PDS system

The PDS system was recently presented at the international modeling fair JetPower.The response from the worldwide visitors was overwhelming and many questions about the new technologies have surfaced. Therefore, here is an explanation of the key core technologies and how to answer frequently surfaced questions.

The PDS system

Goal: In each functional area significant improvements compared with previous systems.

- Uncompromising for Futaba and S.Bus2, for Futaba system integrity.
- True diversity for significant increase
- Optimum power supply, even for current high power servos
- Totally free servo programming with intuitive operation

No compromise

The PDS system works completely without the compromises a universal system would have to make automatically. It does not have to take into account the needs for other manufacturer's technology, nor does it consume much computer capacity or software to use all sorts of systems. 100% access and use of all possibilities of Futaba's ingenious S.BUS2 system takes place here.

True diversity

Conventional systems use 2 receivers with receiver switching, which results in receiver redundancy. However, the PDS system uses **True Diversity Technology**, resulting in receiver redundancy PLUS **significant reception improvement**. After 20 years of experience using true diversity technology in professional environments, they are used in the PDS system to achieve significant reception improvement compared with traditional receiver switching.

Optimal power supply

Optimal power supply is only given if the full battery power is delivered to all servos without any reduction. Only then can the servos can develop their possible power and speed.

It follows almost automatically, that no voltage regulation or reduction is used. These would "cut off" the current peaks that modern servos need for full power and performance.

The adaptation of the PDS system to different servo voltages is achieved by the use of suitable battery types. Thus, the PDS system is a must if the new HPS series servos from Futaba are to be used to make the most of their power and performance. Previous battery switches can not deliver fast enough and not lossless the needed currents.

Servo Programming with the PDS-system

Servo programming offers many new possibilities and simplifies transmitter programming. Model specific settings are made in the receiver, the rest in the transmitter as usual. It is obvious that the operation must be intuitive. For this purpose, the PDS system uses smartphones, which today practically every pilot has with them and their operation is intuitive.

The servo programming

The full name would actually be servo + mixer programming with the PDS system.

The difference to the conventional programming of servo settings via the transmitter is simply that with the PDS system, the "transmitter channels" or TX controls are only there for a defined control function of the model, but these are no longer responsible for the number of servos used for this control function and whose settings.
The servo settings for each servo itself are then performed in the PDS system. In principle, these are "model-specific settings", which are set using servo programming with the PDS system.

In order to set each servo individually, so far for each servo in the transmitter and a transmitter channel must be used.

The number of adjustable servos is limited by the number of available channels in the TX.
Servo programming breaks this limit.

The channels of the transmitter now will be only "the control function", the programmable servo outputs in the PDS system are then each assigned to a control function of the transmitter.

For each control function (almost) any number of servos can be used and set separately. A limitation of the number of adjustable servos is only the number of servo outputs of the PDS system.

Example: Aileron function used with 4 (or more) servos in the model.
With the PDS system, only 1 control function or stick transmitter channel is used with the TX. In the model are used on PDS-System 4 servo outputs and servos

Nevertheless, each servo is separately and independently adjustable (as with 4-way adjustable servo Y-lead).

Important also for e.g. door sequencers for retractable landing gears. Without servo programming, the pilot needs 4-6 channels in the TX. 2 channels/servos for the gears and 2-4 channels/servos for the landing gear doors.

Again, for a PDS system this is only 1ne control function (channel) in the TX, -> gear out/gear IN. And that although in the model are 4-6 servos operated sequentially at completely different times and processes for gear and landing gear doors. External door sequencers are not necessary anymore.

Free servo assignment
Servo programming is also necessary when two coupled receivers with receiver switching are used on a Dual RX-device. Then it must be possible to allocate the servo outputs freely and separately to the transmitters and control functions of the TX. This supplies to the servos always the right commands from the transmitter, no matter which receiver is currently receiving and/or provides the control signals from the TX.

All these examples show why servo programming performs better in the model (receiver or PDS system) than in the TX. The TX requires a transmitter channel for each servo setting, the PDS System can supply a number of servos for a TX channel.

PDS devices can also be used without programming, but free servo assignment is not possible without programming. The servo outputs then correspond to the normal receiver order for the servo outputs, the existing "more outputs" are then logically assigned to the main functions as a secondary connection (V cable function, see above).

In general, servo setting in the PDS system reduces the need of a lot of TX channels, which then can be used for other or more control functions. Therefore, there are only CONTROL functions in the TX, no matter how many servos are used for one of these TX control functions in the PDS system.

Servo programming reduces the need of a lot of TX channels !

Redundant power and voltage supply
Each PDS system has an internal battery backer with electronic ON/OFF switch.

Battery backer, principle
Battery backers or dual battery supplies are used to redundantly secure the power supply of a system by using a second battery. It is called battery redundancy. In the case of failure of one battery, the other battery takes over the power supply of the system.

The battery backer in the PDS system merely prevents power/current from flowing between these two batteries when 2 batteries are connected to the PDS system, from full and resilient to completely empty, or even faulty.

If both batteries are ok, both contribute to the power supply of the system at the same time and are discharged simultaniously. If a battery fails, a high power Dual Schottky Diode prevents current flow from the "good battery" to the "bad battery", e.g. if a battery has a defective cell and thus provides less voltage. The energy of the "good battery" remains available to the system.

These diodes operate completely passive, without any software, the power is always taken from the battery with the higher voltage, without real switching. This results in battery redundancy without software or switching problems.

All these features are offered by the PDS system with significant power surplus (current/amperes).

Voltage regulation, or Lipo receiver battery for standard 6V servos?

The PDS system uses NO voltage regulater circuit, the output voltage at the servo connectors corresponds directly to the input voltage.

When used with LiFe batteries, all servos (from all manufacturers) can be operated with the PDS system. This results automatically from the average voltage of LiFe batteries in operation (5.5V -6.2V), comparable to 5-cell NiCd operation, as was common in the past.

HV servos can also be connected using LiFe batteries, resulting in only slightly lower speeds and forces than when operating with 8.4V LiPo batteries.

The voltage range of the PDS system is 5V - 8.4V.

Additional reasons?

Today, modern voltage regulators are already working very well when delivering relatively high currents. For the large, dynamic, very short fluctuations in power consumption (current peaks) of today's servos, it is nearly not possible designing the control circuit quickly and strong enough without becoming completely uneconomical or large and heavy.

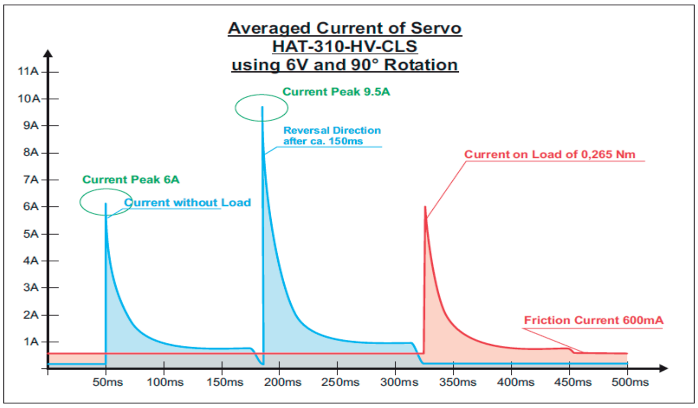
Therefore any voltage regulation is always slower than the rapidly fluctuating power requirements of the servos and slower than the battery, which can deliver these peak currents.

However, modern servos need precisely these peak currents in order to deliver their possible performance. There is nothing better to power such servos than to run the battery voltage directly to the servos without any voltage regulation.

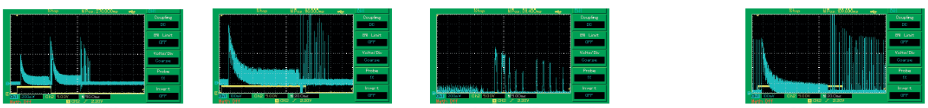
The adaptation of the PDS system to different servo voltages is done simply by using the appropriate battery types. LiFe or LiPo batteries. A voltage regulation is not longer necessary.

Information about servo currents

The current of a Futaba brushless servo as an example is measured with direct, fast servo movement reversal (see diagram).



Rawdata:



It can be seen that current peaks occur without load, which are already 30-40% higher than the starting current peak, and this is already almost twice as high as the blocking current.

Maximum current?

Not the blocking current is the maximum current of a servo, it is the dynamic reversal current, albeit ONLY for a very short time (1-2ms). However, when these current peaks are cut OFF by the voltage regulation, or inappropriate batteries, bad wiring and connectors, etc., the servo does not develop its full power. It is somewhat surprising that this realization is not necessarily standard among model manufacturers. Especially electronic BECs are very often not strong enough and therefore may be dangerous in use.

Of course, the servos also move with lower power input or cut-off current peaks, so perhaps it's not really noticed what power servos could develop today ... .. And after the crash on the ground everything will work again ......

The PDS system WITHOUT voltage regulation is optimally useful for the new Futaba High Power Servos (HPS). These develop enormous forces with their new servo technology, but also very high current peaks, even at the start up of the movement.

Previous power supplies with regulation are hardly suitable for this purpose. If these are undersized, this may be even dangerous if it causes strong voltage dips. Then the receiver can start new and gyros could turn out completely.

LiFe or LiPo batteries ?
We generally recommend (see above) LiFe batteries in a metal jacket and pressure relief valve with the lowest possible internal resistance to supply a receiving system. Because if all other "sources of reduction" are eliminated, it is only the battery, that the servos can develop their full power and performance.

If Lipo batteries are to be used, we recommend also not to use voltage regulation. Instead, using LiPo batteries in a metal jacket with a pressure relief valve and HV servos only, as voltage regulation is never optimal.

There are sufficient battery/servo solutions for every voltage, either actually using Lipo servos (HV), or even using LiFe batteries.

Reception systems

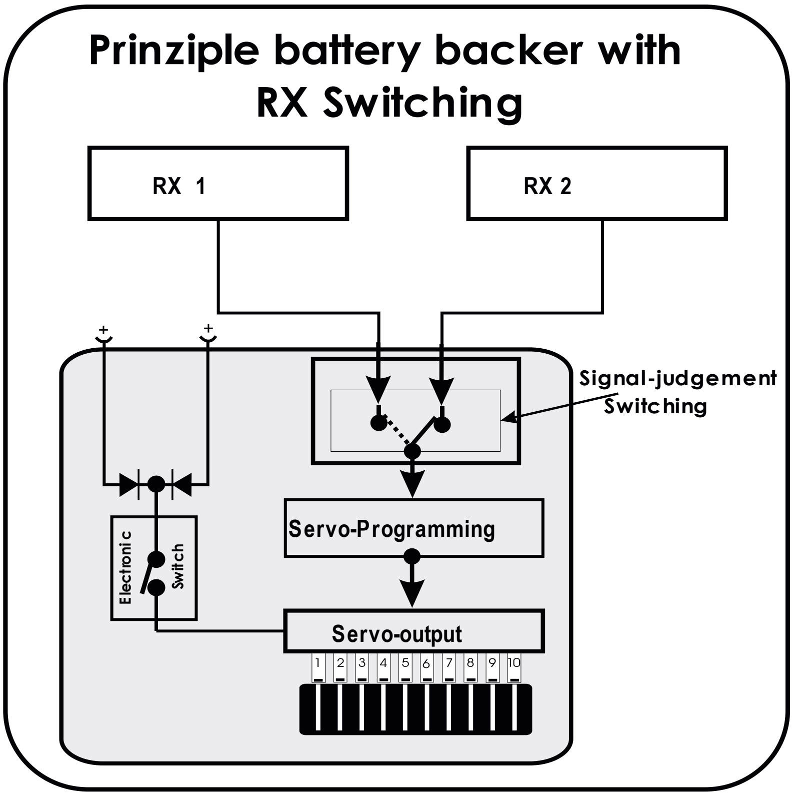
Receiver switching

The need for an expensive model to use the maximum possible transmission security for the remote control, automatically makes the signal transmission path (radio link) as safe as possible.

Of course, one of the ways is to use a basically secure 2.4GHz system like Futaba FASSTEst or T-FHSS. An additional way, which makes sense with any system, is to make the receiving system redundant.

2 receivers, meaningfully switched together, provide more security for the expensive model due to hardware redundancy of 2 receivers.

Conventional systems use 2 receivers with receiver switching, which results in receiver redundancy. It switches from the receiver with the bad signal to the receiver with the better signal. There is always only 1 receiver in operation.



Thus, in the system, an evaluation takes place, which receiver of both supplies the worse signal and when it is switched over to the receiver with the better signal.

After all, this is better than just using a single receiver, but this ultimately only results in receiver/hardware redundancy, only one receiver works at a time.

The fact that two receivers fail at the same time is rare. So then, the servos always are working as long as a receiver works. The reception quality is always limited to the quality one RX can supply.

This process is well-known, because so-called power boxes are generally used in large models, were two receivers are connected and the power boxes are working with receiver switching.

True diversity

The PDS system basically uses 20 years of experience of our RF engineers in applying this technology. In professional radio applications, virtually always true diversity is used.

The advantage is obvious: In addition to the receiver redundancy, there is an additional, substantial improvement in reception quality. Engineers speak about the increase in the signal-to-noise ratio (SNR), which results in a considerably greater safety of the radio transmission path.

To explain a somewhat complex process easier an example or comparison:
Receiver switching improves receiver safety compared with only one receiver (always only one RX is in operation) by receiver or hardware redundancy.

But it is often the case that e.g. one receiver has 60% reception, the other only 40%. Although both receivers deliver usable signals, the 40% signal strength of the "worse" receiver is completely lost and will not be used.

With True Diversity operation there is NO receiver switching, there are always both receivers / signals in operation and are judged from the system. There is a quasi mix of the two receiver signals, both receiver signals are added and mixed. The actual, technical process is much more complex and happens "sliding", the system always runs "synchronously".

Taking the above example, not only 60% of the recovered receiver antenna signal power is used, also the 40% signal will be used, the result is 100% signal.

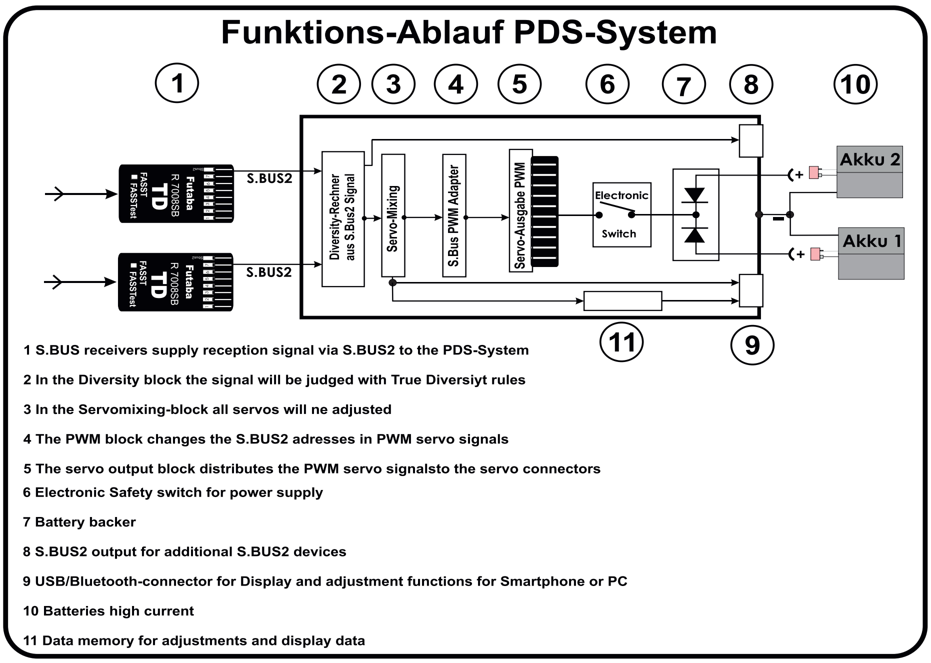
This is an overall significant increase in reception quality and a significant increase in the signal-to-noise ratio = more security for the transmission path. And all that without negative switching and synchronous effects.

The PDS system enables **True Diversity reception** by connecting two Futaba receivers to the PDS system via the S.Bus2 data interface, thus coupling them together to a true diversity system. They then automatically exchange information about the respective reception situation or the servo positions or signal evaluations of each RX.

Function sequence in the PDS True Diversity system

The signals from the transmitter reach the PDS system via the Futaba receiver with the S.Bus2 data line. There, the RF signals are completely evaluated. The result is an assessable S.Bus2 data signal.

In the PDS system, the signals from both receivers are then available. The PDS diversity calculator now uses both, usually completely different signal qualities NOT to switch, but it mixes and adds these as they are, then evaluates them according to its "rules", its "physics" (see below) and thereby always uses both receiving signals simultaneously, it is NOT switched from RX to RX.



Only this procedure results in optimal system synchronity without switching effects, disturbances can be faded out much better. The signal-to-noise ratio increases, and thus the reception reliability for the model.

The control of the servos always gets exactly the signals and executes the functions that are set in the PDS system, no matter which receiver with which signal quality whatever these were won.

The control signals are given in the correct sense with all settings and mixers to the respective servos even in case of a complete failure of one of the connected receivers.

Reception faults and reception quality are recorded in the PDS system and can be displayed graphically after the flight with the smart phone, stored as a csv file or sent via social media.

Excursion into the basics of a digital radio link

How does the (software) task of using two signals in the true diversity process, achieve more security?

In the PDS system, the two receivers transmit signals of varying quality. Now many test procedures follow before the signal is further processed. At 2.4GHz, it is a digital radio link, which e.g. works with data blocks. A data block provides the control information compressed and encrypted, compression and decompression methods take place.

The S.Bus2, when used properly for RF, provides much information about the quality of a signal. One value of many is the signal strength, also called RSSI (Radio Signal Strength Indicator). The RSSI signal indicates how much of the transmitted signal arrives at the receiver. This is an important information in an analogue radio link. This RSSI information is used in most conventional receiver switching systems.

The 2.4GHz radio link works digitally, and the RSSI value as analog field strength alone is worthless. The RSSI signal only shows a value between 0 and 100%. Signal strength values without the digital information, e.g. from the data blocks, can not represent any really useful information for signal judgements.

An example of many other internal operations:

One data block is undisturbed	RSSI display 100%
One data block is disturbed but can still be read	RSSI display 100%
One data block is disturbed, can not be read	RSSI display 100%

Vice versa

RSSI value 0%	The data block arrives nevertheless and can be read out
RSSI value 0%	The data block arrives and can only be partially read out
RSSI value 0%	The data block does not arrive at all

In the evaluation result of the received signal in a digitally operating PDS system, a large number of different factors and the respective calculation models, e.g. synchronicity and plausibility, hopping tables, internal calculation models, etc.

Thus, many other information of the S.BUS2 are still evaluated by the PDS system in order finally to arrive in a result, which evaluates the control information as long as possible for all situations and passes it on undisturbed to the servo outputs.

If a complete interruption of the radio link has actually taken place, there is a special Fail Safe setting for each servo output, individually. In addition, a time setting, from which time (0-30sec) the servos can be de-energized after a Fail Safe has occured.

FAQ for the PDS system

Why does the R8024SBD receiver have 24 channels, Futaba only has 18 channels?
The answer to this question can be seen in the operation of servo programming. The R8024SBD doesn`t have 24 channels, but 24 servo outputs.

The servo outputs don`t correspond anymore to the channels of the transmitter, but are merely servo ports, which can be assigned to the individual function channels of the transmitter, freely or even multiple times.

Thus, considerably more servos can be individually set and controlled than the amount of transmitter "channels". Just read at "Servo-Programming”

Plug systems for the PDS system
So far, T-system connectors are used, but the quality is not sufficient for the PDS system. We will switch to the original MPX green connector system as standard. We will also offer systems with XT connector systems. This also applies to our battery offers, standard is MPX green.

Why a gyro is not installed?
The PDS system as an uncompromising S.BUS2 device, has no internal gyros, as there are enough gyros from Futaba with Futaba S.BUS2 connection. Futaba is certainly the manufacturer of gyros with the greatest experience in this field. So the customer has the free choice out of the Futaba gyro range with S.BUS2.

There are also other producers that specialize in gyros, using the S.BUS2. There is also a great deal of experience for gyro software. For better understanding and simplification the use of a certain Futaba gyro and its application is described in the PDS manual.

Extension of receiver antennas
The PDS receiver R8024SBD is not delivered with the original Futaba receiver antennas, but with low-loss antenna cables with 30cm length. These have a larger diameter, are mechanically much more stable and have lower conduction losses.

For extensions, antenna leads are offered with 50cm, which work without loss of reception quality.
This allows the antenna to be positioned far apart from each other, which also improves the reception performance.

In addition, there is also the industrial version of the R8024SBD receiver, this has screwable antenna and works with 80A continuous current in the battery supply. There are also antenna up to 1m in length.

How is the Futaba telemetry integrated into the PDS system?
All PDS systems are offering an additional S.BUS2 interface. All Futaba sensors can be connected to it. In addition, the S.BUS2 plugs of the receiver outputs are available (Y-lead). The operation thus corresponds to the normal Futaba telemetry system.

Receiver outputs of the external receiver?
These can be used for servos, but should be used for less important functions. These servo outputs on the external receivers do not benefit from the reception improvement of the PDS system.

Where are the settings for servos, etc. stored in the PDS system?
The currently used settings are always stored in the PDS system memory. Backups of the respective settings can always be stored in the smartphone via data export from the system. These can be named and additionally exported to other PDS systems. So there is a normal model storage system in the smartphone app.

Is it possible to use a PDS system without servo programming?
That is possible. Each PDS system provides the normal servo output in order to the transmitter channels up to 12 (PDS-10 channel 1-10) initially and without programming. If this is to be changed, it must be programmed.

With the PDS-18, the servo outputs 13, 14 and 15 operate in parallel with the aileron control function of the transmitter (channel 1). Of these, the outputs 14 + 15 are reversed. Thus, 4 transverse servos can be used and installed horizontally.

The servo outputs 16, 17 and 18 work in parallel with the elevator control function in the transmitter (channel 2), of which the outputs 17 + 18 are reversed. That way 4 elevator servos can be used and installed horizontally.

With the R8014SBD receiver, the outputs 13-18 are working analog to the PDS-18, the servo outputs 19-24 are initially without function, if not programmed.

How programming and set up is done?
With the smart phone. There is an Android app that communicates with the PDS system via the Blue-Tooth interface, which is connected to the PDS system. A PC program for USB is in planning.

Why is there (only) an Android app?
There are Android Smart Phones from € 40.-on, it is not possible to produce an intelligent programming device cheaper. It's just an optimal HMI device.

Which servos can be connected?
All servos of all manufacturers are always working with the PDS System, because PWM output signals are used at all servo outputs.

This also allows all Futaba S.BUS servos to be operated, as these also work with PWM servo signals. S.BUS servos can be further programmed by setting with the transmitter or CIU3.

The new Futaba HPS servos can of course be used, the PDS system works without voltage regulation and therefore provides sufficient power, even fast current spikes, for full power. For these servos Futaba stipulates not to use voltage regulators.

Are the servo outputs of the PDS system protected against overload?
No, because any kind of fuse can also be a factor of uncertainty and only starts with the effect of a problem, not with the cause.

Since the PDS system is uncompromisingly designed for the S.BUS2 from Futaba, when using Futaba-S.BUS2 servos, the maximum current of each individual servo can be set in the servo, these then switch OFF easily in case of overload (and protects the servo). Therefore, the PDS system does not provide fuses of the servo outputs.

Why the PDS system provides additional S.BUS2 connections?
This allows to connect other S.BUS2 devices to the PDS system. These then benefit from the reception improvement through the True Diversity technology, as well as from the power supply safety through the battery backer.

Why additional high-current outputs on the R8024SBD?
If additional S.BUS2 devices are used, e.g. receiver and servos, then these should be supplied with adequate voltages and currents accordingly. In addition, the safety of the battery switch is available at these outputs.

Why not a display in the PDS system?
This question can not be answered from a technical point of view, because these displays (admittedly) looks nice, but are not visible in flight and are therefore hardly needed technically.

PDS System - Engineered + Made in Germany