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The ARC Navomatic 300A Autopilot

Please note its operation highlighted in “blue” below:

The ARC 300A was an option on many single engine Cessna aircraft available near the mid-seventies and stayed on the option list up through the T210L. Cessna 172M, 180J, 182P, TU-206F, these are but a few aircraft that had the 300A on their option list. I’ve been told the 300A was available for the twin-engine 337 Skymaster but I’ve never seen on installed in a twin.



The reason I’m writing this article is because for some reason I’ve received a lot of tech calls about this product, even though this autopilot has been out of production for well over a score. Maybe this writing will answer some of your questions as to the theory behind the 300A and what it takes to fix it.

The ARC 300A autopilot is what we call a “single axis”

system, meaning it only controls the roll axis of the aircraft, only connected to the ailerons. This system has no effect on the other two axis, pitch and yaw. All aircraft rotate around three axis, roll, pitch and yaw; the 300A is only utilized in the roll axis. This autopilot is all electric, thus if you lose vacuum the 300A could keep the wings level. Yes, the vacuum directional gyro would cease to function but still the little 300A could save your bacon if you experienced a vacuum failure during IMC (more on this later). In a nutshell, here's how the 300A operates. Roll and yaw changes in the aircraft are sensed by the G-300A Rate Gyro (turn-coordinator). These changes are what we call error signals which are then sent to the computer. The computer is the box that is located in the bottom of your radio stack that has 300A Navomatic written on it. Also, when the heading or nav function is selected, any deviation from the selected input is transformed into an error signal, which is then processed by the 300A computer. On a good day, the computer figures out the correction needed and moves the aileron via the actuator/servo. Basically the autopilot computer looks for an error signal and tries to null out that signal. The 300A is a very basic system and normally works fairly well in the heading mode. The complete system, including mounting brackets weighs around 10 lbs.

Lets Talk Components. The ARC 300A's computer is called a

CA-395A. Again, this is the box at the bottom of the radio stack with all the switches on it. There's a lot of electronics inside but nothing



modern, remember your 300A may be 25 years old. The panel computer came in a black or gray color and the later model computers had a wide faceplate. While they may be the same electronics wise, the newer model computers may not fit in your older Cessna due to the wide faceplate. The faceplate is a real

chore to change out, don't go there. This computer receives signals from the G-300A Rate Gyro, navigation indicators and G-502A/B heading indicator and possibly your navigation equipment. All controls of this system are located on the front of the computer with the exception of the heading bug, which of course is located on the directional gyro in the instrument panel.

The Control Switches located on the front of the 300A do the following:

A/P. turns the 300A on or off.

Pull Turn. When pulled out and centered in the detent, the aircraft will fly what it *thinks* is wings level. When turned left or right, the aircraft will respond by flying in the selected direction. When properly adjusted, max turn will not exceed standard rate. The exact turn is determined by model of the aircraft and is spelled out in the alignment procedure. In other words, I couldn't just yank a 300A computer out of a Cessna 185 and install it in a Cardinal without performing the alignment procedure, even though the computers are the same.

Trim. Move the white trim control to compensate for variations in the aircraft trim or weight distribution. Be SURE to adjust the rudder trim prior to messing around with the Trim on this computer.

NAV. The pilot can select either a NAV 1 or NAV 2 tracking source. This source could be VHF Nav, Loran or GPS, depending on avionics installed and how the system is wired.

HDG SEL. The best part of the 300A is its capability to track the heading bug. Push in this button (Pull Turn pressed in) and the A/P will follow the heading bug.

NAV INT. In theory when the Nav Int button is pressed in, the 300A should fly the intercept course to the Nav

data you have selected. In "Real World" it may do anything or nothing, depending on the 300A's mood at that time.

NAV TRK. Now this is important, so listen up. When the heading bug is set to the SELECTED course and the PULL TURN knob is pressed in, the aircraft may fly the selected course. I'll go into this subject in detail later but be advised the DG is part of the NAV TRK.

HI SENS. During NAV INT or NAV TRK usage, sensitivity of the 300A is enhanced to provide more precise operation. In the low-sensitivity position (button out), response is somewhat dampened for smoother operation. Normally when tracking a nav function, you'll want this button pressed in even though the POH says different.

BACK CRS. This function is available in the Localizer mode only. In a factory installation, when BACK CRS is pressed in it will reverse the direction of the needle on the selected navigation indicator. This allows the pilot to shoot the back course without the needles deflecting the wrong direction. For more information about back course discuss this with your local CFII. The localizer needle will only be reversed under the following condition. Back CRS button is pressed in, a localizer frequency is cranked in on the selected navigation indicator and the A/P is turned on. Aircraft that have upgraded radios may no longer have the BACK CRS feature.

HDG. When this button is pressed in, the A/P is now going to track the heading bug on the directional gyro. If the heading bug is not centered under the lubber line, then the A/P will turn in the proper direction, near



standard rate turn to place the bug under the lubber line. As the bug comes near the lubber line located at the top of the directional gyro, the bank angle will decrease. Be sure to set your directional gyro to your calibrated wet compass on a regular basis.

The knob on the right, bottom of the directional gyro sets the heading bug; the knob on the bottom left sets the compass card within the directional gyro when pressed in and turned.

Actuator/Servo. Unlike the computer, the actuator/servo voltage is sensitive. The PA295B is for 14Vdc operation and the PA495A operates in the 28Vdc system; barring the voltage issue, they are very similar. The purpose of the actuator is to take a small electrical signal and convert it to a mechanical output that will operate the aileron. This system doesn't have slipping clutch, the clutch is electronic and is easily overridden. The force to override the actuator is only slightly higher than normal control pressure. The PA495A actuator does incorporate a thermostatic switch (built on the motor) that removes power from the actuator should it over heat. It will reset itself once it cools down, normally about 10 minutes. This thermo-protection is a common problem with this system. Actuators are built for a particular model aircraft and MUST be used in the aircraft they were designed to operate in. Yes, you may find an actuator out of a 210 will fit in a 182 but the torque settings are different and

should not be used under any condition. Normally the avionics shop will verify you have the correct actuator installed if they are working on the system, I couldn't begin to count the number of times I've found the wrong servo in a Cessna; just because it will bolt in place doesn't make it the correct part. . The actuator slides into a mount, thus allowing easy removal for troubleshooting and repairs.

Actuator/Servo Mount. The computer sends the actuator a command; the servo electronics develop a signal that turns a gear on the end of the Servo Motor. The servo is mounted inside the servo mount and the gear turns a larger gear within the actuator mount. The gear ratio is determined by the model of Cessna you may have. This large gear is connected to a chain sprocket that moves a chain; a "shear pin" joins the large gear and sprocket. The purpose of the shear pin is to shear should actuator or actuator mount develop a problem. Lets say the motor froze in the actuator; the pilot could give the controls a brisk turn and the shear pin would shear, thus normal operation of the controls would be restored. I've seen dozens of shear pins in my 23 years of general aviation fail but none were due to an



actuator or mount failure. The shear pin is often a failure point and we will discuss why later in this article. Each actuator mount has a tag on the side stating the color and part number of the pin that should be used in that application. A good avionics shop will verify the proper pin is in fact installed in your mount if they are working on the autopilot. If the actuator mount is removed from the aircraft, the bridle cable tension

should be reset after installation.

Rate Gyro (Turn Coordinator). Yes, the turn coordinator (TC) you see in the panel is the main input to the 300A computer. All ARC 300A A/P's used what is called a G-300A gyro. There are two different models available but functionally they are the same. A lot of autopilot problems are generated from the output of this gyro; but without the correct test equipment one may start tweaking on the computer to cure the problem but chances are they will chase their tail and never accomplish anything. It all boils down to knowing what you're doing and having the

correct test equipment. Rate of turn is displayed via a symbolic airplane, which is driven by the precession of the gyro. It's ironic that Cessna used a TC that shows a low wing aircraft. The newer Cessna's now have a high wing aircraft inside. A warning flag is visible and if it's red that's a bad thing. Aircraft power pulls the red warning flag. Even though the flag is out of view, the gyro may not function properly. This warning device has nothing to do with the proper operation of the TC; only tells the pilot there is power to the indicator, nothing else.

Directional Gyro. The ARC 300A came with the G-502A DG or the optional slaved G-502B. Normally with the slaved DG, you set the heading once after the gyro is up and running, then you're done; the electronics will take care of precession. The G-502B has a flux gate and slaving meter located somewhere in



the aircraft. You'll need one of these two heading systems for your

ARC 300A to operate properly. Few autopilot problems are related to the G-502A; most gyros get changed out due to excessive precession. We have had cases where the heading bug internal adjustment was so far out of spec that we couldn't align it to the computer. Anytime the 300A computer has Heading selected, the computer is looking at the DG and TC. Both of the above model directional gyros are vacuum driven.

It's a Matched System. Originally all the components mentioned above were installed as a matched system. Someone on the bench aligned all the pieces together prior to installation in the aircraft. You should not "just" install a DG, turn coordinator or other component in the aircraft and fly away; chances are it will never fly as it was designed to. There's a good chance the aircraft will fly to one side of the heading bug, wing rock or some other strange symptom. In my opinion, an AF-395A autopilot (300A) should not be repaired or serviced unless a H-42A test set is in the hands of an experienced repairman. Normally the actuator/servo can be replaced without any

adjustments being made.

Here's the Way I Align the 300A.

Using the H-42A test box and related extenders, the first thing I do is measure the TC output and verify there is little or no output when the TC is level and no movement. Often we see a huge error signal from the TC when in fact there shouldn't be; often this signal is too large to adjust out using the adjustments on the autopilot computer (these specs are called out in the maintenance manual). If the TC output isn't up to speed, then an overhauled unit must replace it. We use a turntable to verify proper operation of the instrument during turns. If the TC generates excessive noise or the warning flag doesn't function properly, then it's replaced, no questions asked.

Next I measure the output of the G-502A/B Directional Gyro to verify the proper output is present. Often we find there is excessive error from these gyros when the heading bug is centered (nulled out), too much error to adjust out with the adjustments on the computer. If so, the gyro should be replaced. If the unit passes this test then we spool the gyro up on a bench and check for precession. You see, the inputs to the computer must be correct or the 300A will never fly the aircraft as you would desire. Ever heard the saying "Garbage in,



garbage out"? Normally a shop will check the female pins that are in a connector that attaches to the G-502A; these often spread or show signs of wear because of age. Once the gyro has spooled down, it is removed from our rate table and

carefully installed in the aircraft.

Inspection of the Actuator Mount. Did you know Cessna recommended lubing the drive chain and gear teeth every 100 hours? When was the last time your autopilot mount gears and

chain were lubed? Move the ailerons up and down, if they feel ratchety, then you're way past service in this area. Old grease should be removed prior to installing the new lube. I'd highly recommend your A&P check the bridle cable tension at every annual inspection along with lubing the actuator mount. According to the installation manual, bridle cable tension should be 10+3 lbs. While lubing the mount components, be sure to check for loose hardware. We've had a few cases where the posts that act as chain guards have become loose. Oh, don't just spray solvent on the servo mount and actuator. The bearings in the actuator motor are not sealed, thus the solvent will enter and cause all kinds of expensive problems.

Next is the 300A Computer Alignment. Believe it or not, aligning this little computer isn't a huge deal, well unless there's a problem on one of the internal boards. Using the H42A test box makes life simple. I connect the TC and DG into the autopilot computer while on the bench and align it as a system. If all of your components are good and you align the 300A as system on the bench, chances are it will fly the aircraft fairly well



in the heading mode. VOR navigation seldom is satisfactory with the 300A. Why? Well, it's a cheap autopilot and it's getting old.

The Test Flight. In theory, you could slap the components

in the aircraft, grab a check from the aircraft owner and kick him out the door but I always insisted on a test flight to verify proper operation of the system. Yes, there are a couple of airframe issues that will cause havoc with the 300A. We've got what is called a "Break-Out" box that goes between the aircraft autopilot connector in the radio stack and the back of the autopilot computer. In other words, I'm able to have the computer in my lap and perform adjustments while someone flies the aircraft. Often minor adjustments are required during the test flight or in some cases we find the system will not work at all due to airframe problems.

Most of the Flight Test Problems are Related to VOR

Tracking. As mentioned earlier, the 300A is weak when tracking a VOR but often the problem is PILOT INDUCED. Here are the steps that must be done in order to track a VOR, GPS or whatever. Let's say you are tracking a VOR TO the station and the needle centers up on 120 degrees. While still in the heading mode, verify your DG reads close to your magnetic compass and then set the heading bug to 120. Once the aircraft has turned to the 120 heading, press Nav and verify you have the proper nav indicator selected with the 1-2 switch. There's a high probability the system will now track the VOR, it may be somewhat sloppy and if that's the case, press the HI SENS button on the computer, things may get better. You'll probably notice the 300A will track a Loran or GPS much better than a VOR. Bottom line is this...Whatever the Bearing TO the waypoint is, the heading bug MUST be set to the same. In the NAV mode the 300A autopilot looks at both Heading and NAV left/right input. Don't expect miracles out of this system but if properly aligned it does a fair job in the heading mode and may track the nav. For a good description of the operation of your 300A Autopilot, read the Supplement in the back of your Pilot's Operating Handbook; it explains the operation of the unit quite well. When the POH says the word "Will", substitute the word "Might".

There are Several Aircraft Related Problems with regards to the 300A. One of problems is at the top, right side of the cabin. There's a connector there that often corrodes or the pins get loose. Normally when autopilot will only turn in one direction when using the turn knob or the DG, this connector would be the prime suspect. Another high failure area is the relays for the left/right needle movement located in the original Cessna audio control panel. If your audio panel has been updated, chances are these relays are gone. The symptom of failure is the CDI needle will constantly stay in the middle of the CDI (centered needle) regardless there really is a deviation or not! I don't need to tell you how dangerous this could be. If you're flying the localizer and doing a better job than you think you should, the relays could be the problem. If you still have the original Cessna panel and a 300A autopilot, here's something I recommend doing prior to each flight. In the run up area, turn on the A/P and press the nav button. Now select any localizer frequency (doesn't matter if you can receive it or not). Now, press the Back Course button in and out several times. Repeat the process using Nav 2. When you select Back Course under the above conditions, it activates the relay in question and cleans the contacts. While this isn't a

cure all fix, it might keep you from getting a centered needle during an approach. This problem can arise on the front course as well as the back course (A/P on or not) so if something seems strange on the approach check the data with the other nav. By the way, the last time I priced those relays they were in the \$300 dollar range. To be honest, I can't imagine anyone flying today with old ARC radios and the original audio panel still installed.

Loose Bridle Tension. The bridle cable along with the main aileron cable tension is very important. If the tension isn't within book spec chances are the wings will rock constantly. But then again, maybe the wings rock constantly when you fly the machine with the autopilot off anyway....Excessive friction within the aileron system will cause all kinds of problems. If your controls seem too tight, then have your favorite A&P check them out. Cables being off the pulleys, frozen pulleys are just a few of the aircraft related problems we run across from time to time.



Loose Sprocket On the Actuator Mount.

I've found dozens of cases where the setscrew within the sprocket has come loose. In 50% of the cases where the pin has sheared I noted this setscrew was loose. To check the tightness of this setscrew, one would have to remove the actuator mount. I wouldn't recommend removing the actuator mount unless a problem arises in that area. If the autopilot

is turned on while on the ground and if the controls are commanded a sharp turn, often this will shear the pin. I'd recommend having your hand on the yoke anytime you turn the system on while on the ground so the soft pin will not shear. Lack of lubrication within the mount can cause problems; as

mentioned above, the mount should be lubricated every 100 hours as called out in the 300A Service Manual.

Can I add an ARC 300A to my Aircraft? You may if Cessna certified your aircraft for the 300A. One would have to purchase the components listed above, have them installed and wired. You may find it would be cheaper to purchase a S-Tec System 20 than install a 25-year-old 300A. Some aircraft had mounting structure built-in the wing that was completed during wing assembly. If your aircraft falls within this rim (only a few do), then the wing would have to be de-skinned and the properly mounting structure installed. No doubt, this would not be cost effective.

I'd Like to Keep My 300A but I Really Want Pitch; What Can I Do? S-Tec Corporation makes a System 600PSS (Pitch Stabilization) that can be added in conjunction with the 300A that will allow the pitch axis of the aircraft to be controlled. The 60PSS is an additional box in the panel that allows the pilot to select altitude hold, vertical speed and displays pitch trim annunciation; the 60PSS will allow glideslope coupling. This system weighs 7.3 pounds and list price of the "Boxes" is \$5,995.00. The S-Tec System THIRTY ALT only contains altitude hold and pitch annunciation and lists for \$3,895.00. You may find the cost of upgrading to a modern autopilot wouldn't be a lot more than the PSS. The 300A does not allow for GPSS (GPS Steering) that allows the autopilot to track your GPS flightplan, you'll need an S-Tec A/P to get that nice feature.

The ARC AF-295B AKA 200A Autopilot. The 200A does not have a heading input, in fact instead of calling the mode "Heading" Cessna calls it "Direction Hold". In other words it keeps the wings level but goes wherever it likes. Expect the 200A to be a wing leveler and nothing more. The ARC 200A is about as brain-dead an autopilot as one could get; don't spend a cent on it or give it to a friend. The actuator/servo and wiring are the same as with the 300A.

I Have a 200A Installed in my Cessna; can I Update to a 300A? In all but a few cases the answer is yes. Have your local avionics shop verify that your aircraft serial number falls within the rim of the 300A installation range. If so, you'll need a G-502A directional gyro, connector and a 300A computer the same width as your present 200A. The shop will have to install the DG

and run a few wires from the new DG to the autopilot computer connector. Of course the new 300A computer will need to be aligned with the components you now have. Years past this was a popular upgrade; there's a lot of 300A autopilots available on the used market but keep in mind they are old and parts could be an issue if a repair is needed in the future.

During My Days as a "300A Man" I was very successful on repairing the 300A and getting it to fly the Cessna in a satisfactory manner. Basically I'd have my customers bring me the aircraft and I'd align everything as a system as stated above, the end results were usually favorable. Often some one would want to ship me just the computer or the servo but I'd refuse to



touch it. My method of repairing and aligning the 300A worked and I wasn't about to take a "shotgun" approach. Now there's nothing wrong with sending out a failed component to get repaired at an authorized

repair center but once that repair is complete, the 300A needs to be aligned as a system and if the alignment is done as mentioned in this article, chances are you'll be happy with the results. I can't express enough how important to look at the 300A as a system, not individual components and have the proper test equipment. Of course working on the system for over 20 years does help a little© Seldom do I repair the 300A anymore; few are willing to pay the price to get it working as it should. If you want to breathe life back into your 300A, I'd recommend calling a shop that has the proper test equipment as mentioned in this article and has a good knowledge of 300A autopilot. Others may have a different method of repairing this system but this article explains what has worked well for me. Hopefully I've given you some good pointers on how the ARC 300A works and what is required to fix it.

