

RC RADIO RECEIVER PROTOCOLS: PWM, PPM, SBUS, DSM2, DSMX, SUMD



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When it comes to radio receiver protocols, acronyms are often used: PWM, PPM, SBUS, DSMX etc. In this post we will explore the differences of these RC radio receiver types.

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These radio receiver protocols can be confusing to beginners, but often times we don't need to bother with most of them. Still, It's good to know the basic differences between these radio communication protocols, so you don't buy the wrong one. We will also have a look at some of the technology, and see how it makes flying more reliable and safer.

The “protocols” we are referring to here are the communication between radio receiver and flight controller.

PWM – Pulse Width Modulation

This is the most common and basic radio control protocol. In the old days when there were only RC fixed wings planes, the receivers were used to control the servos or ESC directly with standard PWM signal, one channel for each servo. Until today the same technology is still being used in many models.

Multirotors require at least 4 to 5 channels (sometimes even more) and you will see the same numbers of servo leads connected between the receiver and flight controller.



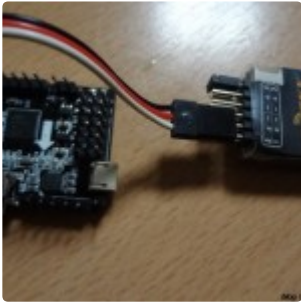
PWM stands for pulse width modulation. It's an analog signal where the length of the pulse specifies the servo output or throttle position. The length of the signal pulse normally varies between 1000μs and 2000μs (micro seconds), with 1000μs being the minimum & 2000μs the maximum.

PWM radio receiver is the most common and usually the cheapest option. However due to the messy wiring, hobbyists now prefer PPM or SBus over PWM.

PPM – Pulse Position Modulation

PPM is also known as CPPM or PPMSUM. The advantage of PPM is that only one signal wire is needed for several channels (typically 8 channels max), instead

of a number of individual wires. So you should only connect the ground, power and signal cable.



A PPM signal where basically a series of PWM signals sent one after another on the same wire, but the signal is modulated differently.

PPM is what they call “analog signal in time domain” (although it can be **a bit controversial** at times), channels are sent one after another and not at the same time. Therefore it's not as accurate or jitter free as serial communications, but it's more widely available and supported by many Flight controllers.

Check out this post for a more **detail difference between PWM and PPM**.

PCM – Pulse Code Modulation

PCM stands for pulse code modulation, it's a data types similar to PPM. However PCM signal is digital signal (using ones and zeros) while PPM signal is analogue, which is the length of time the signal is on. PCM has the potential of signal error detection even error correction, but this still depends on the product you buy.

PCM is more reliable and less susceptible to interference, but additional conversion is required so the equipment tends to be more expensive.

Serial Protocols

Serial Receiver is a digital loss-less protocol that uses only 3 wires (signal, power, ground) for multiple channels. As the name suggests this type of receiver requires serial port on the flight controller. This includes SBUS, XBUS, MSP, IBUS, and SUMD.

SBUS (S.BUS, Serial BUS) – By Frsky, Futaba

SBUS is a type of serial communication protocols, used by Futaba and FrSky. It supports up to 18 channels using only one signal cable.

SBUS is an inverted UART communication signal. Many flight controllers can read UART input, but cannot accept inverted one (such as the Naze32 Rev5) and an inverted is required. However F3 FC's and some FC such as Pixhawks has built-in dedicated signal inverter for this purpose.

IBUS – By Flysky

IBUS is the new flysky serial protocol. It's a two way communication which means it can send and receive data: one port for servo data output and one port for sensors.

XBUS – By JR

XBUS is used by JR, which supports up to 14 channels in one signal wire. One of the advantages is the tiny time delay between each channel.

MSP (multiwii serial protocol)

Protocol that was created as part of the multiwii software. Basically it allows you to use MSP commands as the RC input and it supports 8 channels in one signal cable.

Graupner Hott SUMD

The Graupner SUMD is a serial protocol like Speksat and SBUS. The channels are encoded into one digital signal and have no noticeable latency. Advantages of

SUMD are:

- Compared to SBUS, SUMD doesn't require signal inverter
- Compared to PPM, SUMD has better resolution and no jitter while PPM has only 250 steps and always 4ms jitter

Graupner SumH

SUMH is a legacy Graupner protocol. Graupner have issued a firmware updates for many receivers that lets them use SUMD instead.

What Receiver Protocol and Should I use?

First of all, it depends on your **radio transmitter**. Personally I would prefer PPM or SBUS for multicopter in general because of the simple wiring. However for drone racing and freestyle I would choose SBUS due to its **minimal lag**.

What is Spektrum, DSM2 and DSMX?

“Spektrum” is often mentioned in radio related topics, which is basically a RC brand specialized in radio. So far, what we have been discussing above have been RX to FC protocols, but DSM2/DSMX are protocols between TX and RX (radio protocol) used by Spektrum equipment.

The RX to FC protocols (SBUS counterparts) for Spektrum DSM2 is called SPEKTRUM1024, for DSMX it's called SPEKTRUM2048.

Spektrum DSM2 and DSMX

DSM2 signal is more resistant to noise, interference and other transmitters transmitting on the same frequency. It also finds a backup frequency at start-up in

case the primary frequency fails. This lowers the chance of losing signal greatly, however if both channels become unusable you may still lose the connection.

DSMX was based on and improved from DSM2, which also uses the same encoding scheme. The difference is the DSMX signal is able to switch to a new frequency channel in case of cut out within a couple of milliseconds, so in theory you wouldn't even notice the glitch.

DSM2 is still a popular technology, if you are away from sources of radio interference (such as WiFi, microwaves, and wireless security cameras), it should work just as well as DSMX. But DSMX is just more reliable.

Update (01/11/2016) – Spektrum radio protocol was recently **hacked** which raised concern.

Spektrum Satellite

A Spektrum Satellite is an additional antenna and receiver circuit that usually gets connected to the “main” receiver to improve link reliability by providing diversity reception.