

SeaDrive

Autopilot to be used with SeaClear navigation program.

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Preface

If you like stories read this. Otherwise you can jump over...

After I was introduced myself to great navigational software SeaClear, and noticed that it supports also NMEA-based autopilots by sending output data concerning selected route to autopilot I started to think how could I make it command my own Autohelm3000 autopilot that has no NMEA connection. At the same time I was thinking those completely home made steering systems where a boat driving was done with joystick controlling hydraulic valves and pump by relays. Those things are also outside of NMEA sentences.

How ever few relays, to left and right, could drive those systems as well as my old AutoHelm3000 when it was on standby-mode.

First idea was to build separate microcontroller that would read serial NMEA-data from PC's serial port and drive relays by that knowledge. That would have required learning of microcontroller programming and use (that I will do some day...:-).

Next idea was to make separate program that would run on same PC as SeaClear and connect PC's serial ports together with wire so that NMEA-data would go from program to another. This could also be done by virtual serial ports, a program for Windows that will do this kind of linking completely software based, inside the operating system.

It almost came true, but fortune step into game. After made a finnish translation of SeaClear's manual got contact to SeaClear's programmer.

I got valuable information how to use DDE-link to get some information out of SeaClear without using any external or internal tricks to get the data. DDE is a link between two Windows programs that they can use for easy data transfers.

The final problem now was the programming itself. A programming language supporting DDE was needed. And it also have to be enough easy to use (learn). Some years ago I was seen Delphi, Borland's Pascal-based Windows programming tool. Now I had to dig it on again. Pascal itself is not so strange but the “inside life” of Delphi and specially Windows was the thing I never had time (interest) to learn my self. Now I had to.

Fortunately I was done few test programs with Delphi and I had not lost the source code. (Yes, making backups is worth of...!). So, now just start to think how it all goes.

After all this the final problem was how to operate relays from Windows. Specially from later versions like 2000 and XP that do not allow direct chip programming for programmer. Everything must be done under brother Billy's supervisor (the operating system). Solution was to drive a “printer” with one character at time. Those characters set PC's parallel port's pins to certain states that can be used just by sending “text” to “printer”.

It seems to work, at least on W98 and W2000 that I have tested.

Connections

SeaClear

To get all needed information with DDE-link from SeaClear DDE must be activated at SeaClear. This is done by adding one line to SEACLEAR_2.INI to “Program” section. This line can be added as last line of the file using a text editor like NOTEPAD while SeaClear is NOT in use.

Line goes as follows:

DDE=1

After that file must be saved and SeaClear can be started.

Relay drive

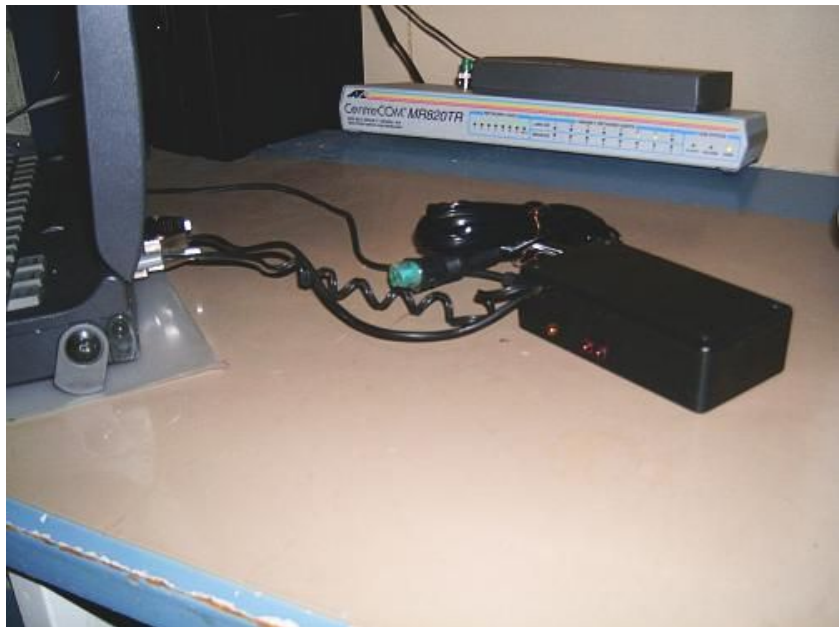
The most usual computer for boat is a Laptop. It is very seldom seen that normal home PC would be installed into boat. That means that normally there is only one parallel port available and it is called “LPT1” in Windows. Home PCs can have more than one parallel port, and then the right port must be selected and named into INI-file.

In Windows setup there should NOT be any printer installed on selected LPT-port, or it may NOT be redirected to any network printer.

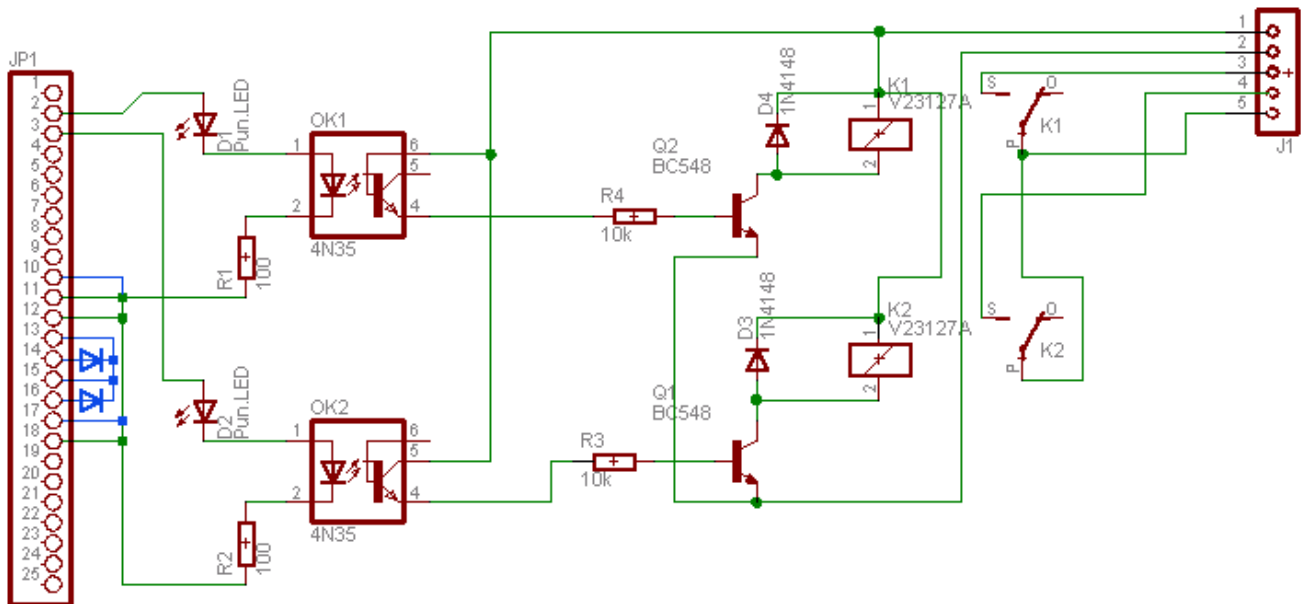
Parallel port uses 25pin female Canon connector. So one male 25p Canon connector is needed for connecting wires to relay unit.

Relay driving directly from parallel port is not possible (not counting on miniature reed-relays) as there is not enough power available. So an external relay board is needed and must be designed by the user.

My recommendation is to use optocouplers to isolate PC circuits from boat electricity.



Here is an example circuit for design support:



Connector JP1's numbers are equal to parallel port's pin numbers.

Connector J1 goes as follows: 1= +12V 2= minus, 3,4 and 5 relay connectors to drive steering system.

One laptop required [blue](#) printed additions to pins 10,13,14,15,16,17 before it started to work.

Normally these are not needed.

Program

Startup

Before connecting relays to boat's steering system it must be remembered that when PC starts relays have some random actions. There must be some kind of isolating switch to be used at start time.

SeaDrive should be started AFTER SeaClear. If it is done other way round SeaDrive will not start as it does not detect DDE-link. Also closing should go in same way, first SeaDrive then SeaClear.

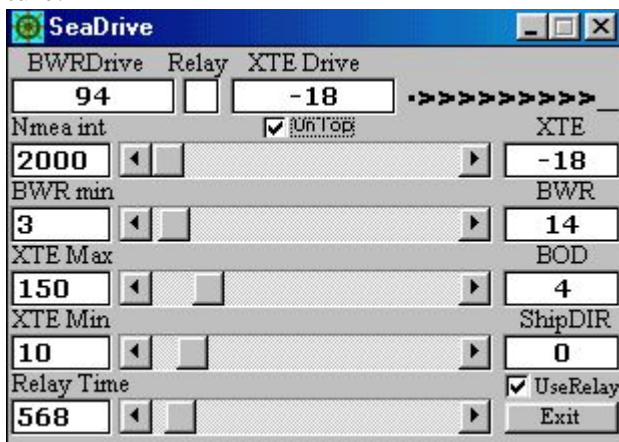
Before start there must be a link between pins 11,12 and 17 on parallel port. Otherwise program will stop and may freeze whole Windows. System will recover when connector with those pins connected is plugged in to parallel port.

You may test the program by inserting a powered printer to parallel port (program waits for "ready/online printer"). After tests have been done it is good to power off the printer as the program has "printer" garbage into printers buffer(relays are driven by writing characters into printer port).

Displays and adjustments

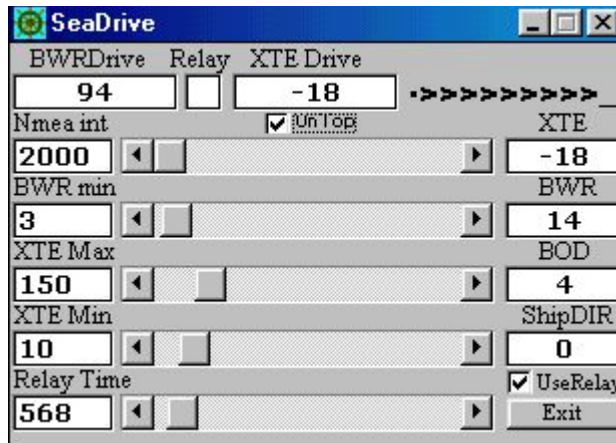
The program has many indicators and scrollbars for watching the values and adjusting them. When program is closed it will save used values to current directory (usually same where SeaDrive.exe is) with file name SEADRIVE.INI.

Same file is used when program starts. If no file is found, preset values will be used. More about Seadrive.ini on another capture.



Adjustments

- Nmeaint** Time slot that is used between new data transfer from SeaClear. After data has been transferred program calculates relay driving times and activates relays, if needed. So this time will set the time interval for steering fixes. Value is in milliseconds (1 sec = 1000milliseconds). Time can be set with scrollbar on the right, and will be saved to INI-file for use at next program start.
- BWRmin** Minimum error in degrees that is accepted wthe compared to ship direction to next waypoint's direction. Error is double sided, so value 3 gives accepted range of 6 degrees (-3 --> +3). Time can be set with scrollbar on the right, and will be saved to INI-file for use at next program start.
- XTEMax** Biggest accepted slip from route (highway). If error is more than this amount relays are switched off. Value is 1/1000 nautical mile (abt 1,8meters). Value can be set with scrollbar on the right, and will be saved to INI-file for use at next program start.
- XTEMin** Biggest accepted slip from route (highway) that does NOT YET activate relays (we are within accepted route area). Error is double sided, so value 3 gives accepted range of 6 units (-3 --> +3). Value is 1/1000 nautical mile (abt 1,8meters). Value can be set with scrollbar on the right, and will be saved to INI-file for use at next program start.
- UseRelay** Selection that turns the actual relay drive on and off. This is usefull in testing and at times when no relay action is desired while program should still run. Relay actions can be seen from relay indicator that is independend from this selection.



Displays

- XTE** The slip of ship from the center line of the route (highway). Value is 1/1000 nautical mile (abt 1,8meters).
- BWR** Direction in degrees to next, selected, waypoint.
- BOD** Direction in degrees from last selected waypoint to currently selected waypoint.
- ShipDIR** Ship direction in degrees.
- BWRDrive** Amount of needed steering if the reason is caused from difference between ship's and selected waypoint's directions. Value is degrees.
- XTEDrive** Amount of needed steering if the reason is caused from slipping too much from route's center line (highway). Value is 1/1000 nautical mile (abt 1,8meters). In this display can also be seen a counter (green/yellow/pink) when ship is on the route, but program is checking and fixing slip caused by wind or flow.
- Relay** Relay indicator. Seen characters can be "<" or ">" meaning direction to steer (relay to use), "-" if there is no need to activate relay, or "!" if activating relays has been denied because of over limit values. The background color is red if relay action is disabled by UseRelay selection or XTE value has exceeded XTEMax.
- >_||_< Highway display. Indicates how well ship is in the middle of route and what direction should be used if there is need for steering.

Function

Program receives NMEA-data from SeaClear using DDE-link that is build in feature of Windows operating system. This data includes information of ship position, movement and selected route. If SeaClear has no selected route (see SeaClear manual) also steering is disabled. If route is selected the steering is based on three different things.

First SeaDrive will check is the ship within the route (highway) with selected tolerance (XTEmin). If no action is needed it will next check if ship's direction (ShipDir) is to selected waypoint (BWR) within given limits (BWRMin) .

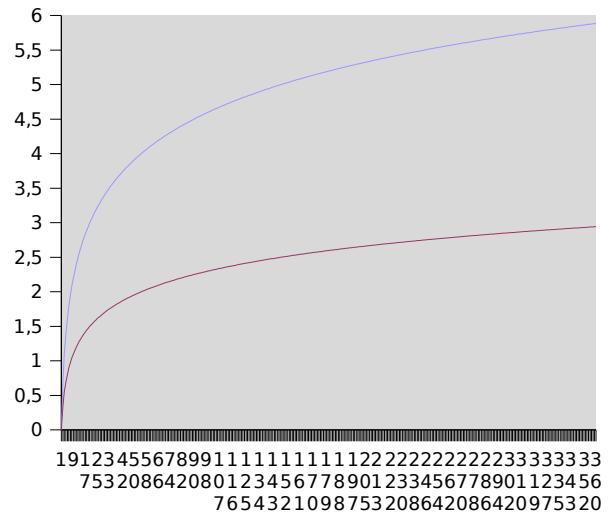
If also this is OK a counter will start from last done steering (relay use). Counter counts timeslots (NmeaTime) on green background. On second round it will record XTE value and goes on up to ComCountMax (yellow background). At that point XTE is read again and it is compared to recorded value. If slip to positive or negative limit of route (XTEmin) has happened one normal length relay pulse is given to fix this error and counter is started again (if still within other limit values). Counter maximum value is 10, but it can be changed by fixing the INI file's CumCountMax value with text editor (like NOTEPAD) while program is NOT running.

If the first check (XTEmin) tells that ship is outside the limits of route (highway) ship will be directed 90degrees angle to route line drawn between last and current waypoint. This is the fastest way to get the ship again within the limits (on highway). Steering is boosted giving longer relay times than the base value given with scroll bar.

Boost is based to natural logarithm from degree value needed for turn. This gives factor 0-5,88 with 0-360 degrees. However program assumes that slip is just marginal and divides this factor by 2 not giving so much effect to turn. This because once ship is inside given limit (but not yet center of route line) it will again steer by BWR, the ship and selected waypoint's direction difference and if turn is not so fast ship is getting more close to center of the route.

That gives the second steering reason. Ship direction differs from selected waypoint's direction (BWD) more than accepted (BRWMin). This mainly happens when the waypoint is reached and next one is selected. At that point amount of turn may be a small, but also very big one comes in question.

Boost is again used as above, but this time without dividing it by 2. That gives more effective turn when difference is big.



INI-file

```
# SeaDrive settings written 30.11.2004 12:33:24
NmeaTime=2000
XteMin=10
BaseRelayTime=250
MaxRelayTime=5000
XteDriveLimit=150
BwrMin=3
CumLim=0
CumCountMax=10
LpOut=lpt1
UseRelay=True
```

In normal case program withes these values by itself. Manual change can be made when program is NOT running. Most of the values can be understood by the scroll bar names, but some of them can not seen on display and may need explanation. These values can be changed ONLY by writing them into INI-file.

MaxRelayTime

Biggest possible time that relay can be on at a time. How ever, if NmeaTime is less than this, the time will be NmeaTime -10 (milliseconds). If NmeaTime is bigger, this value sets the maximum limit of time.

CumLim Value that defines the maximum allowed slip within the route before any action is taken. If value is 0 (zero) there is no free area. If it is 1 (one) area is 2 units wide. Value is 1/1000 nautical mile (abt 1,8meters).

CumCountMax

Counter maximum that releases check of slipping the route center if no BWR or XTE control is needed while counting. Counter runs on green background. Maximum is shown with yellow and if steering is needed background turns pink while relay is acivated for one normal lenght pulse.

LpOut PC's port where the relay card is connected. Normally "lpt1" but "lpt2" or "lpt3" can be possible in some cases.

Although INI-file's values can be changed it must be with care because program does not make any check about these values. Stupid values may cause unexpected program functions. Or may freeze whole program.

There can be comment lines starting # or ;, but writing them has no ming as program will owerwrite all on next shutdown (if not protected by read only flag by filesystem).

Warnings

Never trust electrical navigation equipments ! GPS may turn down and PC may freeze.

Always keep original maps and manual navigation equipments available and learn how to use them. When in trouble, you do not have time to learn any more.

Never, ever leave boat running by automatic steering system without immediate supervision. All automatics are only helpers to give more time to skipper to watch the route and shop functions.

This program *is not intended to be used* for boat steering without *immediate supervision*. This project has been more a technical challenge, than a need to create full working steering system.

Author of this program does not take any responsibility about physical, mental or economical damages to user or surrounding environment that may happen when this program, or a steering system made for it, is in use.

If you find this program useful feel free to use and copy it. Only limitation is that this document must always follow the main program file.

Author reserves full copyright to program and the example circuit.

Comments and suggestions are welcome, but there is no guarantee that they will appear on next versions.

NOTE!

This program , now at version 1.3, is written completely during autumn and winter 2004 off-season. No real time tests have ever been made with boat and it will be possible first time on spring 2005. Does it work at all, who knows. It is sure that timings will need adjustments.