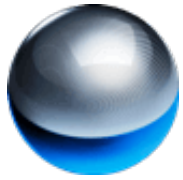


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Aircraft Transponders History

The development of radar in WWII was a huge leap forward in the early detection of enemy aircraft. The scope of the radar operator showed the radar returns reflected by the approaching aircraft, this type of radar is called primary radar. It had its limitations.

As long as the enemy came towards you it was fairly easy to see their location and (more important) where your own aircraft are. This was no problem until aircraft flew into close proximity of each other and radar returns faded into one big blur.

So a more positive identification was desperately needed and as primary radar reflects the original radar signal. Secondary radar sends



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WWII and continues with mode of operation and explains some of the codes used today and moves on to Modes S transponders as they

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become more and more mandatory.

Radar Identification

It became soon clear to the designers that a better identification method was needed. Enter Secondary **Surveillance** Radar. With this type of radar the aircraft participates in returning a signal when the SSR 'lighted' the aircraft. This signal is much stronger than the primary radar return and it can contain extra digital data inserted by the transponder.

In the 1950s this principle was adapted for use by civil ATC to provide traffic services for general and commercial aviation. And as the skies became more crowded it added to the safety of air travel.

Secondary Surveillance Radar (SSR)

SSR is referred to as secondary radar. This is to differentiate it from primary radar that works by passively reflecting a radar signal off of the aircraft. Primary radar works best with metal aircraft, but not so good on small, composite aircraft where the engine is the only large object from metal. Radar range is also limited by terrain and rain or snow (depending on the radio frequency used by the radar equipment) and also detects unwanted objects such as automobiles, hills and trees.

These items can be selectively filtered out by good software. Altitude



detection of an aircraft is also a problem. Secondary radar overcomes these limitations but it depends on a transponder in the aircraft to respond to interrogations from the ground station. It will even operate when primary radar is not operative.

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Transponder Modes

The transponder is capable of inserting specific data in its transmission when interrogated. Listed below are the transponder modes used by general and commercial aviation (military aviation uses these plus other modes):

- Mode 3/A - replies a 4-digit octal code for the aircraft, assigned by ATC
- Mode 3/C - replies a 4-digit octal code included with the pressure altitude
- Mode S - provide multiple data formats to a selective interrogation

Each aircraft is assigned a fixed 24-bit address which means there more than 16 million addresses available (16777216).

Mode A & Mode C (Altitude)

When the transponder receives a radar signal it replies with the selected transponder code, this is 'Mode 3/A'. A transponder code can be paired with pressure altitude information from a dedicated onboard encoder, called 'Mode 3/C'. These modes are used to help ATC to [identify](#) the aircraft and to maintain separation in horizontal distance

and in altitude.

To our knowledge Mode A is not used anymore.

Mode S

Another mode called Mode S (Selective) is designed to help air traffic control in busy areas and allow automatic collision avoidance. Mode S transponders also reply to Modes A/C interrogations.

Mode S is mandatory in controlled airspace in many countries (Europe). Some countries require that all aircraft must be equipped with Mode S, even in uncontrolled airspace (again Europe). However with general / experimental aviation, there have been complaints, because of the cost, size, limited benefit to the users in uncontrolled airspace, and, in the case of balloons and gliders, the power [requirements](#) for these [aircraft that do not have electrical systems](#).

Mode S TIS

Mode S transponders can add additional information, including the permanent identity of the aircraft (24 bit address). Mode S TIS (Traffic Information Service) allows a radar [installation](#) to send information about nearby traffic back to aircraft, which then displays it on the moving [map](#). Mode S TIS is only available when the aircraft is within radar range of a radar installation that supports it. The Garmin G1000 glass cockpit is one example of an avionics suite that supports Mode S TIS. This supplements TCAS equipment.

ADS-B

ADS-B (Automatic Dependant Surveillance - Broadcast) is also an application of Mode S where GPS position and other relevant information is sent back to ground stations or other aircraft equipped with the proper equipment. ADS-B consists of a Mode S Extended Squitter (TSO C-166A), GPS receiver, Universal Access Transceiver (978 MHz UAT) and VHF data link (VDL Mode 4) to transmit these messages. It is used in Europe, Australia, North America and in countries around Indonesia.

Written by EAI.

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