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Diagnostic and Setup Application Notes

Products: Rudder Reference Transducer

Purpose: Onboard or bench diagnostic procedure

Equipment required: Digital multimeter, tools required to gain access to unit

Test data:

Rudder Reference Cable Colors	Resistance Measurements	Comments
Green-Red	5 K Ohms	Measurement is taken between red and green
Green-Blue	Normal rudder travel will display a range of approximately 1.7 to 3.3 K Ohms.	Measurement is taken between blue and green
Red-Blue	Normal rudder travel will display a range of approximately 1.7 to 3.3 K Ohms.	Measurement is taken between blue and red

Test procedure:

Multimeter should be set to:
1. DC Voltage
2. 200 ohm scale

The following procedure should then be followed:

1. Disconnect the transducer from the system.
2. Connect one multimeter lead to the green wire and the other multimeter lead to the red wire. A reading as indicated in the test data table should be present.
3. Connect one multimeter lead to the green wire and the other multimeter lead to the blue wire and a reading as indicated in the test data table should be present. The rudder reference transducer will have to be rotated through 360 degrees to see the full resistance range.

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4. If all readings match those in the test data table then assume the rudder reference transducer is functioning correctly.

Diagnostic tests completed.

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Diagnostic and Setup Application Notes

Product: Fluxgate Compass

Purpose: Onboard or bench diagnostic procedure

Equipment required: Digital multimeter, tools required to gain access to unit

Test data:

Compass Cable Colors	Resistance Measurements	Comments
Red-Green	4-10 ohms	Measurement is taken between the two colors
Red-Yellow	4-10 ohms	As above
Green Yellow	8-10 ohms	As above
Screen-Blue	8-10 ohms	As above
All other combinations	Open circuit	---

Test procedure:

Multimeter should be set to:
1. Resistance scale
2. 200 ohm scale

The following procedure should then be followed:

1. Disconnect the transducer from the system.
2. Connect one multimeter lead to the red wire and the other lead to the green wire and a reading as indicated in the test data table should be present.
3. Follow the above procedure for all the color combinations indicated in the test data table.
4. If all readings match those indicated, assume the transducer is functioning correctly.
5. If readings do not match those indicated, repeat the procedure at the compass core, bypassing the cable.

Diagnostic tests completed.

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Diagnostic and Setup Application Notes

Products: Gyro Plus Transducer, Gyro Plus 2, Pathfinder Smart Heading System

Purpose: Onboard or bench diagnostic procedure

Equipment required: Digital multimeter, tools required to gain access to unit

Test data:

Gyro Transducer Cable Colors	Resistance Measurements	Comments
Red	12 Volts DC	Measurement is taken between red and screen
Screen	0 Volts DC	Reference point for measurements
Yellow	Variable 1 to 4 Volts DC	Reading taken between screen and yellow

Test procedure:

Multimeter should be set to:
1. DC Voltage
2. 20 Volt scale

The following procedure should then be followed:

1. Connect the negative multimeter lead to the transducer screen wire and the positive multimeter lead to the transducer red wire. A reading, as indicated in the test data table, should be present. If the reading is NOT present, then one of the following apply:
    a. The course computer (T100/300, S2, S3) or Gyro Plus 2/SHS electronics module is faulty.
    b. If the measurement is taken along the cable run there may be a faulty connection in some other position along the cable run.
2. With the multimeter negative lead connected to the transducer screen wire and the multimeter positive lead connected to the transducer yellow wire, a reading as indicated in the test data

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table should be present. This reading will be a variable voltage dependent upon lateral movement of the transducer.

Bench Test:

This procedure is for testing the gyro plus transducer when not connected to a system.

1. Apply 12 volts DC to the unit from a bench power supply. Connective the negative (-ve) power supply lead to the transducer screen wire. Connect the positive (+ve) power supply lead to the transducer red wire. This simulates the voltage supplied by the course computer to the gyro plus transducer.
2. With the multimeter negative lead connected to the transducer screen wire and the multimeter positive lead connected to the transducer yellow wire, a reading as indicated in the test data table should be present. This reading will be a variable voltage dependent upon lateral movement of the transducer.
3. If these readings are present then assume the transducer is functioning correctly.

Diagnostic tests completed.

Diagnostic and Setup Application Notes

Product: ST30, 40, 50, 60, 80, 290 Depth Transducer

Purpose: Onboard or bench diagnostic procedure

Equipment required: Spare depth transducer, tools required to gain access to unit

Test data:

Instrument Cable Color	Transducer Cable Color	Measurement	Comments
Red	Blue	+ve signal output	---
Screen	Black and Screen	-ve	---

Test procedure:

The testing of the depth system on board a vessel is a difficult task with out sophisticated test equipment, so the following procedures are very basic and simple methods of test.

1. Make sure the true depth if water is known under the vessel at the time of testing.
2. Gain access to the back of the depth instrument and disconnect the transducer.
3. Connect the spare transducer to the instrument and place the transducer over the side of the vessel. The depth reading reported should match the known depth.
4. It is advisable to check all connections, splices, extensions, junction boxes, etc. the original depth transducer is connected to.

Note:

The depth transducer is known to be very reliable if installed correctly and cleaned periodically. Any faults would tend to be within the depth instrument, thus requiring further bench testing.

Onboard diagnostic test completed.

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Diagnostic and Setup Application Notes

Products: ST30, ST40, ST50, ST60, ST80, ST290 Speed/Bidata/Tridata Speed Transducers

Purpose: Onboard or bench diagnostic procedure

Equipment required: Digital multimeter, 10 K ohm resistor, tools required to gain access to unit

Test data:

Instrument Cable Color	Transducer Cable Color	Measurement	Comments
Red	Red	5 Volts DC	Measurement is taken between red and screen
Screen	Screen	0 Volts DC	Reference point for measurements
Green	Green	Variable 0 to 5 volts	Log pulse signal. Reading taken between screen and green
Yellow	Yellow	Temperature 1	See test Procedure
Blue	Blue	Temperature 2	See test procedure

Test procedure:

Multimeter should be set to:
1. DC Voltage
2. 20 Volt scale

When testing the system for the voltage measurements listed in the table above, access to the rear of the speed master instrument, speed transducer pod (ST80, 290), or junctions within the cable run is required. Care must be taken not to short circuit or break any of the connections. The following procedure should then be followed:

Testing the Speed Transducer Power Supply

1. Connect the negative multimeter lead to the screen wire, and the positive multimeter lead to the red wire. A reading of 5 volts DC should be present. This 5 volts is the supply from the

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speed instrument or host pod to the transducer. If it is not present, one of the following will apply:

a. The speed instrument or speed transducer pod is not energized.
b. The speed instrument or speed transducer pod is faulty.
c. If the measurement is taken along the cable run, there may be an open connection in some other position on the run.

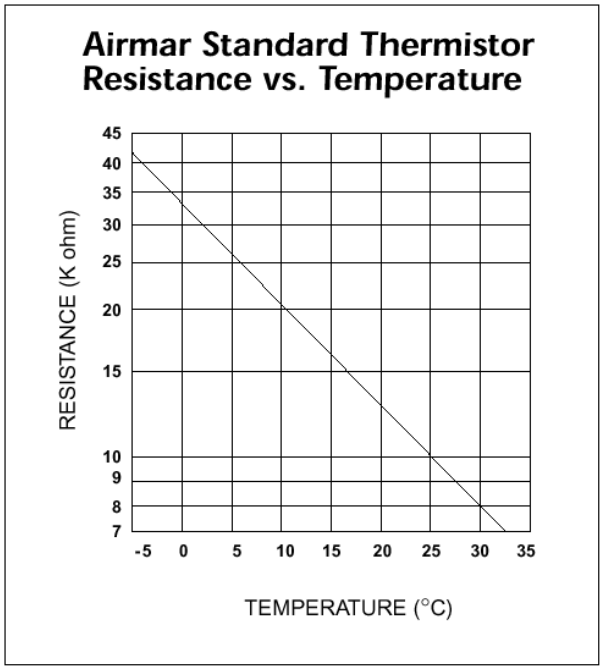
Testing the Boat Speed Elements

2. With the multimeter negative lead connected to the screen and the positive lead connected to the green wire, a variable voltage as indicated in the test data table should be observed, and varies in proportion to the speed of rotation of the paddle wheel. The voltage will increase as the transducer spins faster.
3. If these readings are present then assume the speed transducer is functioning correctly.

Testing the Water Temperature Element

The following should be carried out with the speed transducer disconnected.

4. With the instrument or pod power on, place a 10 K ohm transducer between the blue and yellow terminals on the instrument or pod. The device should register a temperature reading on the instrument of 25 degrees centigrade. Additional combinations of temperature vs. resistance can be tested using either of the charts provided below.



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Airmar Standard Thermistor–Resistance vs. Temperature

Part #07-045 Nominal Resistance: 10,000 ohm at 25° C

Temp.(°C)	Resistance	Temp. (°C)	Resistance	Temp.(°C)	Resistance	Temp. (°C)	Resistance
–20	97083.62	–5	42344.54	10	19911.1	25	10000.0
–19	91626.82	–4	40177.6	11	18980.03	26	9571.689
–18	86507.95	–3	38134.17	12	18098.44	27	9164.221
–17	81704.43	–2	36206.02	13	17262.34	28	8776.205
–16	77198.14	–1	34387.08	14	16469.68	29	8406.722
–15	72967.79	0	32670.43	15	15717.99	30	8054.942
–14	68994.43	1	31048.25	16	15004.33	31	7719.596
–13	65258.81	2	29516.63	17	14327.51	32	7400.123
–12	61748.23	3	28069.29	18	13684.99	33	7095.607
–11	58448.13	4	26701.02	19	13074.77	34	6805.281
–10	55344.09	5	25407.34	20	12494.98	35	6528.319
–9	52422.74	6	24184.14	21	11944.42	36	6264.156
–8	49673.03	7	23026.11	22	11420.69	37	6012.082
–7	47083.13	8	21930.8	23	10923.14	38	5771.551
–6	44644.56	9	20892.93	24	10450.07	39	5541.918
						40	5322.632

5. If this reading is present then assume the instrument or pod is functioning correctly, and any temperature error is due to a faulty temperature circuit within the transducer.

Diagnostic tests completed.

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Diagnostic and Setup Application Notes

Products: ST50, ST60, ST80, ST290 Masthead Wind Transducer

Purpose: Onboard or bench diagnostic procedure

Equipment required: Digital multimeter, tools required to gain access to unit

Test data:

Instrument Cable Color	Transducer Cable Color	Measurement	Comments
Red	Red	8 Volts DC	Measurement is taken between red and screen
Screen	Screen	0 Volts DC	Reference point for measurements
Blue	Blue	Variable 2 to 6 Volts DC	Reading taken between screen and blue
Green	Green	Variable 2 to 6 Volts DC	Reading taken between screen and green
Yellow	Yellow	Variable 0 to 5 Volts DC	Reading taken between screen and yellow

Test procedure:

Multimeter should be set to:
1. DC Voltage
2. 20 Volt scale

When testing the system for the voltage measurements listed in the table above, access to the rear of the wind instrument, wind transducer pod (ST80, 290), or junctions within the masthead cable run is required. Care must be taken not to short circuit or break any of the connections. The following procedure should then be followed:

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Testing the Masthead Unit Power Supply

1. Connect the negative multimeter lead to the screen wire, and the positive multimeter lead to the red wire. A reading of 8 volts DC should be present. This 8 volts is the supply from the wind instrument or host pod to the transducer. If it is not present, one of the following will apply:
    a. The wind instrument or wind transducer pod is not energized.
    b. The wind instrument or wind transducer pod is faulty.
    c. If the measurement is taken along the cable run, there may be an open connection in some other position on the run.

Testing the Wind Directional Elements

2. With the multimeter negative lead connected to the screen and the positive lead connected to the blue wire, a variable voltage as indicated in the test data table should be observed, and varies in proportion to wind vane rotation.
3. With the multimeter negative lead connected to the screen wire and the positive lead connected to the green wire a variable voltage as indicate in the test data table should be observed and varies in proportion to wind vane rotation.
4. If it is possible to view both directional lines simultaneously, you should see the voltage changing in opposition between the two lines (e.g. one increase as the other decreases.)
5. If these readings are present then assume the directional transducer is functioning correctly.

Testing the Wind Speed Elements

6. With the multimeter negative lead connected to the screen wire and the positive lead connected to the yellow wire, a variable voltage of 0 to 5 volts DC should be present. The voltage will increase as the transducer spins faster.
7. If these readings are present then assume the speed transducer is functioning correctly.

Diagnostic tests completed.

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SeaTalk Technical Reference Part 2:

Recognized Datagrams (in hexadecimal notation):

```
Com Att Dat Dat...

 00  02  YZ  XX  XX  Depth below transducer: XXXX/10 feet
                     Display units: Y=0 => feet, Y=4 => meter
                     Flags: Z&1 Shalow Depth Alarm   (Z=1)
                            Z&2 Transducer defective (Z=4)
                     Corresponding NMEA sentences: DPT, DBT

 01  05  00  00  00  60  01  00  Sent by course computer 400G shortly
                                 after power on.
 01  05  FA  03  00  30  07  03  Sent by ST80 Maxi Display shortly
                                 after power on.
 01  05  04  BA  20  28  01  00  Sent by ST60 Tridata shortly after power on


 10  01  XX  YY  Apparent Wind Angle: XXYY/2 degrees right of bow
                 Used for autopilots Vane Mode (WindTrim)
                 Corresponding NMEA sentence: MWV

 11  01  XX  0Y  Apparent Wind Speed: (XX & 0x7F) + Y/10 Knots
                 Units flag: XX&0x80=0    => Display value in Knots
                             XX&0x80=0x80 => Display value in Meter/Second
                 Corresponding NMEA sentence: MWV

 20  01  XX  XX  Speed through water: XXXX/10 Knots
                 Corresponding NMEA sentence: VHW

 21  02  XX  XX  0X  Trip Mileage: XXXXX/100 nautical miles

 22  02  XX  XX  00  Total Mileage: XXXX/10 nautical miles

 23  41  XX  YY  Water temperature (ST50): XX deg Celsius, YY deg Fahrenheit
                 Corresponding NMEA sentence: MTW

 24  02  00  00  XX  Display units for Mileage & Speed
                     XX: 00=nm/knots, 06=sm/mph, 86=km/kmh

 25  Z4  XX  YY  UU  VV AW  Total & Trip Log
                     total= (XX+YY*256+Z* 4096)/ 10 [max=104857.5] nautical miles
```

```
                    trip = (UU+VV*256+W*65536)/100 [max=10485.75] nautical miles

 26  04  XX  XX  YY  YY D1  Speed through water:
                     Sensor 1: XXXX/100 Knots, valid if D1&64=64
                     Sensor 2: YYYY/100 Knots, valid if D1&128=128
                     Corresponding NMEA sentence: VHW

 27  01  XX  XX  Water temperature: (XXXX-100)/10 deg Celsius
                 Corresponding NMEA sentence: MTW

 30  00  0X      Set lamp Intensity; X=0: L0, X=4: L1, X=8: L2, X=C: L3
                     (only sent once when setting the lamp intensity)

 36  00  01      Cancel MOB (Man Over Board) condition

 38  X1  YY  yy  Codelock data

 50  A2  XX  YY  YY  LAT position: XX degrees, (YYYY & 0x7FFF)/100 minutes
                     MSB of Y = YYYY & 0x8000 = South if set, North if cleared
                     Corresponding NMEA sentences: RMC, GAA, GLL

 51  A2  XX  YY  YY  LON position: XX degrees, (YYYY & 0x7FFF)/100 minutes
                MSB of Y = YYYY & 0x8000 = East if set, West if cleared
                  Corresponding NMEA sentences: RMC, GAA, GLL

 52  01  XX  XX  Speed over Ground: XXXX/10 Knots
                 Corresponding NMEA sentences: RMC, VTG

 53  X0  XX      Course Magnetic: XXX/8 Degrees
                 Least significant 2 bits are always 0,
                 giving a resolution of 0.5 degrees
                 Corresponding NMEA sentences: RMC, VTG

 54  T1  TT  HH  GMT-time: HH hours,
                           6 MSBits of TTT = (TTT & 0xFC0) / 64 = minutes
                           6 LSBits of TTT = TTT & 0x3F = seconds
                 Corresponding NMEA sentences: RMC, GAA, BWR, BWC

 55  X1  YY  yy  TRACK keystroke on GPS unit
                 keycodes identical with autopilot (command 86)

 56  M1  DD  YY  Date: YY year, M month, DD day in month
                 Corresponding NMEA sentence: RMC

 57  S0  DD      Sat Info: S number of sats, DD horiz. dillution of position
                 Corresponding NMEA sentences: GGA, GSA

 58  Z5  LA XX YY LO QQ RR   LAT/LON
                 LA Degrees LAT, LO Degrees LON
```

```
                minutes LAT = (XX*256+YY) / 1000
                minutes LON = (QQ*256+RR) / 1000
                Z&1: South (Z&1 = 0: North)
                Z&2: East  (Z&2 = 0: West)
                Corresponding NMEA sentences: RMC, GAA, GLL

 59  22  SS MM XH  Set Count Down Timer
                  MM=Minutes ( 00..3B ) ( 00 .. 63 Min ), MSB:0 Count up start
flag
                  SS=Seconds ( 00..3B ) ( 00 .. 59 Sec )
                  H=Houres  ( 0..9 )   ( 00 .. 09 Houres )
                  X= Counter Mode: 0 Count up and start if MSB of MM set
                                   4 Count down
                                   8 Count down and start
                  ( Example 59 22 3B 3B 49 -> Set Countdown Timer to 9.59:59 )
 59  22  0A 00 80  Sent by ST60 in countdown mode when counted down to 10 Seconds.

 6C  05  04 BA 20 28 2D 2D Second datagram sent by ST60 Tridata shortly after power
on

 6E  07  00  00 00 00 00 00 00 00 MOB (Man Over Board), (ST80), preceded
                by a Waypoint 999 command: 82 A5 40 BF 92 6D 24 DB

 80  00  0X      Set Lamp Intensity: X=0 off, X=4: 1, X=8: 2, X=C: 3

 81  01  00  00  Sent by course computer during setup when going past USER CAL.
 81  00  00      Sent by course computer immediately after above.

 82  05  XX  xx YY yy ZZ zz   Target waypoint name
                XX+xx = YY+yy = ZZ+zz = FF (allows error detection)
                Takes the last 4 chars of name, assumes upper case only
                Char= ASCII-Char - 0x30
                XX&0x3F: char1
                (YY&0xF)*4+(XX&0xC0)/64: char2
                (ZZ&0x3)*16+(YY&0xF0)/16: char3
                (ZZ&0xFC)/4: char4
                Corresponding NMEA sentences: RMB, APB, BWR, BWC

 83  07  XX  00  00  00  00  00  80  00  00  Sent by course computer.
                XX = 0 after clearing a failure condition, also sent once after
power-up.
                XX = 1 failure, auto release error. Repeated once per second.

 84  U6  VW  XY 0Z 00 RR SS TT  Compass heading  Autopilot course and
                 Rudder position (see also command 9C)
                 Compass heading in degrees:
                   The two lower  bits of  U * 90 +
                   the six lower  bits of VW *  2 +
                   the two higher bits of  U /  2 =
                   (U & 0x3) * 90 + (VW & 0x3F) * 2 + (U & 0xC) / 8
```

```
                  Autopilot course in degrees:
                    The two higher bits of  V * 90 + XY / 2
                  Z & 0x2 = 0 : Autopilot in Standby-Mode
                  Z & 0x2 = 2 : Autopilot in Auto-Mode
                  Z & 0x4 = 4 : Autopilot in Vane Mode (WindTrim), requires regular
"10" datagrams
                  Rudder position: RR degrees (positive values steer right,
                    negative values steer left. Example: 0xFE = 2° left)
                  SS & 0x01 : when set, turns off heading display on 600R control.
                  SS & 0x02 : always on with 400G
                  SS & 0x08 : displays “NO DATA” on 600R
                  SS & 0x10 : displays “LARGE XTE” on 600R
                  SS & 0x80 : Displays “Auto Rel” on 600R
                  TT : Always 0x08 on 400G computer

 85  X6  XX  VU ZW ZZ YF 00 yf   Navigation to waypoint information
                  Cross Track Error: XXX/100 nautical miles
                   Example: X-track error 2.61nm => 261 dec => 0x105 => X6XX=5_10
                  Bearing to destination: (U & 0x3) * 90° + WV / 2°
                   Example: GPS course 230°=180+50=2*90 + 0x64/2 => VUZW=42_6
                   U&8: U&8 = 8 -> Bearing is true, U&8 = 0 -> Bearing is magnetic
                  Distance to destination: Distance 0-9.99nm: ZZZ/100nm, Y & 1 = 1
                                           Distance >=10.0nm: ZZZ/10 nm, Y & 1 = 0
                  Direction to steer: if Y & 4 = 4 Steer right to correct error
                                      if Y & 4 = 0 Steer left  to correct error
                  Example: Distance = 5.13nm, steer left: 5.13*100 = 513 = 0x201 =>
ZW ZZ YF=1_ 20 1_
                           Distance = 51.3nm, steer left: 51.3*10  = 513 = 0x201 =>
ZW ZZ YF=1_ 20 0_
                  Track control mode:
                     F= 0x1: Display x-track error and Autopilot course
                     F= 0x3: Enter Track Control Mode, i.e. lock on to GPS.
                             Display x-track error, autopilot course and bearing
                             to destination
                     F= 0x5: Display x-track error, distance to waypoint,
                             autopilot course and bearing to destination
          normal--> F= 0x7: Enter Track Control Mode, i.e. lock on to GPS.
                             Display x-track error, distance to waypoint,
                             autopilot course and bearing to destination
                     F= 0xF: As 0x7 but with x-track error alarm
                     F= 2, 4, 6, 8 ... causes data errors
                   Corresponding NMEA sentences: RMB, APB, BWR, BWC, XTE

86  X1  YY  yy  Keystroke
                 X=1: Sent by Z101 remote control to increment/decrement
                      course of autopilot
     11  05  FA     -1
     11  06  F9    -10
     11  07  F8     +1
     11  08  F7    +10
```

```
     11  20  DF     +1 &  -1
     11  21  DE     -1 & -10
     11  22  DD     +1 & +10
     11  28  D7    +10 & -10
     11  45  BA     -1        pressed longer than 1 second
     11  46  B9    -10        pressed longer than 1 second
     11  47  B8     +1        pressed longer than 1 second
     11  48  B7    +10        pressed longer than 1 second
     11  60  DF     +1 &  -1  pressed longer than 1 second
     11  61  9E     -1 & -10  pressed longer than 1 second
     11  62  9D     +1 & +10  pressed longer than 1 second
     11  64  9B    +10 & -10  pressed longer than 1 second (why not 11 68 97 ?)

                 Sent by autopilot (X=0: ST 1000+,  X=2: ST4000+ or ST600R)
     X1  01  FE    Auto
     X1  02  FD    Standby
     X1  03  FC    Track
     X1  04  FB    disp (in display mode or page in auto chapter = advance)
     X1  05  FA     -1 (in auto mode)
     X1  06  F9    -10 (in auto mode)
     X1  07  F8     +1 (in auto mode)
     X1  08  F7    +10 (in auto mode)
     X1  09  F6     -1 (in resp or rudder gain mode)
     X1  0A  F5     +1 (in resp or rudder gain mode)
     X1  21  DE     -1 & -10 (port tack, doesn´t work on ST600R?)
     X1  22  DD     +1 & +10 (stb tack)
     X1  23  DC    Standby & Auto (wind mode)
     X1  28  D7    +10 & -10 (in auto mode)
     X1  2E  D1     +1 & -1 (Response Display)
     X1  41  BE    Auto pressed longer
     X1  42  BD    Standby pressed longer
     X1  43  BC    Track pressed longer
     X1  44  BB    Disp pressed longer
     X1  45  BA     -1 pressed longer (in auto mode)
     X1  46  B9    -10 pressed longer (in auto mode)
     X1  47  B8     +1 pressed longer (in auto mode)
     X1  48  B7    +10 pressed longer (in auto mode)
     X1  63  9C    Standby & Auto pressed longer (previous wind angle)
     X1  68  97    +10 & -10 pressed longer (in auto mode)
     X1  6E  91     +1 & -1 pressed longer (Rudder Gain Display)
     X1  80  7F     -1 pressed (repeated 1x per second)
     X1  81  7E     +1 pressed (repeated 1x per second)
     X1  82  7D    -10 pressed (repeated 1x per second)
     X1  83  7C    +10 pressed (repeated 1x per second)
     X1  84  7B     +1, -1, +10 or -10 released

 87  00  0X        Set Response level
                  X=1  Response level 1: Automatic Deadband
                  X=2  Response level 2: Minimum Deadband
```

```
 88  03  WW  XX  YY  ZZ  Autopilot Parameter: Sent by AP every
                         second while in parameter setting mode.
                         (User or Dealer Calibration Mode)
                         WW Parameter Number
                         XX Current Setting
                         YY Max Parameter Value
                         ZZ Min Parameter Value
                         Known Paramters: Parameter (min-max) [default]
Number
                         rudder gain  (1-9)
[2]                                    1
                         counter rudder (1-9)
[2]                                   2
                         rudder limit  (10-40)
[30]                                 3
                         turn rate limit  (1-30)
[off]                                 4
                         speed  (4-60)
[8]                                            5
                         off course limit  (15-40)
[20]                               6
                         auto trim  (0-4)
[1]                                            7
                         power steer [Joy Stick] ON/OFF (not on new
400G)             9
                         drive type  (3,4,5)
[3]                                    A
                         rudder damping  (1-9)
[2]                                   B
                         variation: (full degrees)(-30 to +30)
[0]                     C
                         auto adapt: 0=Off,1=North,2=South
[1]                        D
                         auto adapt latitude (0-80)
[0]                                 E
                         auto release (only for stern drive)
ON/OFF                   F
                         rudder alignment (-7 to +7)
[0]                             10
                         Wind Trim (Wind Response) (1-9) [5] (only for
sail)         11
                         Response  (1-9)
[5]                                     12
                         Boat type:1=displ,2=semi-
displ,3=plan,4=stern,5=work,6=sail 13
                         Cal Lock:  0=OFF, 1=ON
[0]                                 15
                         Auto Tack Angle (40-125) [100] (only for
sail)              1d

 89  U2  VW  XY  2Z  Compass heading sent by ST40 compass instrument
                     (it is read as a compass heading by the ST1000(+) or ST2000(+)
autopilot)
```

```
                      Compass heading in degrees:
                        The two lower bits of  U  *  90   +
                        the six lower bits of VW  *   2   +
                        the two higher bits of U  /   2   =
                        (U & 0x3) * 90 + (VW & 0x3F) * 2 + (U & 0xC) / 2
                      Locked stear reference (only send by the ST40 compass):
                        The two higher bits of V * 90 + XY / 2
                      Z & 0x2 = 0 : St40 in Standby mode
                      Z & 0x2 = 2 : St40 in Locked stear mode
                    Corresponding NMEA sentences: HDM, HDG, HDT, VHW

 90  00  XX        Device Indentification
                  XX=02  sent by ST600R ~every 2 secs
                  XX=05  sent by type 400G course computer
                  XX=A3  sent by NMEA <-> SeaTalk bridge ~every 10 secs

 91  00  0X        Set Rudder gain to X

 92  02  XX  YY  00 Set Autopilot Parameter: Sent by the remote head
                   (e.g. ST600R) to set a particular parameter.
                   XX Parameter Number (see 88)
                   YY Value to set to.

 93  00  00         Enter AP-Setup: Sent by course computer before
                   finally entering the dealer setup. It is repeated
                   once per second, and times out after ten seconds.
                   While this is being sent, command 86 X1 68 97 is
                   needed for final entry into Setup. (600R generates
                   this when –1 & +1 are pressed simultaneously in this
                   mode).

 95  U6  VW  XY 0Z 00 RR 00 0T  Replaces command 84 while autopilot is in value
setting mode
                  e.g. lamp intensity or response level

 99  00  XX        Compass variation sent by ST40 compass instrument
                     or ST1000, ST2000, ST4000+ autopilot every 10 seconds
                     but only if the variation is set on the instrument
                     Positive XX values: Variation West, Negative XX values:
Variation East
                     Examples (XX => variation): 00 => 0, 01 => -1 west, 02 => -2
west ...
                                                 FF => +1 east, FE => +2 east ...
                  Corresponding NMEA sentences: RMC, HDG

 9A  09  L11  L12  L13  L14  L21  L22  L23  00  00  00  Version String:
                  L11 means line 1 char 1. There are two lines, line 1
                  Can have 4 characters and line two can have 3
                  Characters. Char: “A”= 0x00, “B”= 0x01,……..
                  Char: “0”= 0x25, “1”= 0x26, …….
```

```
                  Some special characters are mapped to the range
                  Between alphas and numeric chars. It seems modulo
                  masked at 0x36, and wraps around from there.

 9C  U1  VW  RR   Compass heading and Rudder position (see also command 84)
                    Compass heading in degrees:
                      The two lower  bits of  U * 90 +
                      the six lower  bits of VW *  2 +
                      the two higher bits of  U /  2 =
                      (U & 0x3) * 90 + (VW & 0x3F) * 2 + (U & 0xC) / 8
                    Rudder position: RR degrees (positive values steer right,
                      negative values steer left. Example: 0xFE = 2° left)
                    The rudder angle bar on the ST600R uses this record

 9E  FC  49  49 03 XX AA BB YY OO PP GG HH II JJ   Waypoint definition
                  XX: Degrees LAT, YY: Degrees LON
                  min&sec LAT= AA+(BB&0x1F)*256, BB&0x80 = 0: North, BB&0x80 =
0x80: South
                  min&sec LON= OO+(PP&ßx1F)*256, PP&0x80 = 0: West,  PP&0x80 =
0x80: East
                  GG HH II JJ: Last four characters of waypoint name

 A1  XD  49  49 GG HH II JJ C1 C2 C3 C4 C5 C6 C7 C8  Destination Waypoint Info
                  GG HH II JJ: Last four characters of waypoint name
                  C1...C8: Up to 8 characters of WP name, unused are 0
                  Longer names (> 8 chars) create an additional record:
                  X=0: single record (short name)
                  X=1: 1st record, more follows
                  X=3: last record
                  Corresponding NMEA sentences: RMB, APB, BWR, BWC

 A2  X4  00  00 00 00 00 Arrival Info
                  X&0x2=Arrival perpendicular passed, X&0x4=Arrival circle entered
                  Corresponding NMEA sentences: APB, AAM

 A5               GPS and DGPS Info

 A5  57  QQ  HH ?? AA GG ZZ YY DD   GPS and DGPS Fix Info
                  Signal Quality= QQ&0xF, QQ&0x10: Signal Quality available flag
                  HDOP= HH&0x7C, HH&0x80: HDOP available flag
                  Antenna Height= AA
                  Number of Sats= (QQ&0xE0)/16+(HH&0x1), HH&0x2: NumSats available
flag
                  GeoSeperation= GG*16 (-2048....+2047 meters)
                  Differential age=(ZZ&0xE0)/2+(YY&0xF), YY&0x10: Diff. age
available flag
                  Differential Station ID=(YY&0xC0)*4+DD, YY&0x20: Diff.St.ID
available flag
                  Corresponding NMEA sentences: GGA, RMC, GSV, GLL, GGA
```

```
 A5  74  ID  ID ID ID ID   GPS Info: ID numbers of satellites
 A5  XD  NN  AA EE SS MM BB FF GG OO CC DD XX YY ZZ   GPS Info: Sat Position and
Signal
                  Data of up to three sattelites [1,2,3] per datagram
                  Satellite number: [1] NN&0xFE, [2] (MM&0x70)/2+(BB&0x7), [3]
CC&0x3F
                  Satellite azimuth:[1] AA*2+(EE&0x1), [2] (BB&0xF8)*2+(FF&0xF),
[3] (CC&0xC0)*2+DD&0x7F
                  Satellite elevation:[1] (EE&0xFE)/2, [2] (FF&0xF0)/2+GG&0x7, [3]
XX&0x7F
                  Satellite signal: [1] (SS&0xFE)/2, [2] (GG&0x80)/2+OO&0x3F, [3]
(YY&0xFC)/2+ZZ&0x1

                   It seems that there will be 4 sat info
                   datagrams generated, the first with X=0
                   carries the position and signal data of the
                   1st 3 satellites. The second also with X=0,
                   but NN&0x1 set and a length of 0x0C carries
                   the data of the next 2 satellites and then
                   the ID numbers of the 1st 4 sats. A
                   datagram like the 1st one, but with X=2
                   carries data of 3 more sats [6,7,8]. It was
                   not possible to get more than 8 sats mapped
                   to SeaTalk. Finally a datagram with X=7
                   carries the next 5 ID numbers.

                  Corresponding NMEA sentences: GSV, GSA
```

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