# Getting Started on the Amateur Radio Satellites (Part V)

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**(The bulk of this article was previously published as "How To Use Linear Amateur Satellite Transponders" in the November 2010 issue of *Monitoring Times*, Brasstown, NC 28902)**

In previous columns, I've been discussing ways to find, track, listen for and then communicate through our expanding fleet of Amateur Radio satellites. In this installment, I'll be introducing you to another (non-FM) type of satellite transponder called a "linear" transponder that is carried aboard many of our current amateur satellites. I'll also discuss how our OSCAR satellites get their names on orbit.

You'll remember from previous columns that a *transponder* is the circuit in a satellite that receives an uplink signal and then retransmits what it hears via its downlink transmitter … much like your local FM repeater does. However, unlike your local FM repeater (and most of our FM satellites which have specific input and output frequencies) most of our so-called "linear" satellite transponders (sometimes also called "analog" transponders … the terms are often used interchangeably) receive and then retransmit *a whole band* of frequencies commonly called a *passband*.

What's more, linear amateur satellite transponders come in one of two "flavors". These transponders are usually classed as *inverting* or *non-inverting*. If the satellite has a non-inverting transponder, when an operator's uplink signal frequency is on the high end of the uplink passband, their downlink signal will also be in the high end of the downlink passband.

Conversely, in an inverting transponder, when an operator's uplink frequency is on the high end of the uplink passband, it will become "inverted" (hence the name) and come out on the lower end of the downlink passband. Put another way, inverting transponders make mirror images of the signals they pass.

This holds true for the sideband sense as well. In a non-inverting transponder, the signals an operator sends up to the satellite (USB or LSB) will come out the same way on the downlink. However, in an inverting transponder, a USB uplink will be "inverted" and come out as LSB on the downlink. Conversely, a LSB uplink will be "inverted" and come out as USB on the downlink. The latter approach (USB signals on the downlink) is also what's most preferred by operators using our linear satellite transponders today. Fortunately, CW will be CW regardless of the transponder's variety!

Note that most linear-transponder-equipped satellites currently in orbit (including FO-29, VO-52 and HO-68) use inverting transponders. The one exception is our old AO-7 satellite that was launched back in 1974 and which is still "sort of" operational (that is, it operates only when it is in sunlight). It uses a *non*-inverting, linear transponder.

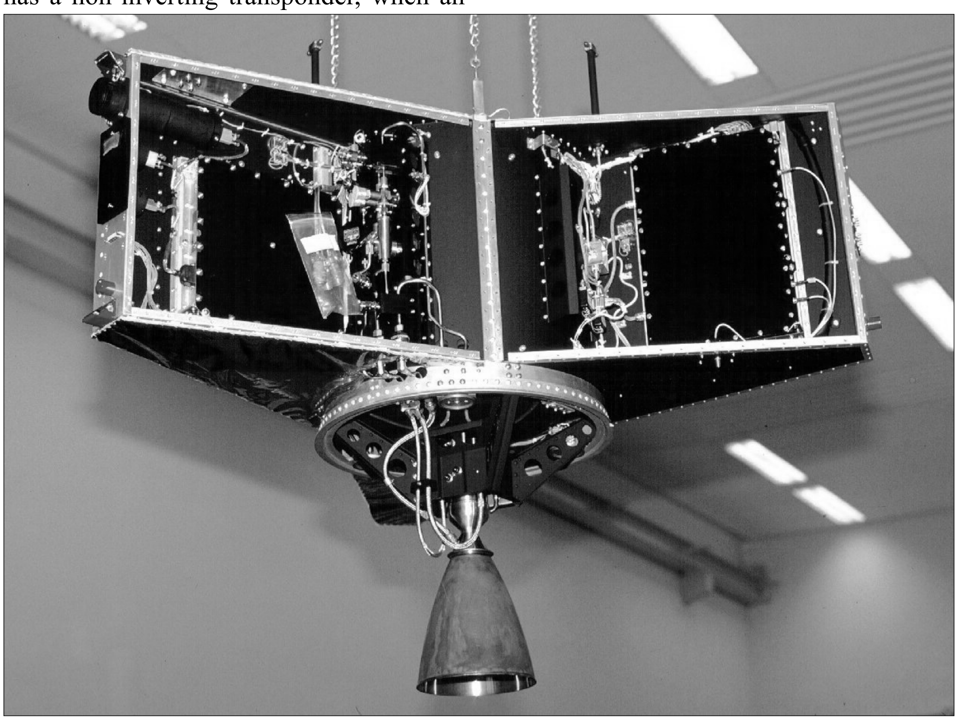

***Photo1: Dubbed Phase 3-B prior to launch, the satellite that would eventually become AMSAT-OSCAR-10 on orbit hangs in the payload integration hall prior to its launch from Koruou, French Guyana. (Courtesy: AMSAT-DL)***

As with the FM birds, common operating practice on amateur satellites with linear transponders is to first listen for your own signal on the downlink. You'll remember from my previous columns that working through a satellite transponder is a *full duplex* operation, much like talking on a telephone. This means that others can usually hear you as well as you are hearing yourself.

Finding your own signal in the downlink passband of a satellite with a linear transponder the first few times can be tricky. However, I've found that placing your transmit frequency somewhere in the middle of transponder's passband and then sending a few "dits" of CW while tuning your ***receiver*** to find your own downlink signal works best. Once you've located your own signal, you're ready to try making a contact.

However, unlike the FM birds, calling CQ on these satellites ***is*** acceptable and you'll usually find the convention of CW operations in the low end of the passband with phone operation in the upper part of the passband (an arrangement common to High Frequency (HF) Amateur Radio operation) generally also holds true for satellite work as well.

As I have also noted in previous columns, since a satellite is a moving target, its downlink signals will exhibit a pronounced *Doppler shift*, just like the changing pitch of a train whistle as it approaches and then passes. During a satellite QSO, the "old" (that is, prior to computer frequency control) so-called "One True Rule" of thumb for linear satellite operation is that if the uplink band is *higher* in frequency than the downlink, you should slowly shift your ***transmit*** frequency on the uplink as the Doppler effect changes the frequency of your downlink signal. Conversely, you should shift your ***receive*** frequency if the uplink band is *lower* in frequency than the downlink.

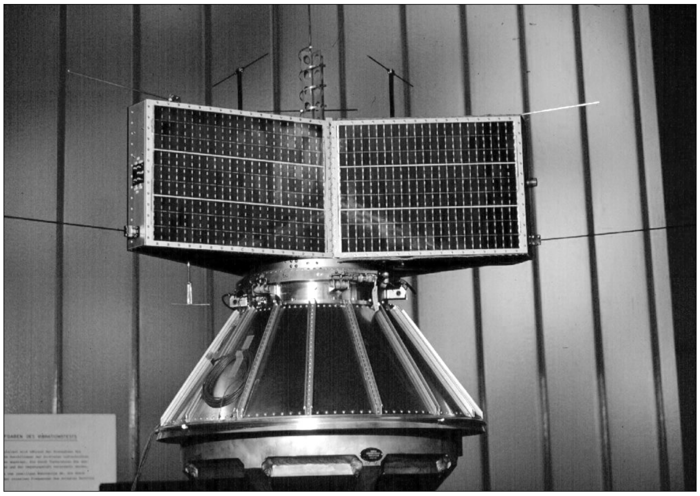

**Photo 2: Phase 3-B (AO-10) sits atop its carrying structure prior to launch. Although its onboard computer was eventually hobbled by radiation damage, AO-10 provided many hams with their first taste of a truly high altitude, linear-transponder-equipped satellite. (Courtesy: AMSAT-DL)**

Practically speaking, this means that you should shift your ***transmit*** frequency on the Mode U/V (the old Mode B) satellites, and your ***receive*** frequency when operating on the Mode V/U (the old Mode J) satellites. This approach will usually help prevent an inadvertent shift of your conversation into someone else's conversation on the transponder. However, unfortunately, in the "heat of the moment" with everyone frantically searching through the passband for their own downlink signals, my experience has shown that these conventions are often ignored.

Hopefully, as more and more of us employ computer-aided frequency control for our satellite contacts, this age-old problem should eventually take care of itself. A much more detailed discussion on this (often controversial!) subject is contained on the AMSAT Web site at: **http://www.amsat.org/amsat/features/one_true_rule.html**

**Photo 4: AMSAT's satellites are usually at the "bottom of the launch stack". Here, the faring used to protect Phase 3C (AO-13) from the rigors of launch is shown being lowered around the satellite. (Courtesy: AMSAT)**

## Keep The Power Down!

Because it is generated by relatively small solar panels illuminated by the Sun, satellite power is a finite (and, therefore, scarce!) resource. That's why it is *very* important to use only enough power on your uplink transmissions to produce a readable signal on the downlink.

As I've said, when operating on the satellites, you need to get used to the idea that satellite work is *weak signal work*. It's *not* like operating on HF (or terrestrial VHF or UHF) where the use of more power is usually "better". Besides being potentially harmful to a satellite's battery life by using more uplink power than is necessary, overpowering your uplink signal beyond the point of creating a discernable signal through the satellite's linear transponder on the downlink will *not* appreciably improve the overall strength of your downlink signal.

On the contrary, such activity will do little more than "pump" the satellite's automatic gain control as it tries to compensate for the onslaught you are creating with your overpowered uplink signal. Such activity will only gobble up yet *more* of the satellite's precious available power, not to mention limiting the overall downlink power available for others using the transponder.

Unfortunately, all it takes is one overpowered uplink signal in the linear passband to drastically cut the strength of everyone else's downlink signal. As you might expect, such activity will *not* make you a popular camper on the satellites for *crocodiles* ... those who operate with "all mouth and no ears" ... are about as welcome on the birds as *lids* are elsewhere in Amateur Radio.

## FM Is Particularly Unwelcome!

Also, because satellite power is such a scarce commodity, most linear satellite transponders are built to use the most efficient operating modes possible. Normally, this equates to Single Sideband (SSB) voice and/or Morse (CW).

Therefore, it should also come as no surprise that another big *"no-no"* is running FM through linear satellite voice transponders. FM signals occupy a much larger bandwidth and take a significantly greater portion of a transponder's precious output power to handle than do CW and SSB signals. And while some people have met with moderate success operating through linear satellite transponders by "simulating CW" ... using the push-to-talk circuit on a 2 meter FM radio for example ... this approach often produces a wide (and *very* "chirpy") CW downlink signal.

Either way, your FM signals will gobble up lots of downlink power and stick out like a sore thumb. Just imagine how obnoxious you'd sound running SSB signals through your local FM repeater and I think you'll agree that *all* use of FM should be avoided when operating through a linear satellite transponder.

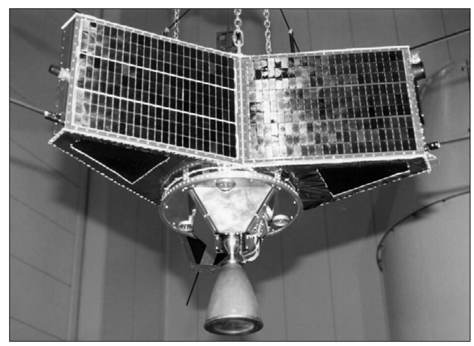

**Photo 3: By far, AMSAT's most successful, high altitude linear transponder equipped satellite was Phase 3-C. Later named AMSAT OSCAR 13 (AO-13) on orbit, it provided many years of long-duration, satellite DX QSOs to users worldwide. (Courtesy: AMSAT-DL)**

## Linear vs. FM

Of course, all of this begs the obvious question as to which mode is "better". Having operated in both modes on a number of different satellites over the years, suffice it to say that neither mode is "better" than the other; they are just "different".

Clearly, our FM birds offer an easy path for newcomers to get started as they usually only require an FM handheld (and something like an Arrow or Elk handheld antenna) to use. On the other hand, because our FM birds usually operate on a single channel, they are also wonderfully popular. And because of

***Photo 5: Technicians put the finishing touches on the launch mechanism of JAS-1B, a linear transponder-equipped satellite that later became FUJI-OSCAR 20 (FO-20) on orbit. (Courtesy JAMSAT)***

the hoards of users this feature attracts, the overcrowding that results means that most of your conversations on the FM satellites will, of necessity, be of the "hello and goodbye" variety.

However, if you are even marginally equipped to operate on the linear transponder-equipped satellites (as I am these days with just a pair of "eggbeater" satellite antennas) you will often find a lot of "wide open spaces" on these satellites where you and the person you eventually hook up with can actually engage in an old fashioned "rag chew" during most (if not the entire)

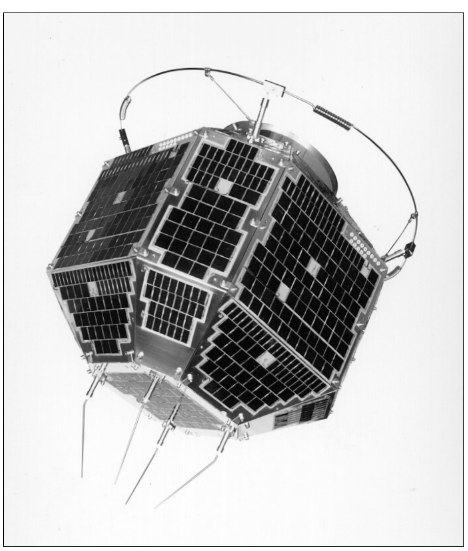

***Photo 6: JAS-1B (FO-20) as it might have appeared in on orbit. (Courtesy: JAMSAT)***

pass. Sadly, as of late, my experience has also shown that a lot of the bandwidth our current fleet of linear satellites now offer us on a daily basis goes begging most of the time. Clearly, because our satellites have a very definite lifetime, the old adage of "use it or lose it" very much applies.

### **OSCAR** *Who?*

If you are new to the satellites, sooner or later you will probably start wondering how our amateur satellites get their names. Most newcomers know that our satellites are called "OSCARS". But few may know how (and when) our satellites get their on-orbit numerical designations. Believe it or not, there IS a logical plan for it all!

Since 1961, some 60 plus "OSCARS" (short for Orbital (or Orbiting) Satellite Carrying Amateur Radio) have been built and launched by a number of Amateur Radio-related organizations worldwide. And just like their Hollywood counterpart of the same name, there are some very strict rules as to how our amateur satellites get to be so honored and officially become "OSCARS".

Before launch, most of our fleet of Amateur Radio satellites are called by many other names. Indeed, for several years, AMSAT-NA has simply used a sequential alphabetical identifier for most of its satellites before launch. For example, prior to launch, our very popular AO-51 satellite was called "OSCAR-E", "AMSAT OSCAR Echo" or just "Echo". So, it should come as no surprise that the next satellite in this series (and the current satellite AMSAT's experimenters are working on) is called "The Fox Project", "AMSAT-Fox" or just "Fox". AMSAT Fox is shaping up to be a small, so-called "1U CubeSat" that, if all goes as planned, will be an on-orbit replacement for AO-51. That's because, after nearly 7 years in the harsh environment of space, AO-51 is getting "long in the tooth" and its batteries are now starting to show their age.

Similarly, prior to launch, our German AMSAT compatriots have traditionally referred to their string of very successful high altitude (so-called "Phase 3") satellites with alphanumeric designators. In that regard, their Phase 3-B satellite went on to become OSCAR 10 (AO-10), Phase 3-C became OSCAR-13 (AO-13) and Phase 3-D eventually became OSCAR-40 (AO-40) on orbit. Currently, the folks at AMSAT-DL are hard at work preparing their Phase 3-E satellite for another (as yet to be determined) high-altitude launch.

Other AMSAT organizations have used different names for their satellites prior to their launch and on-orbit activation. For example, our Japanese friends (in the JARL and JAMSAT) refer to their satellites as "Japan Amateur Satellites" (abbreviated "JAS") followed by a number. And, true to form, their long-popular satellite, FO-29 was called "JAS-2" prior to launch.

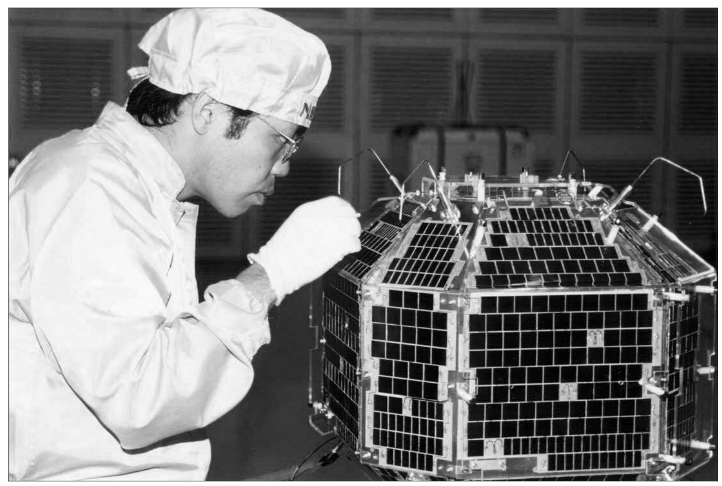

***Photo 7: A technician makes a final adjustment to the JAS-2 satellite prior to launch in 1996. Later re-named FUJI-OSCAR 29 (FO-29) on orbit, the satellite is still "semi-operational" to this day. (Courtesy: JAMSAT)***

However, once our amateur satellites are successfully launched, a name change to something more universally recognized becomes necessary. Otherwise, these (largely alphabetical) designators would lead to endless confusion. But, to be called an "OSCAR" satellite on orbit, these proposed OSCAR satellites must meet a number of very specific "litmus tests".

First, they have to be capable of transmitting and/or receiving in the Amateur Radio bands. They also have to successfully achieve orbit and be activated in space. And, lastly, the builders of the satellite have to formally request that an OSCAR number be assigned to their (now orbiting) handiwork.

Today, by mutual agreement between AMSAT and the original Project OSCAR team (the West Coast team who built and launched the very first OSCAR satellites) those formal requests all go to AMSAT

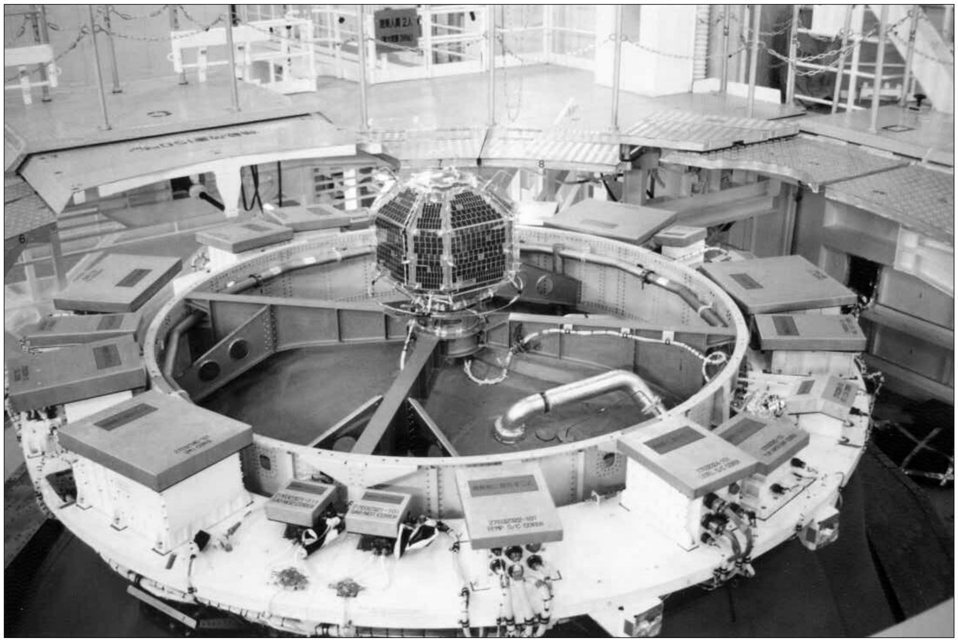

**Photo 8: JAS-2 (FO-29) is dwarfed by its carrying structure. A Japanese H-II rocket launched from Japan's Tanegashima Space Center in southern Japan successfully placed the satellite into a circular, Low Earth Orbit (LEO). (Courtesy: JAMSAT)**

founding member and past president, Bill Tynan, W3XO, who then passes judgment on the "amateurness" of the payload before he officially assigns an OSCAR number.

Usually, the "O" part of the on-orbit designator stands for "OSCAR", while the number following it is sequentially assigned by Bill, depending on precisely when the satellite's transponder was activated on orbit. However, the first letter of the OSCAR designator can stand for many things. That letter is usually suggested by the satellite's builders or sponsors and often gives a hint about its heritage. For example, the "F" in FO-29 stands for "Fuji" (for "FUJI-OSCAR") while the "A" in AO-51 stands for "AMSAT" (as in "AMSAT-OSCAR 51").

But there are exceptions to this rule and the "A" doesn't *always* stand for AMSAT. For instance, the "A" in AO-27 stands for "AMRAD", the suburban, Washington, DC Amateur Radio group that built the Amateur Radio satellite payload and which was later launched aboard its commercial host (called "EYESAT") in 1993. The "S" in SO-50 stands for "SaudiSat" as a university team in Saudi Arabia sponsored the building and launch of that satellite. However, the "S" in SO-67 also stands for "SumbandilaSat". Sumbandila is a South African Venda word that means "lead the way". And that satellite's full name, when freely translated into English, means "pathfinder" as more satellites of the same type are intended to follow.

Now, if this "alphabet soup" all sounds a bit confusing, that's probably because it is! Just remember that the letter "O" in a satellite's official, on-orbit name followed by a dash and then one or two numbers *usually* indicates that the satellite is one of our fleet of Amateur Radio (OSCAR) satellites.

## Wrap Up

That's all for this installment of my "getting started" series. In future columns, I'll be discussing some more interesting aspects of this unique part of the Amateur Radio hobby as well as to bring you up to date on the history and current status of some of our on-orbit satellites, including a discussion about the Amateur Radio equipment now being carried aboard the International Space Station. See you then.

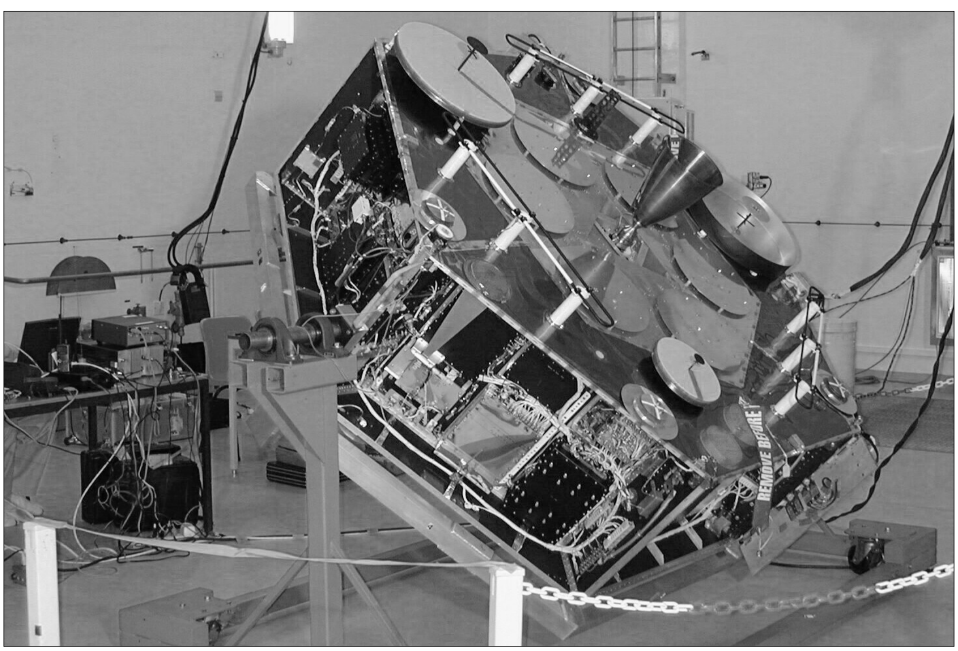

**Photo 9: AMSAT's Phase 3-D satellite (later renamed AMSAT-OSCAR 40 on orbit) awaits final integration at ArianeSpace's Guiana Space Center in Kourou, French Guiana in November, 2000. (Courtesy: AMSAT)**

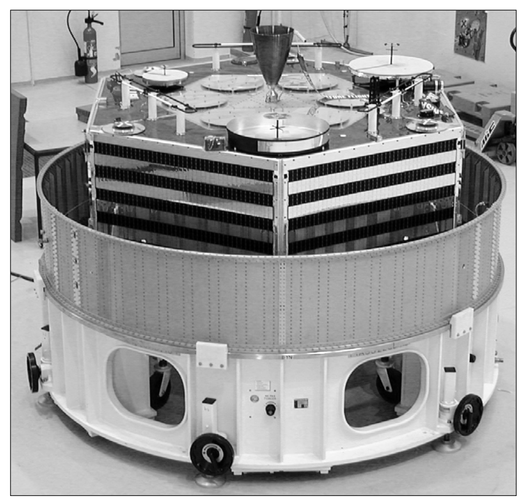

**Photo 10: Phase 3-D (AO-40) is shown here neatly tucked inside its Specific Bearing Structure (SBS) prior to launch in 2000. AMSAT's experimenters designed, built, tested and then later freely provided that SBS design to the European Space Agency in exchange for a reduced "ticket to ride" for Phase 3-D. (Courtesy: AMSAT)**