



TRANSPONDER USE

1. Introduction

A transponder (short-for transmitter-responder) is an inboard electronic device that produces a response when it receives a radio-frequency interrogation. It assists ATC (air traffic controllers) in identifying aircrafts on a radar scope and other aircraft's collision avoidance systems.

2. Transponder in real life

2.1. Technical description

The ATC radar sends an interrogative 1030 MHz radio frequency pulsed signal.

The aircraft answers on the 1090 MHz radio frequency with another pulsed signal.

After decoding and measuring the delay of answer, the transmitted signal is used on ATC radar to identify the aircraft (code and/or call sign) and display relevant information (azimuth, altitude, speed, flight path).

2.2. Transponder type

Several different RF communication protocols have been standardized for civilian aviation transponders. Depending on the interrogation mode, transponders can provide identification code, aircraft position, pressure altitude, call sign and other information.

Transponder types are coded using one letter and are present in the ICAO flight plan:

Transponder Type

Transponder Type

- N - no transponder on board
- A - Mode A only (no altitude reporting)
- C - Mode C
- E - mode S (with aircraft ID, pressure altitude and ADS-B)
- H - mode S (with aircraft ID, pressure altitude and enhanced surveillance capability)
- I - mode S (with aircraft ID, but without pressure altitude)
- L - mode S (with aircraft ID, pressure altitude, ADS-B and enhanced surveillance capability)
- P - mode S (with pressure altitude, but without aircraft identification)
- S - mode S (with aircraft ID and pressure altitude)
- X - mode S (without aircraft ID and pressure altitude)

ADS-B / ADS-C (applies only for mode S transponders)

<input type="checkbox"/> B1 - ADS-B with dedicated out capability	<input type="checkbox"/> V1 - ADS-B out capability using VDL Mode 4
<input type="checkbox"/> B2 - ADS-B with dedicated in and out capability	<input type="checkbox"/> V2 - ADS-B in and out capability using VDL Mode 4
<input type="checkbox"/> U1 - ADS-B out capability using UAT	<input type="checkbox"/> D1 - ADS-C with FANS 1/A capabilities
<input type="checkbox"/> U2 - ADS-B in and out capability using UAT	<input type="checkbox"/> G1 - ADS-C with ATN capabilities

OK Cancel

Description of different transponder modes:

- **Mode A** equipment transmits an identifying code only,
- **Mode C** provides identifying code and aircraft pressure altitude,
- **Mode S** (for selective) provides multiple information formats to a selective interrogation (data exchange), including the call sign - it is designed to help avoiding over interrogation and to allow automatic collision avoidance.

The transponder mode S is the most widely used mode.

2.3. Transponder settings

A transponder switch usually has several positions:

- OFF
- STBY
- ON
- ALT
- TA
- TA/RA



The “**STBY**” function will power the transponder and make it ready for operation (warming up). The “**ON**” function (MODE A) will only send primary information to the radar that is code and position. The “**ALT**” function (MODE C or S) will additionally transmit altitude information. Functions such as “**TA**” and a “**TA/RA**” will provide traffic advisory and traffic advisory resolution.



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2.4. Transponder IDENT

All mode A, C, and S transponders include an IDENT button, which activates a special function known as IDENT (short for identify) in order to help air traffic controllers locate an aircraft.

Squawk IDENT button on a real instrument:



2.5. Transponder codes

Transponder transmission usually uses a discrete code in order to identify the flight.

For certain type of flights and/or situations, specific transponder codes are used.

Squawk codes are four-digit octal numbers. The dials on a transponder read from **0** to **7**, inclusive.

Thus the lowest possible squawk is **0000** and the highest is **7777**. Four octal digits can represent up to 4096 different codes, which is why such transponders are often called "4096 code transponders".



There is no '8' and no '9' digit in transponder code.

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3. Code allocation

SSR transponder code is normally allocated by each State with coordination with regional air navigation agreements and taking into account overlapping radar coverage over adjacent airspaces.

In IVAO, SSR transponder code should be allocated by division with coordination with regional air navigation agreements and taking into account the code allocation practiced in adjacent divisions.

Codes 7700, 7600, 7500 shall be reserved internationally for use by pilots encountering a state of emergency, radio communication failure or unlawful interference, respectively:

- 7700 : Emergency code
- 7600 : Radio failure code
- 7500 : Hi-jack code

Here are the description and the usage of some code attribution:

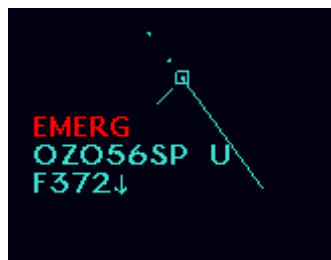
3.1.1. Transponder 7700 : the emergency code

The pilot of an aircraft in a state of emergency shall set the transponder to code 7700 unless ATC has previously directed the pilot to operate the transponder on a specified code.

The pilot shall continue to use the specified code unless otherwise advised by ATC. If the pilot is facing a simple pan or failure, this code shall not be used.

The pilot shall not use the 7700 code outside a state of emergency.

An ATC can request a pilot to squawk 7700 if he declares an **emergency or distress** situation (**MAYDAY**).



Radar capture with aircraft using active code 7700

After the aircraft has landed, an air traffic controller should ask the pilot to set a normal code when the emergency is terminated. As a pilot, set the transponder code to 2000 or ask a new code to the air traffic controller after the emergency is terminated.

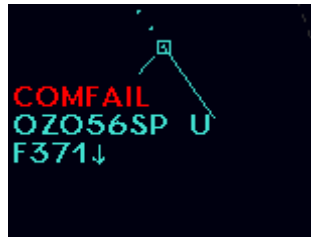
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3.1.2. Transponder 7600 : the radio failure code

The pilot of an aircraft losing two-way communication shall set the transponder to code 7600.

On the IVAO network, if a pilot cannot initiate two-way communication by voice with the air traffic controller, pilot and ATC must try to communicate by text as far as possible and does not use squawk 7600.

This code is mainly used when a pilot is facing serious technical problems with his connection that cannot permit voice and text communication or for training/examination purpose.



Radar capture with aircraft using active code 7600

A controller, who notices a communication failure code, will determine the extent of the failure by instructing SQUAWK IDENT or to change the code. With that operation, if it is determined that the aircraft receiver is functioning, further control of the aircraft will be continued using code changes or IDENT transmission to acknowledge receipt of clearances.

This code shall not be used to ignore ATC clearance and contact.

3.1.3. Transponder 7500 : hi-jacking code

In real aviation, if there is unlawful interference with an aircraft in flight, the pilot-in-command shall attempt to set the transponder to code 7500 in order to indicate the situation.

The use of this code is strictly prohibited on the IVAO network. (R&R 6.4.1)

“Special operation including simulation of terrorism and act of wars are prohibited.

Although armed conflicts do exist in the real world, we do not allow the simulation of any form of aggression or violence on the IVAO network.”



Radar capture with aircraft using active code 7500

(This image was created with special authorization from a supervisor in order to make this documentation).

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As an air traffic controller, if you observe the use of 7500 code within or outside your airspace, you should advise the pilot to change his transponder code to a new code immediately as the use of this code is forbidden in IVAO.

If the pilot continues to use this code, please call a supervisor using the .wallop command.

3.1.4. Non-controlled VFR code

Depending on local regulations, non-controlled VFR codes can change.

The most frequently codes used are:

- **1200** : USA and Canada standard squawk code
- **7000** : Europe VFR standard squawk code
- **2000** : ICAO standard squawk code



Other default codes are dependent on whether local regulations have made them available (ex 1400, 3000).

3.1.5. Non-controlled IFR code

There is one unique worldwide for non-controlled IFR flights code which is 2000.



3.1.6. Other codes

This is a list of some other codes available:

- **0000**: this code shall not be used. It is a non-discrete code. It is usually displayed on IvAp in case of some specific technical problems.
- **7777**: Non-discrete code used to test transponders and to check correctness of radar stations
- **74xx**: these codes are sometimes used for NATO special operations

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4. How to use Transponder as a pilot with IvAp

When an aircraft carries a transponder, the pilot shall operate the transponder at all times during flight regardless of whether the aircraft is within or outside airspace where radar is used for air traffic service purpose (secondary surveillance radar SSR).

Pilots shall indicate the capability of the transponder aboard the aircraft in item 10 of the flight plan by inserting the appropriate letter.

Except in specific cases (see specific procedure), the pilot shall:

- Operate the transponder and select transponder code as directed by ATC unit with which contact is being made.
- Operate the transponder on code as prescribed on the basis of regional air navigation agreements
- Operate the transponder on code 2000, in the absence of any ATC unit.

Regional VFR non controlled codes are examples of prescribed codes defined by regional air navigation agreements.

When requested by ATC to confirm squawk (code), the pilot shall:

1. Verify the code setting on the transponder
2. Reselect the assigned code if necessary
3. Confirm to ATC the setting displayed on the controls of the transponder

Pilot shall not **SQUAWK IDENT** unless requested by ATC.

4.1. Transponder mode with IvAp

IvAp shall be considered as a type mode S transponder on IVAO network.

Other mode can be programmed when filling the flight plan using adequate letter.

4.2. Transponder status with IvAp

The transponder has two settings on IVAO:

- **STBY** (associated with the orange spot)
- **TX** (associated with the green spot) can be considered as **ALT real mode**.

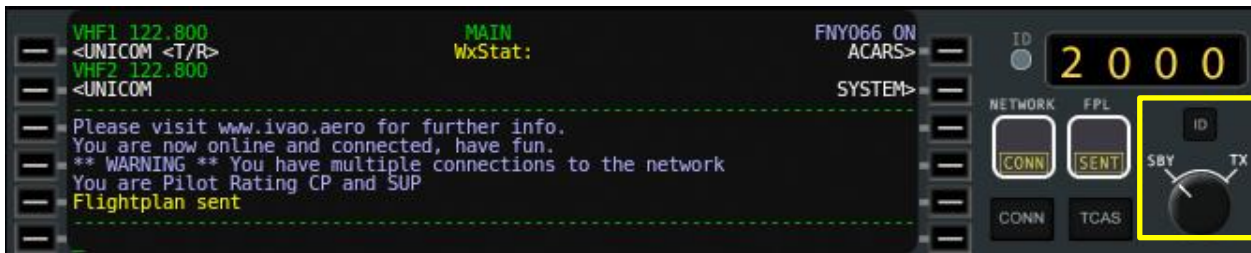


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4.3. Transponder status with x-IvAp

The transponder has two settings on IVAO:

- **STBY**
- **TX** can be considered as **ALT real mode**.



4.4. Transponder rules to follow in IVAO

All pilots must:

- Set transponder to **STDBY** position before connecting to the IVAO network
- Set transponder to **STDBY** position on apron and during taxi
- Set transponder to **TX** position when cleared entering on runway for departure, and at the latest before take-off.
- Keep transponder to **TX** position while flying all the time
- Set transponder to **STDBY** position after vacating the landing runway

As a pilot in command, you must set your transponder code yourself.

During formation flights, only the leader has to set his transponder on **TX**. The other aircrafts must maintain visual contact with the leader and will keep their transponder on the **STDBY** position.

There is no OFF mode in transponder equipment IVAO. Equipment lower position is always standby. In conclusion, you cannot disappear from the IVAO radar.

TA and TA/RA mode are simulated using the IvAp TCAS system

4.5. Transponder IDENT button

When an air traffic controller wants to locate you quickly, he can request a “transponder ident” to the pilot. The pilot accordingly will press the **IDENT** button of his IvAp interface.



Squawk IDENT button on IvAp

Note that the pilot must press the IDENT button only when requested to do a “transponder IDENT” or “SQUAWK IDENT” procedure from an air traffic controller.

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4.6. Transponder code

The pilot shall tune the transponder code using the IvAp interface or instrument in the cockpit. The air traffic controller will receive the transponder code displayed on the IvAp interface.

In phraseology, controllers use the term “squawk” before sending transponder code – for example “Squawk 2103”.

When entering a control zone, the pilot shall initiate communications with the active ATC. After first contact, the controller can assign a new transponder code. The pilot shall tune it without delay.

When leaving a control zone or when flying in uncontrolled airspace, a pilot shall tune the default transponder code in accordance with his navigation rules even if not requested by ATC.

4.6.1. Non-controlled IFR code

There is one unique worldwide for non-controlled IFR flights code which is 2000.

It is the responsibility of the pilot to setup this code when he is not inside controlled airspace.

4.6.2. Non-controlled VFR code

Depending on local R&R, several codes can be used for uncontrolled VFR flights; the most frequently used are:

- **1200** : USA and Canada standard squawk code used when no other has been assigned
- **7000** : Europe VFR standard squawk code when no other code has been assigned
- **2000** : ICAO standard squawk code and when local regulation is unknown by the pilot

If you fly outside any controlled zone, you are not allowed to tune a code given by any air traffic controller except non controlled code.

Example:

You fly IFR in Uruguay in a non-controlled zone; a Brazilian controller outside your flight zone gives you 0535 transponder code => you must **keep 2000 or tune 2000** if you forget to tune it.

You fly IFR in Uruguay in a non-controlled zone; a Brazilian controller outside your flight zone gives you 2000 transponder code => you **must tune 2000** as this is a non-controlled transponder code.

Other default codes dependant on local regulations are available (ex 1400, 3000).

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5. How to handle transponder settings as an air traffic controller

In his area of control, an active controller is responsible to assign a transponder code to all aircraft. It is the responsibility of the pilot in command to tune this transponder code in their aircraft.

To reduce pilot and controller workload and the need for controller/pilot communication, the number of code changes required of the pilot should be kept to the minimum.

5.1. Transponder code

As the system of discrete transponder codes is very complex in real aviation, there are no IVAO global rules to assign specific series of transponder codes to a specific activity or type of flight. Outside of specific cases given in this documentation, the transponder code assignment is free.

Be aware, as ATC, you cannot assign a particular code to an aircraft outside your airspace.

Some countries have their own transponder code allocation. Contact the ATC Operations Coordinator of the related division or ATC Operations Director.

Except for aircraft in a state of emergency, or during radio communication failure, the transferring unit shall assign transponder code A2000 to a controlled flight prior to transfer of communications except before a transfer to an accepting ATC unit.



Figure showing aircraft squawking 2000 in non-controlled area after ATC transfer to Unicom.

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5.2. Transponder status with IvAc

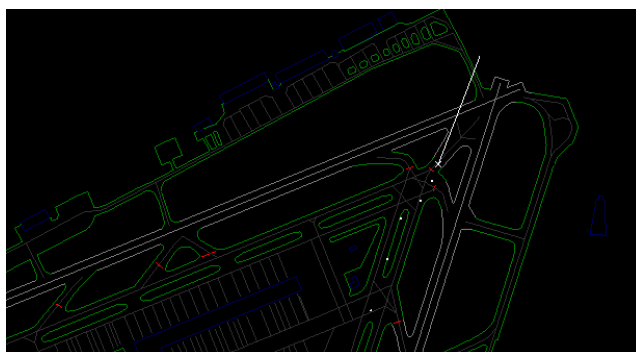
It is the responsibility of the active controller to check that a pilot correctly uses the STDBY/TX position of his transponder.

All pilots must:

- Set transponder to **STDBY** position before connecting to the IVAO network
- Set transponder to **STDBY** position on apron and during taxiing
- Set transponder to **TX** position when cleared entering on runway for departure, and at the latest before take-off.
- Keep transponder to **TX** position while flying
- Set transponder to **STDBY** position after vacating the landing runway

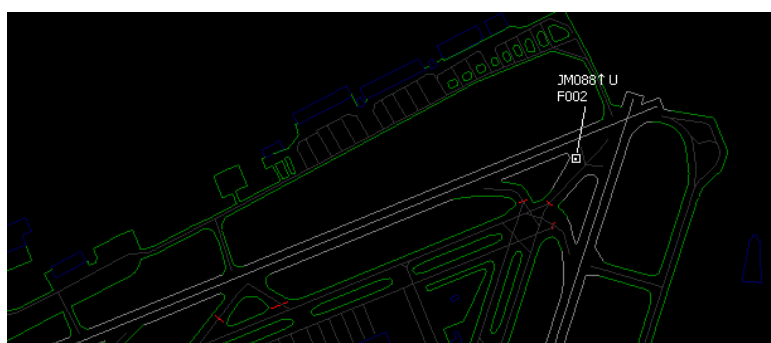
5.2.1. IvAc representation

The figure below shows an aircraft taxiing in **STBY** mode on the radar screen (no altitude is shown):



(Aircraft call sing may be displayed, depending the IvAc settings)

The figure below shows an aircraft in **TX** mode (known as ALT / ALTICODER mode) on the radar screen (altitude is shown):



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There are only two representations of the transponder mode:

- **Mode A** transponder with no pressure altitude information



This representation is also valid for **N**, **X** and **I** modes. The aircraft identification is always active in IvAp.

- **Mode C** or **Mode S** transponder with pressure altitude information



This representation is also valid for **P** mode. The aircraft identification is always active in IvAp.

5.2.2. Aircraft Identification with transponder

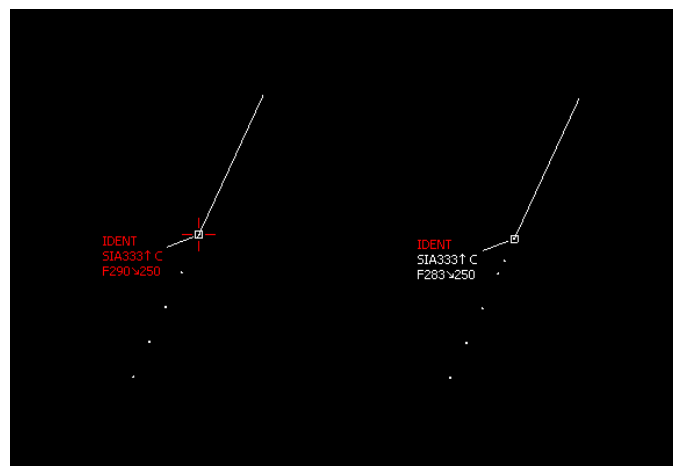
As an air traffic controller in a large zone, you may not easily locate an aircraft quickly.

In order to speed up identifying an aircraft location, the air traffic controller can use the IDENT procedure by giving a "transponder IDENT" or "squawk IDENT" command to the pilot.

When receiving a transponder IDENT request, a pilot will press the IDENT button on his instrument. When the radar equipment receives the IDENT, it results in the aircraft's blip blinking on the radar scope.

Note that IDENT should be performed on request of ATC only.

IDENT can also be used in case of a reported or suspected radio failure to determine if the failure is only one way and whether the pilot can still transmit or receive, e.g., "Air France 8542, if you read, squawk IDENT".



The figure shows the 2 aircraft states during the blinking IDENT on the radar screen.

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