to-Bus adapter were just as straightforward; all that had to be done was to program the servos to the desired channel number. Nothing abnormal or unexpected happened. Everything worked to our complete satisfaction.

Futaba S-Bus brushless servos will work perfectly with the new PowerBox Systems PowerBus system.



Ready-made cables are available in various lengths, making it a quick, simple job to assemble a reliable bus system in a model aircraft.

SPECIFICATIONS

PowerBus splitter	
Operating voltage:	4.0 – 9.0 V (2S LiPo, 2S LiFePo, 5S NiCd / NiMH)
Maximum load current:	Max. 30 amps
Signal input:	PowerBus
Operating temperature range:	-30° to +75° C
Dimensions:	59 x 33 x 9 mm
Weight:	Approx 17 g
PowerBus-to-PWM Adapter	
Operating voltage:	4.0 – 9.0-volt (2S LiPo, 2S LiFePo, 5S NiCd / NiMH)
Maximum load current:	Max. 20 amps
Signal input:	PowerBus
Channels:	18
Servo sockets:	4
Servo signal resolution:	0.5 µs
Operating temperature range:	-30° C to +75° C
Dimensions:	59 x 33 x 9 mm
Weight:	Approx 17 g
PowerBus-to-Bus Adapter	
Operating voltage:	4.0 – 9.0-volt (2S LiPo, 2S LiFePo, 5S NiCd / NiMH)
Maximum load current:	Max. 20 A
Signal input:	PowerBus
Channels:	18
Servo sockets:	4
Operating temperature range:	-30° C to +75° C
Dimensions:	59 x 33 x 9 mm
Weight:	Approx 17 g

We also wanted to investigate how the electronic fuses in the adapters operated, so we stripped part of the insulation from all three wires in a servo connecting lead. This enabled us to deliberately short the conductors. We did this between the earth and signal wires, and also between the power wires. The result was absolutely clear: shorting the conductors had absolutely no effect on the operation of the other servos. They continued to function completely normally, so our verdict is 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 overestimate 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 design is 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 definitely raises the bar 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 continuing 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 defective servos. Anyone planning to outfit a new large-scale model should seriously consider the adoption of this new technology! RCSF