PowerBox Systems

World Leaders in RC
Power Supply Systems

Operating Instructions

PowerBox RRS

- Intelligent receiver backer with LCD screen
- Simultaneous switching of seven control channels
- Suitable for all receiver systems: AM, FM, PCM
- Suitable for all frequencies: 36 MHz, 40 MHz, 72 MHz, 2.4 GHz
- Suitable for use with all **PowerBox systems**

Dear customer,

We are grateful for the confidence you have shown in us by purchasing the **PowerBox *RRS*** (**R**edundant **R**eceiver **S**ystem) receiver backer from our range.

You are now the owner of a reliable, high-performance receiver backer for your valuable model aircraft; a unit which has undergone protracted testing in the hands of ourselves and our pilots. It represents a method of coupling together two trusted receivers of your own choice, as well as a means of monitoring them constantly by means of the integral LCD screen. This product is the outcome of many years of development, and ultra-precise measurements of reception conditions in typical model flying environments.
Here at **PowerBox Systems** we aim to achieve security and reliability by intelligently minimising the number of components, and by making devices which are very easy to understand and user-friendly in practice, without adding superfluous supplementary functions which tend to cloud every issue. We believe that safety and reliability always result from minimising the components and functions of any electronic accessory.

A feature shared by all products from **PowerBox Systems** is their great ease of use, and the **PowerBox *RRS*** is no exception. Creating devices which are easy for the operator to use can often be just as difficult as developing the electronic components and software required to make it work as we want them to.

When a new product from **PowerBox Systems** appears, it is always the result of our many years of experience, discussions with and ideas from many model pilots which we have gathered at Fairs, open events and competitions, plus - of course - the expertise and comments of the world's best model pilots, who for years have trusted **PowerBox systems** almost exclusively.

All our products are developed in-house in a modern production facility, are tested at our own model flying site in our own models, and - of course - are manufactured in-house. **PowerBox Systems** products are assembled on four production lines, each of which has access to electronic checking and measuring equipment which has been developed specifically for this task. High-quality microscopes are used for visual checking, and a further two monitoring stations are dedicated to the final checking of products. The net result of this arrangement is that quality control alone accounts for around **75% of the production time** for any **PowerBox Systems** product.

Although this receiver backer is simple to operate, you do need to understand certain points if you are to exploit its advantages to the full. Please read through these instructions attentively before using the RRS module for the first time; this will ensure that you quickly feel "at home" with your new equipment.

We wish you many seasons of pleasure and successful flying with your **PowerBox *RRS***.

Content

1. Introduction:

Which considerations resulted in the PowerBox RRS system?
Of course, redundant receiver systems are nothing new; they have actually been employed in satellites and other military applications for several decades. In terms of receiver backers for use in models we must mention one name here: C. Nicollet from Paris. His receiver backers were designed in the 1990's, and were based on the electronic components of the period. These backers, which we think of as **"Nicollet system"** units, were primarily installed in French large-scale model aircraft, as were flown every year at La Ferté Alais - probably Europe's most famous model flying event. However, this technology has been superseded almost completely by more modern components; the biggest difference being that current electronics can now be controlled using modern, tailor-made software.
All receiver backer products currently sold for modelling purposes are based on the principle of the **"Nicollet system"**.

However, let us return to **practical** considerations of radio reception:
Ever since the first radio-controlled model aircraft were flown, model pilots have actually managed well with just one receiver. Originally this unit was equipped with an aerial which was deployed outside the model's fuselage, usually tensioned to the fin. In later years, receiver technology has continued to develop from the early AM on to FM, then PCM, SPCM and lately 2.4 GHz technology. The receivers available became steadily better at rejecting interference, and their effective range increased. Even today, most large models - including model jets - are still flown without problem using a single receiver, even though nowadays the receiver and its associated servos are generally fed current by a sophisticated power supply system, which itself provides a further improvement in the margin of safety.

Within the typical radius of operation in which these models are flown, problems occur relatively seldom - provided that all the installed systems are working perfectly.

Current “Diversity” systems - twin-aerial arrangements - are now claimed to offer the maximum possible security, but honest research has shown that one receiver and one aerial actually provide just as good a performance, with the proviso that the equipment must be of the latest design and construction, and that all the systems are efficiently installed. Companies which promote these systems tend to ignore the factors of transmitter, transmitter power and frequencies, despite the fact that these are actually the main factors - together with the receivers - which are crucial to an effective, reliable radio link, i.e. full working range!

Why then the development of the PowerBox *RRS* module?

We have been testing the predecessors of the **PowerBox *RRS*** module for a period of almost two years in conjunction with virtually every modern receiver and transmitter available commercially today. During this test programme we discovered again and again that absolutely no reception problems occur within a radius of up to about 500 m, provided that the conditions for radio transmission are ideal. Even potential “problems” in the vicinity, including power lines, radio masts, radio relay systems and much more, have a virtually insignificant effect on potential radio range within these limits.

In contrast, greater distances, unfavourable aerial positions relative to the transmitter, and severe local circumstances often result in fail-safe phases (lasting two to five seconds) during flights.

The effective range diminishes drastically if the model carries airborne “interference” in the shape of engines with ignition systems, poorly suppressed magnetic valves, inadequately suppressed smoke pumps,

electric power systems and much more besides. From these findings we offer one serious piece of advice: when purchasing electronic accessories please select top-quality manufacturers only!

We developed the **PowerBox *RRS*** module with the aim of protecting your model when it is flying close to the limits of good reception. (Naturally the protection is also effective against total failure of one receiver; more on this later.)

If the model's receiver switches briefly into fail-safe mode due to an unfavourable flight attitude relative to the transmitter, and if the second receiver currently offers better reception, then the **PowerBox *RRS*** module is immediately able to switch over to the second unit. In fact, provided that the two aerials are deployed differently, the alternative aerial will momentarily be at a different position relative to the transmitter, and it is safe to assume that it will therefore have better reception. There is no point in deploying the two aerials parallel to each other, as this offers no advantages. Please note that the "dual-aerial theory" only offers positive benefits when the model is flying close to the limits of range, as described above.

Why does the PowerBox *RRS* module only switch seven channels simultaneously?

The first and crucial reason is once again: safety. Safety is not assured by senselessly inflating the number of supplementary functions, especially as they can be shown in practice to be unnecessary; the basis for real safety is often created by restricting the number of components and functions in a sensible manner.

As initially mentioned, countless tests have shown that what we term fail-safe events are invariably relatively brief. If one of the receivers went into fail-safe mode, in most cases it was for a period of between two and five

seconds. The second receiver is effortlessly capable of bridging this period, and the pilot is completely unaware of the problem.
Seven control channels enable a pilot to launch, fly and land any model aircraft in safety. Very few models are flown actively using more than seven channels simultaneously, and this is most certainly the case if your model is fitted with a **PowerBox Champion** or **PowerBox Royal**; if you are using one of these power supply units, five channels can be set up to control twenty servos individually. If you are using a power supply system which does not offer this facility, several transmitter channels usually have to be sacrificed just so that you can adjust the neutral position and end-points of individual servos.

When the system is operating, all the functions of both receivers work simultaneously, including those functions which are not controlled via the **PowerBox *RRS*** module. This means that channels which operate auxiliary functions (wheel brakes, aero-tow release, valves, smoke system, landing lights) can simply be connected to one of the two receivers directly, or shared out amongst the two receivers.

Now back to the real world:
Let us assume that receiver 1 is currently active when a brief fail-safe phase occurs, due to great range and unfavourable flight attitude relative to the transmitter. Within a period of 60 milliseconds (ms) the **PowerBox *RRS*** module switches to the second receiver. In our experience this fail-safe event will last no longer than two to five seconds, and you, as pilot, will be utterly unaware of the fact that the module has switched receivers to cope with it. Let us imagine that you have connected the auxiliary function wheel brakes and landing lights to the first receiver - the one which is in fail-safe mode for a few seconds - while the other receiver has been assigned the smoke pump and retracts.

In practice the situation is as follows: during this brief fail-safe period of two to five seconds, the wheel brakes and the landing lights will not work, although the other auxiliary functions connected to receiver 2 - smoke pump and retracts - will operate properly even for these two to five seconds, because the fail-safe of this receiver has not been triggered.

Now we ask you to wonder if it makes sense to manufacture the **PowerBox *RRS*** module with a capability to switch, say, fourteen or more channels, simply in order to ensure that the model's wheel brakes (for example) still function properly for three seconds of a flight when the model is at an altitude of 200 metres and is 500 metres away. As mentioned above, we believe that a good starting point for safety is to restrict components and functions; and in any case the seven functions which are crucial for controlling the model are always active. Auxiliary functions are simply connected directly to the two receivers.

In practice, if you use today's modern receivers - especially PCM units - you will soon find that the **PowerBox *RRS*** module's integral screen shows that very little switching occurs between the two receivers. As mentioned earlier, this is simply due to the fact that a good receiver with a sensibly deployed aerial is perfectly adequate under normal circumstances. If you find that the module has switched receivers five, eight or even more times during a typical flight, then this should be a warning to you: check the electronics, the receivers, the aerial locations in the model, **and don't forget to check the transmitter output power.**

Of course, the **PowerBox *RRS*** module also provides safety if a receiver should fail completely. For these reasons it is our firm opinion that the ingenious receiver-switching technology of the **PowerBox *RRS*** module

provides a more capable performance overall than a pure “twin-aerial receiver system”.

When a “Diversity reception” system is used, the input signals are co-ordinated, and the signals may be complementary to each other. Coupling two receivers together may be of benefit to the input stage of the receivers. However, no servos can be controlled using this input signal alone. It is only at this point that the receiver starts processing the signal; the decoder and the output drivers eventually feed a usable signal to the receiver servo sockets, and only then can the servos be controlled.

Our long years of experience convince us that it is not only receiver input stages which are susceptible to faults; we have often been asked to check faulty receivers which turned out to have quite excellent reception, but the model has crashed due to faults in the decoder or the output drivers.

The **PowerBox *RRS*** module works by analysing the signals (> 0.8 ms. and < 2.2 ms.) which are really, actually present at the receiver output for controlling the servos, and switches receivers accordingly; alternatively it uses the fail-safe signal generated by your individual receivers as the trigger. This principle means that the checking process assesses the receiver as a whole - not just the signal it picks up. The module analyses the actual signal quality which the receiver generates for controlling the servos, not just the signal at the aerial input - which the servos are unable to use in any case.

If both receivers are operated in PCM mode, the task of the **PowerBox *RRS*** module in assessing the receiver’s function is particularly easy. Every receiver manufacturer, whether Futaba or JR, has defined the minimum

reception standard for all that company's PCM receivers, and the receiver switches to fail-safe mode if this bottom limit is reached.

The actual trigger point is specific to each receiver, since the effective range of one may be greater than the other. If used with PCM receivers, the **PowerBox *RRS*** module uses these values, as defined by the manufacturer.

For this reason one free channel of each PCM receiver must be programmed to respond to a fail-safe event. If the receiver switches to its own fail-safe mode due to a momentary difficulty in reception conditions, the module instantly switches to the second receiver, without any further checking of the servo signal, provided that the second receiver is still supplying a valid signal. This checking occurs within a period of about 60 ms.

2. Product description:

The electronic components of the **PowerBox *RRS*** module are so designed that the servos are always controlled by one receiver.
At any one time one receiver is always selected, i.e. the servos are never supplied signals from both receivers simultaneously.
If the module detects a defective receiver, it only switches over to the second unit if the latter is working faultlessly. If both receivers are supplying an invalid signal, no switching takes place between them.
In contrast to other systems, the *RRS* module is able to switch to and fro between the two receivers within a very short time-span.
The two receivers in the system are always considered of equal value by the **PowerBox *RRS*** module; it does not differentiate between a "main" and a "back-up" receiver. The active receiver always remains active until such time as it no longer delivers a usable signal.

Right hand side of the PowerBox ***RRS***-module:

Sockets for seven patch leads from receiver 1 (RX 1)
Servo signal input from receiver 1, sockets 1 to 7

The seven receiver channels can be selected without restriction, i.e. they do not need to comply with the channel numbering. For example, if you consider that receiver channel 8 is vital to the safe operation of your model, then you can simply choose to pass this channel through the ***RRS*** module, and connect another channel, e.g. channel No. 6, directly to one of the receivers in its place. Please note that you do not need to connect all seven of receiver 1's inputs. For example, only five receiver channels can be remotely accessed if you are using a PowerBox 40/16 Expert or Evolution; in this case you would simply connect two additional servos directly to the RRS module.

If you are using a PCM receiver, you must connect one channel to the fail-safe (FS) socket on the module, and this channel must be programmed to fail-safe at the transmitter.

Important! The sequence of all the channels of both receivers must be identical in numerical terms, i.e. channel 1 of the receiver "RX 1" must also be channel 1 of the receiver "RX 2".

Left hand side of the PowerBox ***RRS***-Module:

Sockets for seven patch leads from receiver 2 (RX 2)

Servo signal input from receiver 2, sockets 1 to 7

The seven channels of receiver 2 must be in agreement with the channels of receiver 1, i.e. channel 1 of receiver 1 must also be channel 1 of receiver 2, etc.

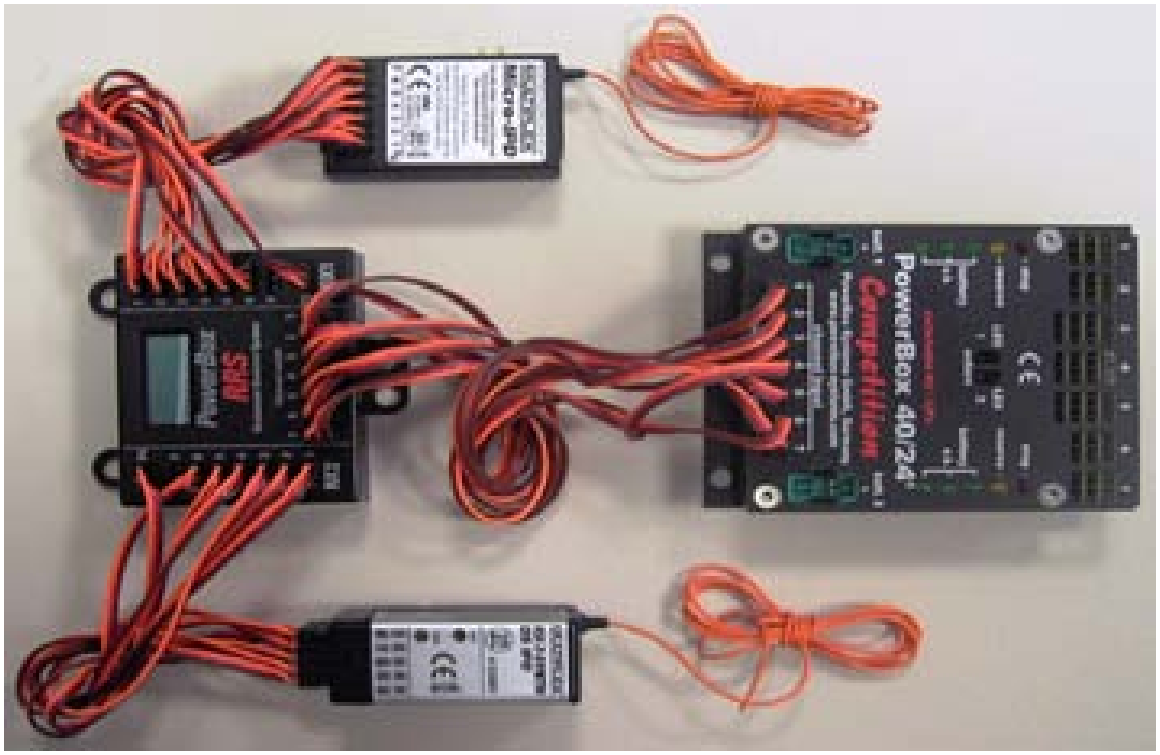
You must connect one channel to the fail-safe channel (FS socket) as for receiver 1, and this channel must be programmed to fail-safe at the transmitter.

A small tip for robbe / Futaba customers using the Futaba G3 receiver: do not forget to synchronise the second receiver to your transmitter, as described in the Operating Instructions supplied with your T 14 or FX 40 system; the system works perfectly provided that you expressly set up the transmitter to work with a second receiver.

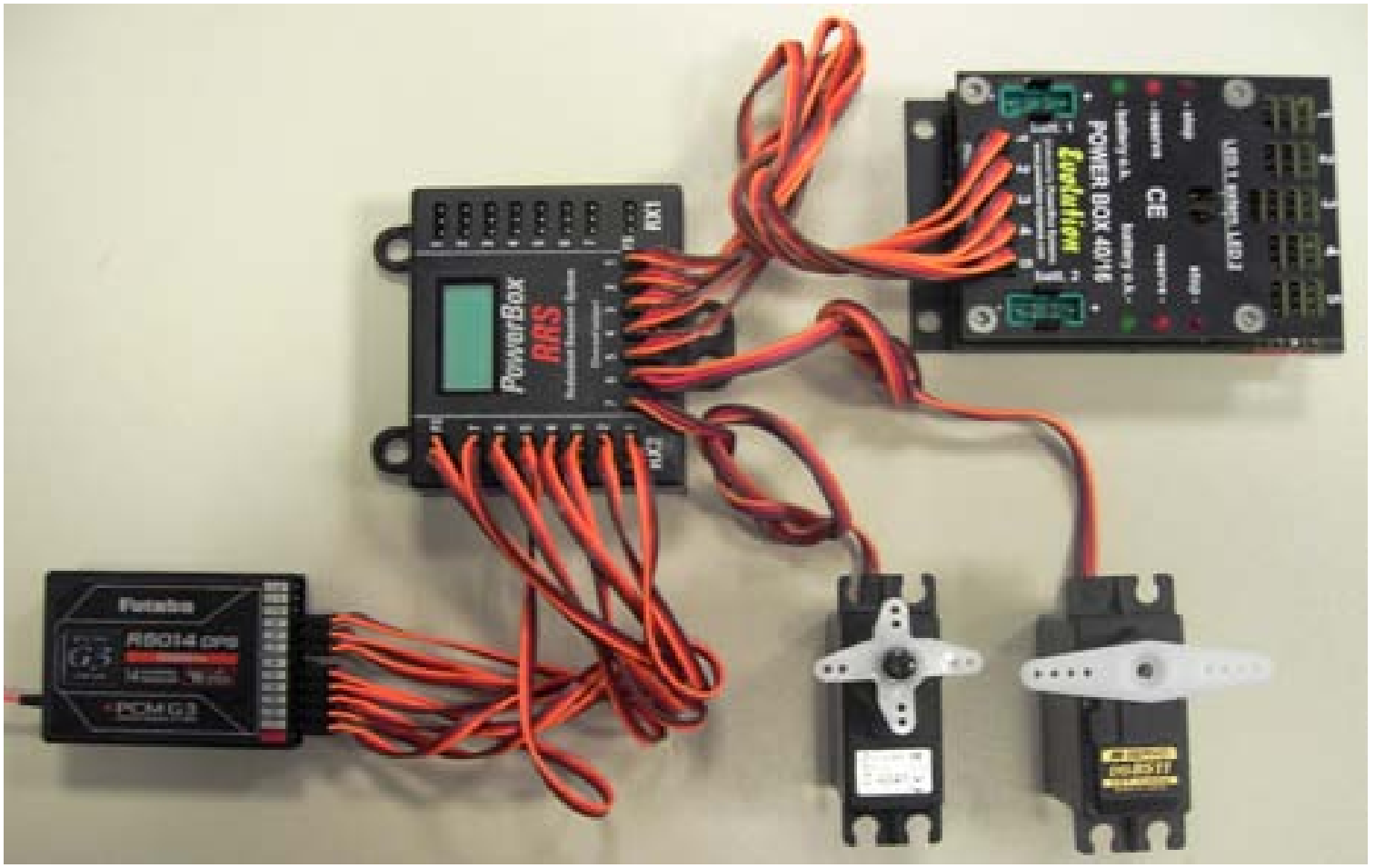
MPX-IPD-Receiver are using programmable failsafe as well, you have to use it.

3. Using the PowerBox *RRS* module for the first time:

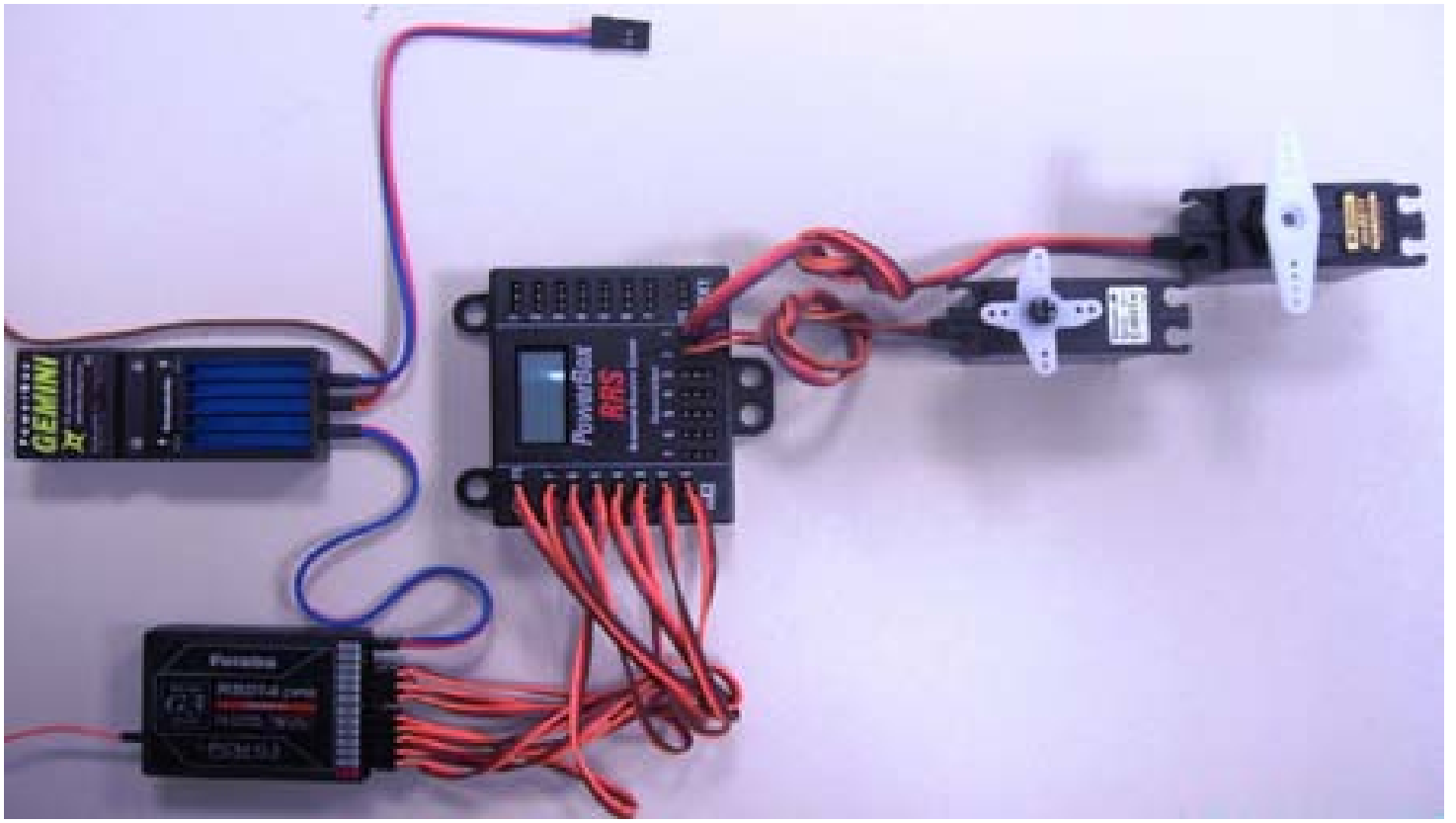
Connect your **PowerBox** (or the servos you wish to switch) to the **PowerBox *RRS*** module. It is up to you to select the channels for the appropriate functions in your model, although they would usually be the primary functions such as elevator, rudder, aileron, landing flaps, retractable undercarriage. Auxiliary functions such as smoke system, wheel brakes and landing lights can be left connected directly to the receivers.
When carrying out these connections please take great care to maintain correct polarity of the patch leads and the servo leads.
As can be seen in the photo below, two MPX IPD receivers are connected to the module: one a modern Synthesizer version and one crystal-controlled unit. Since both are seven-channel receivers, only six channels are connected for receiver switching, while the seventh channel is programmed to fail-safe and connected to the FS 1 socket.



The photo below shows the method of connecting the system using a **PowerBox Evolution**. Seven channels of the Futaba G3 receiver are connected to the ***RRS*** module, plus the fail-safe channel. Since the **PowerBox Evolution** only caters for five remotely accessed channels, there are two vacant sockets on the ***RRS*** module to which two more servos can be connected. All the remaining channels of the Futaba G3 receiver could also be used directly at the receiver.



In the third photo we see a schematic arrangement for using the **PowerBox *RRS*** module with servos connected directly to the module. Seven receiver channels plus the fail-safe channels are connected to the module using the patch leads, as described above. The servos can now be plugged directly into the module. As power supply system we recommend the **PowerBox Sensor**, or - as seen in the picture - the **PowerBox Gemini**, or even the **PowerBox 12** (the switch backer). These power supply systems feature dual electronic switches, dual voltage stabilisation, voltage monitoring and two connecting leads for both receivers. This arrangement means that you have a consistent security system for your model when using these power supply units: two batteries, two switches, two voltage regulators and two receivers.



It makes no sense to connect one switch and one battery to each of the two receivers. In this configuration the batteries are not de-coupled, and could therefore discharge each other if one battery should fail.

These wiring arrangements have no effect on any settings entered at the transmitter or at the receiver, nor to any programmed settings on the **PowerBox Champion**; no particular settings are required for operating the ***RRS*** module.

You will find the “Fail-Safe” sockets located close to the seven channel inputs for both receivers, but slightly apart from them; these sockets are marked “FS” on the ***RRS*** module. This socket should be connected to one receiver channel which you have programmed to fail-safe at the transmitter.

At the transmitter you should select a vacant channel, i.e. one which is assigned to no other function, and program it to fail-safe.
It is essential to program this fail-safe channel in such a way that it switches from 0% to -100%, **or** from 0% to +100% (half servo travel), when the fail-safe is triggered.
For information regarding the correct method of fail-safe programming, please refer to the operating instructions supplied by your RC system manufacturer.

You can use the following test to check that the fail-safe programming is correct: connect a servo to the appropriate channel, then switch the transmitter off. If the channel is correctly programmed, the servo should now move to half its full travel, e.g. from centre to one servo end-point. In this way you can easily check visually that the receiver is generating the correct fail-safe signal.
One minor additional tip: if you had to define a switch at the transmitter for the fail-safe programming (FX 40 / TZ 14, MPX), complete the programming and then disable the switch again (i.e. switch the appropriate transmitter control off). This ensures that the receiver switching process occurs automatically, without requiring the deliberate operation of a switch.

4. Use with two PPM receivers:

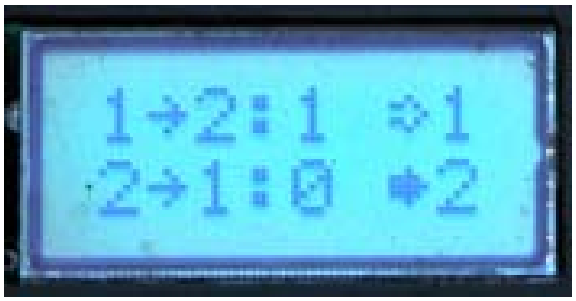
If you intend to use the unit in conjunction with **PPM** receivers, the receiver switching process is controlled by an internal program developed in-house by **PowerBox Systems**.
In this case the **PowerBox *RRS*** assesses the validity of the servo signal generated by both receivers.
The pulse width of a valid servo signal from the receiver lies between 0.9 and 2.1 ms.
If the pulse width is less than 0.8 ms or greater than 2.2 ms, if the pause between the signals is excessive, or if no signal at all is present, then the **PowerBox *RRS*** module assesses this as an unusable servo signal.
Assuming that the second receiver is still delivering valid servo signals, the **RRS** module now switches over to it.
If you are using **PPM** receivers (not IPD), the “FS” sockets should be left unused. However, you can check that the ***RRS*** module is working properly by disconnecting **Channel “1”** from the receiver or from the ***RRS*** module: in so doing you generate an invalid signal. Now look at the screen: you should see a black arrow in front of one of the two numbers RX 1 or RX 2;

the other number should only be preceded by a dot. Re-connect **Channel "1"** of RX 1, and repeat the checking procedure with **Channel "1"** of RX 2. At this stage you should carry out a careful, conscientious check of all the control surfaces. Make sure they all work correctly, and ensure in particular that they deflect in the appropriate directions.

5. What will I see on the screen?

Wire up the complete redundant receiving system, ready for use. Switch the transmitter on, followed by the receiving system.
The LCD screen has three different displays:

Display 1:

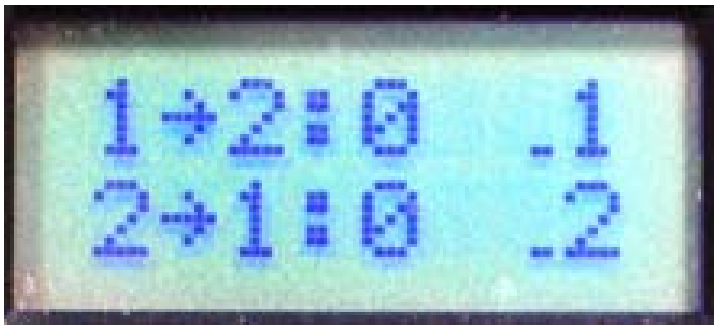


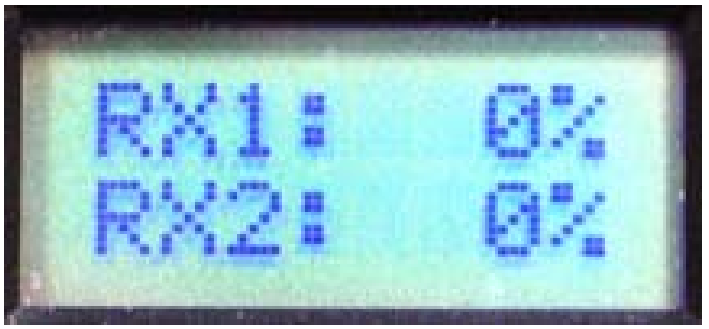
First line:
No. of switches from RX 1 to RX 2: => one event. The empty arrow before the figure "1" is very important: it tells you that receiver 1 is working properly, but is not currently being used for reception.

Second line:
No. of switches from receiver 2 to receiver 1: => 0 events.
The solid black arrow is again very important: it tells you that receiver 2 is working properly, and **is** currently being used for reception, i.e. this receiver is actually controlling the servos.

Important! An arrow must be displayed before both numbers 1 and 2, as this indicates that both receivers are working correctly. If both arrows were present for previous flights, but one of them suddenly disappears, you must assume that this receiver is faulty, or that the fail-safe programming is incorrect: check the crystal, the aerial, the receiver and the programming.

Display 2:





If a receiver fails, you will see a dot preceding the number 1 or 2 instead of the arrow (as shown in the left picture).

If this display should appear when you switch the system on, i.e. there is only a dot in front of the numbers, then **neither** of the two receivers is working correctly (as shown in the right picture, or description for display 3)

In this event you need to settle the following questions:
- Are the two receivers set to the same channel as the transmitter?
- Are the crystals, receivers and transmitter in full working order?
- Have you entered the fail-safe settings correctly?

The fail-safe programming is really the most likely problem. Carry out the fail-safe test with one servo connected to the fail-safe channel, as described earlier, so that you have a visual check of the fail-safe function.

Display3:

If this display appears, the receivers 1 and 2 are both working correctly, both are exhibiting 100% reception.

If this display appears after a flight, then you can be satisfied with the quality of the receivers and the positioning of both receiver aerials.

If one of the two receivers should only show, say, 70%, there are various potential problems for you to check:

- The receiver aerial deployment may not be optimum. Try a different aerial position, and if the displayed value is better after the next flight, then you are on the right track.
- We recommend that you install one whip aerial and a second aerial in the wing. Two aerials set up as vertical whips in the same plane are not an efficient arrangement. Ensure that you do not screw the whip aerial down onto carbon rovings. It is often the case that the two fuselage shells are joined or reinforced with carbon fibre tape. Before you drill the hole for the whip aerial socket, you must sand away the carbon fibres around the hole over an area at least **5 cm in diameter**. Carbon fibres are conductive!
- The receiver has poor reception performance. Replace the receiver, or send it to the manufacturer for checking.

Important! The percentage figure after RX 1 and RX 2 always indicates a proportion of the duration of the last flight.

To clarify this: your flight might have lasted ten minutes, and RX 1 shows 100%, while RX 2 shows 90%. This means that receiver 2 was inactive for 10% of the flight, i.e. for one minute it was not delivering usable reception, or was in fail-safe mode. If the screen shows 99% for both RX 1 and RX 2, but also indicates that five switching events took place between the receivers, this means that both receivers suffered brief fail-safe phases - perhaps lasting only a few seconds - since the switching events had no significant effect on the percentage time values.

If power is supplied to both receivers separately, then the power supply to the **PowerBox *RRS*** module and the servos connected to it comes through all the connected patch leads to the two receivers.
Normally the **PowerBox** connected to the system supplies power to both receivers and all the servos connected to the system via all seven channel outputs of the ***RRS*** module (exception: five outputs with the **PowerBox Expert** and **Evolution**).

Note:
The **PowerBox *RRS*** module fits perfect for the usage on two different frequencies or bands. This allows real dual-channel-usage with double HF-modules in the transmitter as well as a wireless instructor-beginner-system or for co-pilot purposes.

6. Installation note:

Even though the PowerBox RRS module is very well protected from the effects of vibration, the unit should always be mounted in a part of the fuselage which is relatively low in vibration.

Typical installation in Günther Hölzlwimmer's 2.30 m span Composite ARF Extra

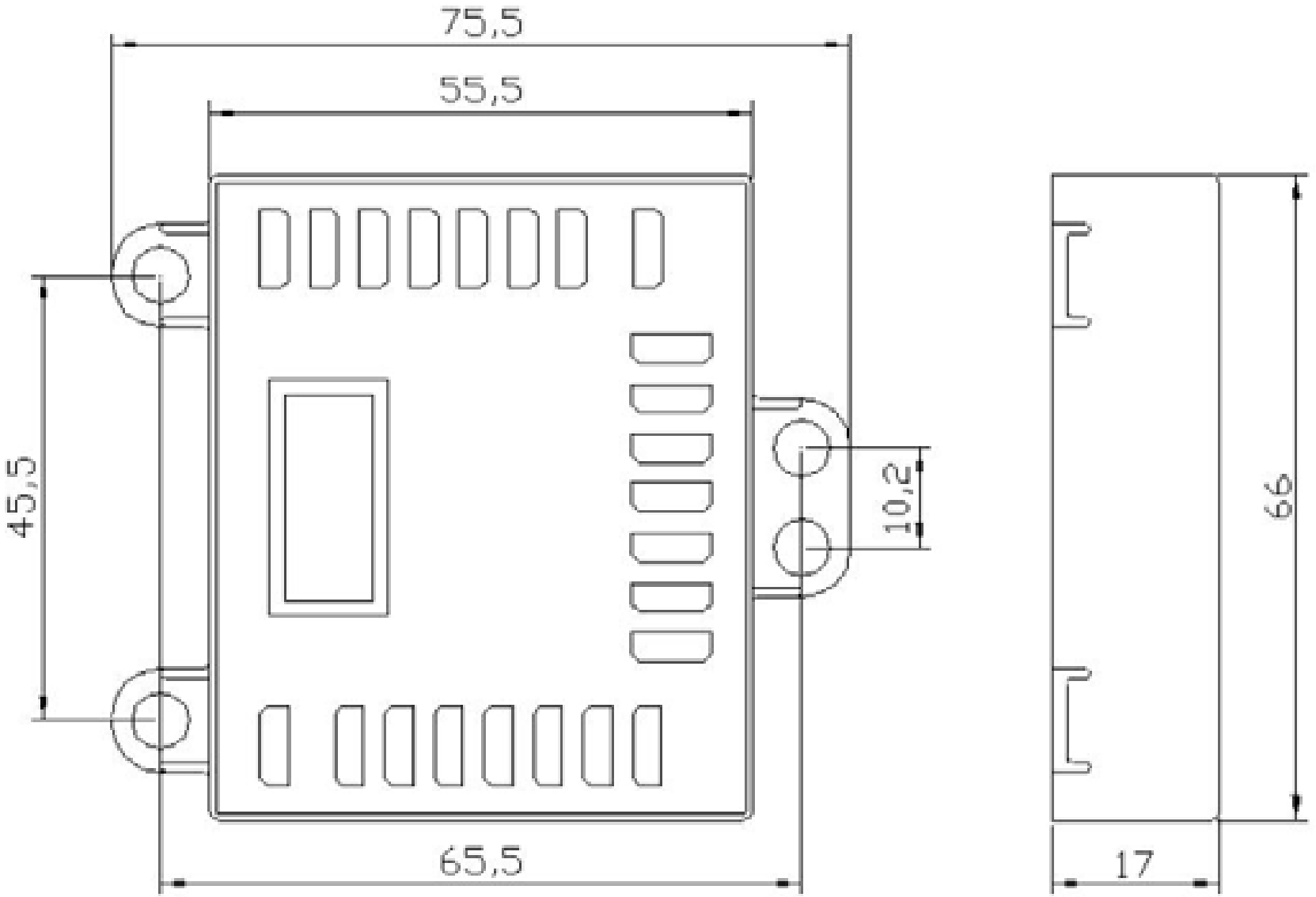
7. Specification:

Operating voltage:	3.5 Volts to 9.0 Volts
Idle current drain:	max. 7 mA, no consumer units connected
Number of switchable channels:	7 control channels, 1 FS channel, per receiver
Temperature range:	-10° to +75°C
Dimensions:	55 mm x 65 mm x 17 mm (L x W x H)
Weight:	44 g
Guarantee:	36 months

8. Set contents:

- **PowerBox *RRS*** module with integral LCD screen
- Sixteen patch leads, length 17 cm
- (Leads available in other lengths upon request - 20 and 40 cm)
- Fixings (rubber grommets, metal spacers, screws)
- Operating instructions in German and English

9. Installed dimensions:



The PowerBox *RRS* satisfies the EMV protective requirements, which entitles it to carry the **CE symbol**. However, the unit is designed exclusively for use in modelling applications, and is only approved for use in radio-controlled models.

The unit must not be connected to a mains PSU.

10. Guarantee conditions:

During the production process each **PowerBox *RRS*** module undergoes a complex series of tests. As you will be aware, we take the maintenance of the highest quality standards very seriously, and that is why we are able to grant a **36 month guarantee** on this product, valid from the initial date of purchase. The guarantee covers proven material faults, which will be corrected by us at no charge to you. We wish to emphasise expressly that we reserve the right to replace the unit if a repair is impossible for economic reasons.

Proof of the commencement and progress of this guarantee period is the purchase receipt which you received when you purchased the device. Repairs which we carry out do not extend the guarantee period. The guarantee is invalidated by misuse and maltreatment, such as reversed polarity, excessive voltage and the effects of damp. The same applies to faults due to severe wear or excessive vibration. The guarantee does not cover any additional claims such as consequent damage.

We expressly deny liability for damages which are caused by the device, or arise through the use of the device!

Liability exclusion:

We are unable to ensure that you install and operate the **PowerBox *RRS*** module correctly, nor that the entire radio control system has been maintained properly.

For this reason we are unable to accept liability for loss, damages or costs which result from the use of the device, or are connected with its use in any way.

Unless otherwise prescribed by law, our obligation to pay compensation, regardless of the legal argument employed, is limited to the invoice value of our products which were immediately and directly involved in the event in which the damage ensued.

We wish you every success using your new **PowerBox *RRS*** module, and hope you have loads of fun with it.

Donauwörth, March 2007

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