Why We Squawk©

During WWII the British developed a top secret 10" x 10" x 10" radar transceiver. It would respond to a radar interrogating signal by responding with a coded transmission. A code would allow the land based radar station to distinguish British from German aircraft on their radar screen. The radio also contained an internal thermite bomb which, when triggered by an inertial switch (crash), would destroy the interior of the set. This was supposed to prevent German discovery of the codes. (A reverse ELT?) The British code named the system Parrot. The United States Army Air Forces version of the system was called IFF, for Identification Friend or Foe.

As with many WWII developments, the IFF system was designed to prevent a clever German ruse. The Germans were following the night bombers back to England. German aircraft would join in the stream of returning British bombers. They would wait until the bombers were most vulnerable, just prior to landing, and then shoot them down. Parrot allowed detection of these German aircraft since their (primary) return would not have a distinctive code.

To control the operation of the airborne coded set to the best advantage, the ground based radar station would radio instructions regarding the operation of "Parrot". The aircraft would be directed to "squawk your parrot", meaning to turn on the set for identification; or to "strangle (not kill) your parrot" as a directive for turning the set off. The power of the transponder signal would often hide other targets.

The only vestige of this that remains today, other than the entire ATC system itself, is the term "Squawk", as an ATC directive for operation or code for the transponder. Old time ATC controllers may still have you "strangle" your parrot (x-ponder)

Today the transponder usually has a four position switch—off, stby (standby), on (mode A), and alt (altitude Mode C), a test button, and ident (identification) button, a response light, and four selector switches with numbers from 0 to 7. Certain aircraft letters and numbers cannot be reproduced but frequently the discrete code can be seen to represent a specific aircraft due to their similarity.

ATC has a system by which the code used on the transponder shows a specific type of operation. Operations such as VFR without advisory, VFR with advisory, IFR, specific airport operation, TCA, ARSA, Local IFR, Tower enroute IFR, X-country IFR, emergency, hijack, and radio failure all have differing first two digit codes which tell ATC controllers your situation.

There are 4096 possible code selections on a transponder from 0000 to 7777. This is a Base 8 number system which is used by computers as a short method of storing Base 2. Base 2 is the number system of computers.

The four places of the transponder from right to left are 1's, 8's, 64's, and 512"s. We know it is a base 8 because the highest digit is 7. The eight possible digits are 0, 1, 2, 3, 4, 5, 6, and 7. Counting in Base 8 proceeds as follows:

					Base 10
Place Values	512	64	8	l	equivalent

```
                  0     0    0   0 =  0
Set as             0    0    0   1 =  1  (1 one)
transponder    to
code numbers.      0    0    0   7 =  7  (7 ones)
                   0    0    1   0 =  8  (1 eight, no ones)
                   0    0    1   1 =  9  (1 eight and one one)
                  to
                   0    0    7   7 =  63  (7 eights, 7 ones)
                   0    1    0   0 =  64  (1 sixty-four, no
                                           eights, no ones)
                   0    1    0   1 =  65  (1 sixty-four, no
                                           eights, one one)
                  to
                   0   7    7   7 =   7 sixty-fours, 7 eights,
                                        and 7 ones)
                      448 + 56  + 7  =511
                to
                   7    7    7   7 = 4095
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4095 added to 0000 makes the possible 4096 transponder codes. More than you ever wanted to know?

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      Emergency    7    7    0   0 = 4032 in base 10
      Nordo        7    6    0   0 = 3968
      Hijack       7    5    0   0 = 3904
      VFR          1    2    0   0 =  640
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Radar Separation

Terminal Area (TRACON)

Basic separation within 40 miles of single antenna is three miles in airport/terminal airspace. IFR/VFR separation is 1.5> miles in Class B. Beyond 40 miles of antenna it is 5 miles.

Air Route Traffic Control Centers (ARTCC)

5 miles is the minimum for IFR. Several antenna returns are displayed as one.

The pilot should know that under VFR conditions once you have told ATC that you have visual contact with traffic you may not receive any further radar advisories on that traffic. They may not advise you again of altitude or direction. It is up to you to evade any possible wake turbulence. ATC will let you fly right under a DC-10' wake turbulence and not issue a warning. You must be aware of this lack of protection and be assertive enough to make a 360 or whatever it takes for avoidance.

Radar Identification

Contact and identity established by 1-mile or runway is 'contact". Radar return at specific reported position is 'contact'. Radar vectors may be used to identify and establish 'contact'. Transponder codes are used. Mode C gives altitude which must be validated by each successive controller. This is why when you make contact after a radar hand-off you should always include your altitude. If you don't, the controller is required to confirm your altitude.

Data Block

The computerized radar is capable of showing the aircraft route, a conflict with another aircraft, range and bearing from any fix, and a minimum safe altitude warning.

All transponders operate on 1090 MHz. For Mode A the transponder gives back only the four digit code. For Mode C includes the altitude. This is done 600 times a second but only 20-30 responses occur during the radar beam passage. If two radar interrogations occur nearly simultaneously the transponder response may become garbled at the radar site. This often leads ATC to claim that your transponder isn't working properly. Your recycling the transponder is a way of changing the response sequence. If one radar location has had no difficulty with your transponder refer the problem site to them. Often different locations are using widely age different systems. Ask that the radar tapes be saved so that the FAA may make an analysis of the problem.

All codes are discreet and assigned by ATC to give other controllers information regarding your type of flight and destination. Operations such as VFR without advisory, VFR with advisory, IFR, destination, specific airport operation, TCA, ARSA, Local IFR, Tower enroute IFR, X-country IFR, emergency, hijack, and radio failure all have differing first two digit codes which tell ATC controllers about your flight and destination. An improved Mode S system is under development which will allow selective interrogation.

An airplane may be without an altitude encoder and operate only on MODE A or ON. Under Mode A, ATC will expect you to maintain either an assigned or agreed upon altitude and to report changes. Flight with Mode A is somewhat restricted. If you know that your transponder does not have Mode C capability, be sure to advise ATC. Know the following restrictions.

Aircraft above 10,000 feet are required to have an operative transponder with Mode C. Aircraft in Class C airspace or above the outer perimeter of the Class C airspace up to 10,000' are required to have a transponder Mode C. Any flight above the Sacramento Class C comes under this last requirement. Any aircraft in a Class B or operating within 30 nautical miles of the Class B primary airport is required to have an encoding transponder. Exceptions are made for aircraft without electrical systems and high mountain flights within 2500' of the surface. The transponder and encoder system must be inspected every 24 months. It is illegal not to use your transponder, while flying, to its highest capacity.

An aircraft without an operating transponder shows, if at all, as a primary target. All transponder targets are called secondary. Under MODE C, or ALT, your aircraft will have an encoder which tells ATC your altitude. ATC will always need to know if your altitude encoder is operating correctly. This altitude encoder is cross-checked by ATC with your altimeter setting via radio. They will remind you of the current altimeter setting and perhaps ask you to switch to MODE A if your encoder is off by more than 300'. An error of 300' makes the transponder unsafe to use for traffic avoidance purposes.

If you should experience a transponder failure, be cautious about accepting flight into a radar environment where radar is the prime system. Once you land at a Class C airport without a transponder you may be unable to get out. Trick: Try to get piggy-backed on to another aricraft as a flight of two. Nice if you can get out in the direction you want to go. Radar can track a primary signal with little difficulty today. They can even attach a data block. Planed flights into Class C or even B require one hour notice.

Any MODE C traffic that has not been cross-checked will be given to you as UNCONFIRMED altitude. For this reason you should always include your altitude in the information to ATC. Advise if you are level, climbing, descending and final altitude. When you have not been assigned an altitude be sure to advise ATC when you plan to make changes of an established altitude.

On the ground the transponder should be set to standby. This stops the squawk but allows the transponder to stay warm and ready for operation when needed. The start takeoff, emergency, and post-landing checklist should have transponder as a checklist item. Whenever changing codes on the transponder recommendation is that 'standby' be selected during the change since it prevents inadvertent discrete codes being sent to ATC. The transponder should be turned on as you taxi onto the runway for takeoff. Use of MODE C is now required in many cases as noted in a prior paragraph.