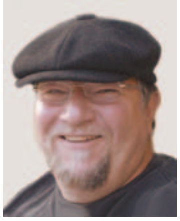
Air/Ground Sensing explained



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There is one, simple three-word phrase which will incite an immediate and passionate response from a pilot. No, it's not "I love you", nor is it the more commonly heard "Where's my alimony?" No, if you want to invoke the wrath of an airline aviator, try entering the words "Ground Checked Serviceable" into the logbook in response to a snag.

I was once summoned to the cockpit by an angry captain who asked if I was suggesting he should taxi the aircraft to Havana. As maintainers of aircraft, 99 percent of our time spent aboard these wondrous machines is when they are sedately at rest on the ground. It's easy for us to lose sight of the fact that they (the airplanes) spend 99 percent of their time aloft, tens of thousands of feet above the ground, whistling along at several hundred miles per hour. Besides the physical dynamics, many aspects of an aircraft's behaviour and systems operations change dramatically once it has "slipped the surly bonds of earth." A better understanding of air/ground functionality will enable us to more effectively troubleshoot, inspect, repair and maintain our aircraft.

The enormity and mass of a modern passenger jet easily tricks us into believing it is as solid and firm as a granite apartment building. It is easy to forget that one of these machines, weighing in at over a million pounds when fuelled and ready for departure, can indeed fly at speeds in the neighbourhood of 600 mph. The amount of airframe stress and strain experienced by such an aircraft in flight is enormous. Wings flex up and down, sometimes as much as 20 feet; fuselages twist and bend, and of course, all associated wiring is also subject to this same stretching, vibrating, twisting, and chafing action in flight. This can lead to all sorts of problems as wires are stretched, twisted, and subjected to vibrations created by air loads, engine operation, gearbox action, etc. Conduits, ducts, motors, valves, actuators, switches, sensors, and all other operational components must endure this type of in-flight dynamic as well. Add to this a frigid outside air temperature of about minus 50 degrees, and one can readily imagine how all of these dynamic factors could result in component failures, systems difficulties, and a logbook full of snags.

However, once the aircraft has returned to earth and has been towed into the cozy confines of the maintenance hangar where all of those nasty flight dynamics don't exist, many of those snags seem to disappear. There can exist an understandable temptation on the part of the busy aircraft maintenance technician to simply test the snagged system, and sign it off with the notorious "Ground Checked Serviceable" aphorism. A more appropriate course of action would be to check the system, bearing in mind factors which may exist in an airborne configuration, but not on the ground. Wiring and duct work should be inspected for signs of chafing, cracking, and separating which might occur under flexing, bending and stretching flight-dynamic conditions. Consideration should be given to components such as motors and actuators, which may operate normally under static ground conditions, but could be prone to failure under high vibration or extreme cold.

So different are airborne flight conditions to static ground conditions that virtually all aircraft large enough to employ retractable landing gear employ some sort of air/ground sensing system, enabling the aircraft's systems to operate differently depending upon which of these two milieus it is operating in.

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Most air/ground sensing is done by means of a switch or sensor on the landing gear. The switch will open or close whenever the aircraft's weight is either transferred to, or removed from, the landing gear. For this reason, these switches are referred to as squat switches or weight on wheels (WOW) sensors. While most aircraft have the squat switches located on the main landing gear, some use the nose gear for this purpose. As maintainers, it is important that we recognize the implications of "tricking" an aircraft into air mode when it is in fact on the ground, and also the ramifications of actually putting an aircraft into air mode (i.e. on jacks) when it is in a static, maintenance environment. It is crucial that proper procedures are followed when placing an aircraft into air mode for maintenance purposes, as serious damage and injury can occur if these procedures are NOT followed, and properly sequenced.

The process of manually tricking an aircraft into flight mode typically involves mechanically closing or opening the actuator of a mechanical squat switch, or using ferrous and non-ferrous materials to "fool" proximity sensors. Of course, when an airplane is placed on jacks and the weight comes off the wheels, the aircraft **is** in air mode and will behave accordingly. There are also certain tricks and techniques that are type-specific to particular aircraft that can be employed to alter the air/ground sensing system. Pulling the landing gear lights circuit breaker on the old Boeings would remove the gear warning indicator lights and put about 80 percent of the aircraft's systems into flight mode.

Due to the dramatic temperature difference between ground level and cruising altitudes, thermal anti-ice systems operate very differently on the ground as opposed to in-flight. The amount of heat applied in flight conditions would result in serious damage if used on the ground. Extreme care must therefore be exercised with regard to systems such as pitot-static heat, prop de-icing, and wing/body thermal de-ice systems when tricking an aircraft into air mode. Severe damage would be caused by the application of full in-flight anti-icing heat to any of these systems while the aircraft was on the ground. Likewise, precautions should be taken before putting an aircraft on jacks to ensure the air/ground sensing doesn't cause automatic activation of any heater elements.

Factors also exist that pose risks to personnel when aircraft are placed into flight mode while still on the ground. The aforementioned pitot-static heat issue can result in very serious burns should anyone contact these probes while they are being heated in air mode. Automatic movement of outflow valves and ram air doors when an aircraft enters air mode can cause serious injury . Inadvertent deployment of ram air turbines (RAT) can also result in serious injury to maintenance workers.

With airplanes becoming "smarter" as a result of advancing technologies, new hazards associated with air/ground sensing are being created. An aircraft equipped with fly-by-wire technology, if tricked into flight mode while on the ground with engines running, may throttle up in attempt to gain airspeed. Wheel brakes and nose gear steering may be disabled in flight mode. Imagine the scenario of a transport category aircraft being ground run by an engineer, and being tricked into air mode; engines roar to full power, brakes are disabled, no nose gear steering available, and fly-by-wire technology means pulling back on the throttles has zero effect. It could lead to a spoiled afternoon.

Air/ground sensing is, generally speaking, designed to prevent various systems from operating inappropriately on the ground or in flight. It can also ensure systems are enabled or disabled as befits the aircraft's situation. As maintainers, we are occasionally required to trick the air/ground sensing system. It is crucial that when doing so, we precisely and accurately follow all procedures to guarantee the safety of the aircraft and personnel in the vicinity of the aircraft. Failure to do so could have catastrophic results.

Q: What is the commonly used term for the air/ground "weight on wheels" sensor?

Answer to the question from last issue:

Q: What is the process of varying or changing R.F. signals called?

A: The process of varying or changing R.F. signals is known as "modulation". Amplitude modulation (AM) and frequency modulation (FM) are both used in aircraft applications.

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