Basic Operation of S-Tec 2-axis Autopilot (System 50)
And GPS Steering Module

Preflight test:

Never turn on the AP on the ground unless the yoke gust lock has first been removed.

When the AP is first turned on, flick the switch up to the TEST position. The AP will conduct its own pre-flight tests, during which various enunciator lights will go on and off. When the "TRIM DN" light goes out, the test is complete and the AP can be switched to the ON position for use.

There are other manual preflight tests you can do, as described in the manual. These are not really necessary except right after an annual inspection, or unless system malfunctions are suspected.

Emergency or Normal Disengage:

There are several ways to disengage the AP, should you need to do that in an emergency or simply when you want to disengage it in normal flight.
1. Preferred method: Press the AP Disengage button on the yoke.
   a. This is the quickest and simplest method and should be used when disengaging AP for normal flight operations.
2. Push the OFF Button on the AP (Same function as yoke button)
3. Turn the AP switch to OFF (down). This will shut down the system.
4. Pull circuit breaker. This will eliminate all power to AP.

Operating Modes:

The autopilot has 6 modes of operation as described below. Each has its own enunciator light (or lights) which will identify which mode you are in.

1. **STB – Wing Stabilizer Mode**
   a. Allows you to manually set the ailerons to maintain straight and level flight.
   b. Allows you to steer the plane using the L-R Turn Knob. Maximum amount of turn available is standard rate turn.
   c. Turning this knob has no effect in any other operating mode.
   d. Pushing this knob will toggle between STB mode and HDG mode.

2. HDG – Heading Mode – with GPSS also in "HDG" mode

    a.   With GPSS also in HDG mode, this mode will cause plane to follow the heading bug on the HSI.

    b.   AP will turn the plane to the selected heading and then hold it there.

    c.   A new heading can be assigned by adjusting the heading bug.

    d.   All turns will be at a maximum of 90% of standard rate.

3. HDG – Heading Mode – with GPSS in "GPSS" mode

    a.   This mode allows plane to follow a flight plan (or GPS approach) that has been programmed into the GPS. (AP will <u>not</u> follow the heading bug.)

    b.   GPSS will take its input directly from the Garmin GPS, rather than the HSI. GPSS input to the AP is much more precise and smooth than when following a CDI in the NAV mode. Also, GPSS will <u>anticipate</u> turns before flying plane over each waypoint, and automatically roll out on new heading.

    c.   While programming Gamin GPS, keep GPSS in "HDG" mode (to let the heading bug direct the plane). After route has been programmed, switch to GPSS mode.

    d.   Remember, a GPS route can be complex, even including a GPS approach. But it can also be as simple as a "Fly Direct" single leg plan.

    e.   Before using this mode, you should manually bring plane to within 10 degrees of desired heading. Steering adjustments are small. GPSS will take too long to make huge course adjustments on its own.

    f.   GPSS module has no effect on AP when AP is in any mode OTHER than HDG. (GPSS will have no effect in NAV mode.)

    g.   To read more about how GPSS works, click on the picture of the GPSS module in the "New Panel" section of our web site.

4. NAV – Navigation Mode

    a.   This mode causes AP to follow a CDI (on the HSI or the Nav 2 CDI) i.e. for VOR course tracking.

    b.   Switch between Nav #1 and Nav #2 with toggle switch.

    c.   Can switch HSI CDI between GPS input or VLOC input (VOR/Localizer) by using CDI button on GNS 530

        i.   Whichever signal is input to the HSI from the Garmin GNS 530 would then subsequently be output to the AP in NAV mode.

        ii.   Following the HSI when Garmin CDI button is set to "GPS" would be how we would follow a GPS route if we did <u>NOT</u> have the GPS Steering module. The difference between this mode and the HDG/GPSS mode (#3 above), is in how the AP gets its input – either from HSI (NAV mode), or directly from the Garmin GPS via the GPSS module. (HDG/GPSS mode).

d. Before using the NAV mode, you must manually place aircraft within 10 degrees of the desired course. AP will NOT make large course adjustments in NAV mode.
e. In NAV mode AP tracts CDI with minimum authority, ignoring temporary needle deflections. This keeps the plane from constantly "swerving", or exhibiting erratic behavior when crossing over a VOR.

5. **APR – Approach Mode**
   a. This mode is exactly like the NAV mode with one exception: It tracks the CDI with much greater authority, as you would want to do if you were flying a localizer approach.
   b. As with the NAV mode, the plane must first be manually brought to within 10 degrees of the intended course.

6. **REV – Reverse Mode**
   a. Like the APR mode, this mode will follow the CDI with maximum authority. However it will follow the <u>reverse</u> of the CDI movement, as you would be doing if you were flying a localizer back course approach.

Altitude Hold

Altitude hold can be used with the AP in any operating mode. It will not work if no operating mode is selected (in other words, with the AP disengaged).

There is a pressure altitude transducer and a servo in the plane's tail cone which adjusts the elevator to keep the plane flying at a selected pressure altitude.

Our system will NOT automatically adjust the elevator trim. So you must make sure the plane is properly trimmed for level flight <u>before</u> applying altitude hold. If the plane gets out of trim beyond an established threshold, one of the yellow trim lights will come on. When that happens, manually adjust the trim wheel in whatever direction is needed to put the elevator back into trim and extinguish the light. (There is no need to disable altitude hold while re-adjusting the trim. Just watch the lights.) If you ignore the trim light and fail to adjust the trim, the light will begin flashing after a few minutes.

The easiest way to engage and disengage the altitude hold function is to use the yoke button designated for that purpose.

When first engaging Altitude Hold, the system will often lock on an altitude that is slightly above or below what you intended. If that happens, just push the button again, adjust your altitude, and then re-engage the altitude hold. Not sure what causes this to happen, but it appears to be a normal characteristic of the system. To remedy this, I have become accustomed to simply setting the Altitude Hold twice, whenever I use it.

Interaction between GNS-530, HSI, GPSS, and Autopilot

Sometimes it's easy to get confused by what is taking input from what, but here is an easy way to think about the relationship between the GNS 530, the HSI, and the autopilot:

The autopilot NEVER takes NAV or HDG input directly from the GPS (or a NAV radio). With only one exception (see below), the autopilot ONLY gets it's input from the HSI or from CDI #2, depending on how you set that toggle switch to the left of the autopilot controls. In NAV mode, the autopilot is reading the output from the CDI needle, while in HDG mode, it is taking input from the heading bug on the HSI (via the GPSS converter). The HSI receives its input only from the GNS 530. It can either receive VLOC (VOR/Localizer) input, or it can receive GPS input. The pilot can toggle the HSI input between VLOC or GPS with the "CDI Button" located on the GNS 530. Regardless of whether the GNS 530 is in VLOC or GPS mode, it is sending its output ONLY to the HSI – never directly to the autopilot.

The autopilot also takes input from the turn coordinator, which is part of the S-tec system. But it only uses that for roll control. This is what enables the autopilot to never exceed 90% of standard rate turns.

So far, the navigation signal which the autopilot receives via the HSI or CDI is easy enough to follow. But, there is an exception to the above explanation. That exception has to do with the GPSS (GPS Steering) module. Think of the GPSS as a separate navigation instrument whose purpose is to enhance the GPS output for the autopilot. The GPSS takes its input directly from the Garmin GPS and NOT through either CDI. Because it is entirely digital, the GPSS reads the GPS much more accurately, and reacts much more precisely, than a CDI would. As you know, it also reads trip plan and approach information, which is what enables it to direct the autopilot to make smooth turns while following airways and approaches.

GPSS only works with the autopilot in HDG mode. While in HDG mode, all navigation information comes to the autopilot via the GPSS module. If you put the autopilot in any other mode (i.e. NAV, APR, REV, STB), the GPSS is disengaged and taken out of the loop. The GPSS itself has two input modes: "HDG" or "GPSS". When the GPSS is in heading mode, it simply passes along the input it receives from the heading bug. When the GPSS is in GPSS mode, it takes its input, not from the heading bug on the HSI, but directly from the Garmin GPS. In either mode, the GPSS module outputs heading correction information directly to the autopilot. In actuality, the autopilot does not "know" if the GPSS is sending it heading input from the heading bug or the GPS. It just treats either as heading input and it does what is needed to steer the plane accordingly. Heading output to the autopilot is much more precise than CDI output, which is why the autopilot is in HDG mode, and not NAV mode, when taking input from the GPSS.

The GPSS is an amazing navigation instrument. To fully understand its capabilities, I recommend studying the GPSS Operator's Manual.