Replacing a Raymarine ST6000+ by a Navman/Northstar G-Pilot 3100 S Auto Pilot

My 6 year old 40' yacht was originally fitted out with a complete Raymarine package consisting of Seatalk instruments (tri-data, wind instruments), a Raymarine Pathfinder chartplotter/radar, Seatalk GPS and type 100 Autopilot with ST6000+ control unit.

The seemingly obvious thing to do when the Raymarine Autopilot "brain" (type 100) had developed errors and could not be repaired, was to replace it by a new Raymarine unit. The S2G with built in gyro was the preferred Raymarine model, but for a number of reasons I decided for a different solution.

The specifications of the Navman/Northstar G-pilots were quite impressive and I decided to purchase the G-pilot 3100S. The following describes the problems I encountered with integrating the new autopilot with the existing Raymarine equipment and the solutions I found to make everything work together smoothly. The end result is very pleasing. The auto pilot performs better than the Raymarine 6000 in all 3 steering modes (Compass mode, GPS mode and Wind mode), operation is more user-friendly and there are several other bonusses as well. And all this for a much better price.

The Navman G-pilot 3100 package consists of the following components: The computer, the 3100 instrument, a fluxgate compass, a gyro unit, a rudder reference unit, all cabling.

Physical and mechanical compatibility

- The computer is of similar physical size as the Raymarine type 100 course computer and installation in its place presents no problems.
- The Navman 3100 instrument head unit is of the same standard instrument size as the Raymarine ST 6000+ and installation instead of the ST6000+ instrument does not present any problems.
- The old Raymarine fluxgate compass was removed and replaced by the Navman supplied compass and gyro units. I could have placed them in the same position as the Raymarine fluxgate compass, but found a better place closer to the roll and pitch point of the boat.
- The original linear hydrolic drive unit with hydrolic pump and bypass solenoid valve of the Raymarine installation fitted well within the drive-unit specs for the Navman auto pilot and needed no modification.

Electrical compatibility

- Power supply cabling of the Raymarine auto pilot could be used without changes.
- The Navman can supply an impressive 20 amps for the drive unit. This is ample power to drive the hydrolic pump (Raymarine part # HC5319.
- The control signal to engage/disengage the drive unit clutch or, in this case, the bypass solenoid valve, can be maximum 300 milliamps for the Navman. The solenoid valve clearly requires a higher current. This was resolved by installation of a small 1 amp relays.

Integration with GPS and instruments.

The Raymarine autopilot was linked with the GPS, chartplotter/radar and instruments via the Raymarine proprietry Seatalk bus. The instrument data is essential for wind and GPS steering modes and boat speed data is required for best autopilot performance in general. Navman have their own proprietry protocol "Navbus" but the auto pilot also has NMEA in- and output ports. For integration with the Seatalk equipment, translation of Seatalk to NMEA was necessary. One possibility was to connect the auto pilot to the

NMEA out port of the chart plotter, but this means that the chart plotter always has to switched on when the auto pilot is being used. This is a disadvantage, especially on a sailboat. A Raymarine Seatalk-NMEA interface box is another possibility, but the best solution for the Seatalk to NMEA translation is a Brookhouse NMEA multiplexer with Seatalk option. The additional functions offered by the multiplexer turned out to be essential for complete integration of all equipment.

NMEA requirements

The Brookhouse multiplexer translates all instrument data required by the autopilot for compass and wind steering modes. Speed data (SOG) is obtained from the multiplexer-generated NMEA RMC sentence. The SOG (speed over ground) can be displayed on the 3100 instrument, as well as other NMEA data. This is a nice feature. As the SOG is important input for the general performance of the auto pilot, also in compass mode, the RMC sentence should be available to the autopilot at all times. **However, it was found that the G-pilot only recognises the data from the RMC sentence if the NMEA RMB sentence is also being received.** A GPS usually transmits the RMB sentence only if there is an “active” waypoint, i.e. when the GPS (or chartplotter or computer) is being used for navigation to a pre-defined waypoint. Besides the position, the RMB sentence contains information such as the range and bearing to the waypoint, cross track error etc. If the auto pilot is used in GPS mode (“track” mode in Raymarine terminology) to steer to a waypoint or along a route, this is not a problem, because the RMB is sent as one of the sentences containing the navigation data. However, for the other autopilot modes the absence of the RMB sentence means that the SOG display is not available and the auto pilot cannot perform optimally. Tests showed that it was sufficient to include a “dummy” RMB sentence, with empty parameters, in the NMEA input stream. The presence of the empty RMB sentence caused the auto pilot to display the COG, SOG, etc. from the RMC sentence.
The solution to this problem was to program the Brookhouse NMEA multiplexer for the following task:

1. **If no navigation data is being received from a computer or chart plotter after a 10 sec time-out, the multiplexer automatically generates an RMB sentence with empty data fields following each RMC sentence that is generated during the Seatalk to NMEA conversion process.**

2. **As soon as navigation data is being received from a computer , the empty RMB sentence is no longer generated and the responsibility for the RMB sentence lies with the chart plotter or computer.**

NMEA sequence with nav program steering to a waypoint

$IIRMC,220110,A,3612.689,S,17517.045,E,6.5,215.0,310108,0.0,W,A*08	(translated from ST by mux)
$IIMWV,52.0,R,5.7,N,A*08	(translated from ST by mux)
$IIVWR,52.0,R,5.7,N,,,,*7A	(translated from ST by mux)
$IIDBT,159.8,f,49.8,M,,F*0F	(translated from ST by mux)
$IIMTW,24.0,C*15	(translated from ST by mux)
$IIVHW,,,,,0.00,N,,*19 (0.00 because paddle wheel was taken out)	(translated from ST by mux)
$IIVTG,,,214.0,M,6.5,N,,*42	(translated from ST by mux)
$IIRMC,220110,A,3612.691,S,17517.044,E,6.5,214.0,310108,0.0,W,A*01	(translated from ST by mux)
$GPAPB,A,A,0.08,L,N,V,V,206.7,M,1,206.6,M,206.6,M*01	(generated by nav program laptop)
$GPRMB,A,0.08,L,0,1,3641.555,S,17459.110,E,32.23,206.6,6.45,V*1C	(generated by nav program laptop)
$GPBWC,220118,3641.555,S,17459.110,E,206.6,T,206.6,M,32.23,N,1*2C	(generated by nav program laptop)
$IIMWV,62.0,R,5.7,N,A*0B	(translated from ST by mux)
$IIVWR,62.0,R,5.7,N,,,,*79	(translated from ST by mux)
$IIDBT,159.5,f,49.7,M,,F*0D	(translated from ST by mux)

Special features

The Navman G-pilot has 2 NMEA ports. One is a dedicated input port. The second can be configured as an input or output port. If configured for output, the fluxgate compass heading is transmitted. The transmission rate can be set to 1Hz or 10Hz (10 NMEA HDG sentences per second). The fast rate is ideal to be used as input for Raymarine radar/chartplotters with Marpa. The high frequency auto pilot HDG output has a good resolution and can be used instead of a fast heading sensor, recommended by Raymarine to improve Marpa performance.

The Navman G-pilot performance is controlled by a number of parameters. Combinations of parameter settings can be saved as “profiles” for certain steering conditions. This is a very nice feature and allows the creation of setting-combinations that work best for the vessel under different sea conditions, at different courses.

The menu system of the Navman is much more user friendly and logical than the key-combinations used by Raymarine to select certain functions.

Sea trials

I have been able to test the auto pilot under different circumstances during two 50 mile passages and the results were very pleasing. The course keeping abilities were impressive in all three steering modes. The effects of changes in response level, gain, and ratio were clear and predictable. The only negative was the fact that when entering GPS mode, the pilot always reported a TRK error, even if the XTE was minimal. This was hardly a problem, as pressing the Ent key clears the error and causes the pilot to start steering along the track. In GPS mode we had the boat steered by the laptop, running navigation software Oziexplorer.