Technical Knowledge

- [Transponder](#)

Transponder

Radar basics

If you've ever flown in real life or on VATSIM, then you've probably come across the transponder and entered 4 digits. But why is all this necessary?

There are two types of radar for monitoring air traffic:

- **Primary radar:** These are the huge, rotating radar antennas that detect so-called primary targets. According to a simple physical principle, the radar emits pulses that are reflected by aircraft. The radar can calculate the distance to the detected target based on the time between transmitting the pulse and receiving the reflection. The transponder therefore plays no role for this type of radar.
- **Secondary radar:** Secondary radar is used to obtain information about the aircraft's callsign and altitude in addition to its position. This is based on a question-and-answer principle. The radar antenna triggers the transponder via a signal, which then sends the code and altitude back to the ground station.

In the picture you can see the Deister radar system of German air traffic control (Deutsche Flugsicherung – DFS). The large curved part is the primary antenna, the small and flat area at the top is the secondary radar antenna.

Transponder code and correlation

The pilot can enter a four-digit transponder code into their transponder. The transponder has the digits 0-7 available for each digit. The system is therefore based on an octal code and offers 4096 different possibilities for a transponder code. Together with the clearance from air traffic control, the pilot receives the code to be set in the transponder. But why do we see a callsign on the radar

and not a four-digit number? Well, as soon as the controller has assigned the transponder code on the ground, this code is stored in the flight plan of this specific aircraft. As an example, let's assume that flight DLH414 is assigned the code 2301. If flight DLH414 now takes off, it emits code 2301 and is thus detected by a secondary radar. The secondary radar then sends the position, altitude and code 2301 to the air traffic control center. The radar system then checks the flight plan database and recognizes that code 2301 belongs to flight DLH414. The radar system therefore displays the callsign DLH414 and the corresponding altitude to the controllers at the reported
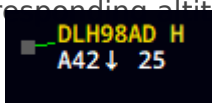
position, as shown in the following image.

Further information on the transponder can be found here.

Mode S

As technology progressed, new transponders were introduced that were able to transmit many other parameters in addition to the altitude and the code, such as speed, heading, etc. With these transponders, which are called Mode S (Mode Sierra) transponders, the callsign is no longer transmitted via a four-digit code. Instead, the callsign is transmitted directly from the transponder to the secondary radar without the detour via code. Therefore, these flights no longer necessarily need different codes and usually receive Squawk 1000.

Mode S is now mandatory in Germany.

Further information on Mode S can be found here.

Special codes

Fixed transponder codes are defined for certain flights in Germany. There are also international codes in the event of air emergencies.

Squawk code	Usage
0020	Helicopter rescue flights
0023	Federal police operational flights
0024	Night low flying system military flights conducting terrain following flights
0025	Drop aircraft for parachutists
0027	Aerobatic flights
0030	Photogrammetric surveying flights

Squawk code	Usage
0031	„Open Skies" flights
0032	VFR flights by civil aircraft in the identification zone (border between Germany, Poland and the Czech Republic)
0033	VFR flights by military aircraft between GND and FL 100
0034	Search And Rescue missions (SAR)
0035	VFR / IFR flight rule changes
0036	Police operational flights
0037	Police operational flights with residual light amplifier
1000	Mode S transponder code
2000	Military flights in the Night low flying system
7000	VFR flights by civil aircraft (standard VFR code)
7500	Hijacking (prohibited on VATSIM)
7600	Radio failure
7700	Emergency