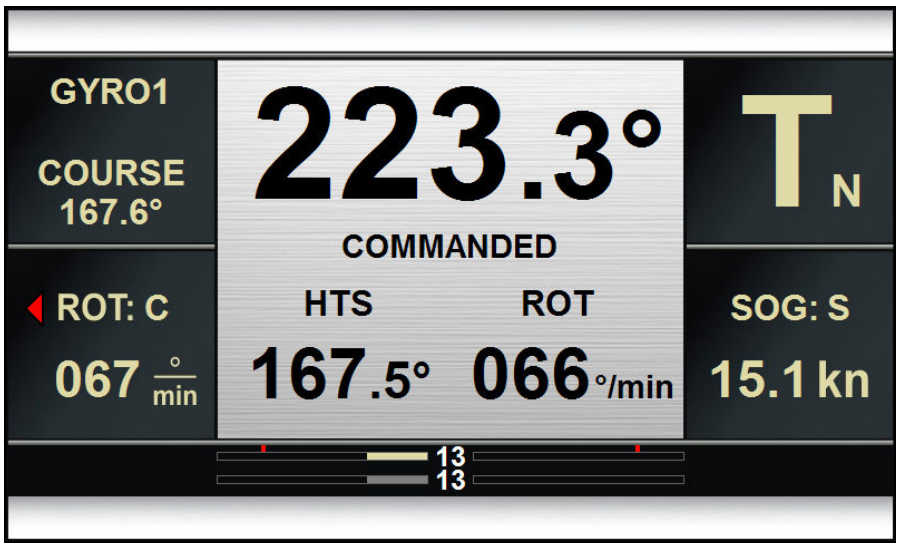
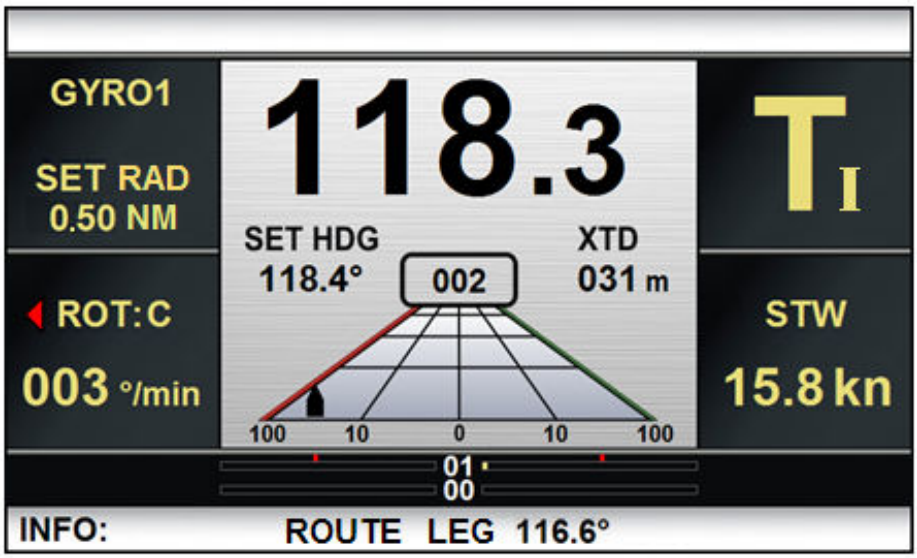
Navis AP3000-C
Navis AP SYSTEM
Navis NavAP

NAVIS AP SYSTEM /NAVAP - TCS CAT C INTERFACING REVISION 5.1





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Document history

Revision	Date	Modifications	Author
1.0	June 02, 2011	Document was created and reviewed.	AMA
2.0	October 17, 2011	Appendix A "NMEA messages" was corrected.	AMA
3.0	March 15, 2012	Messages $PNEY,001 and $PNEY,002 are added	AMA
4.0	August 22, 2012	Incoming $xxHTC sentences: statuses "Selected Steering Mode" - "H" and "T" are updated	AMA
5.0	September 03, 2012	statuses "Selected Steering Mode" - "H" and "T" are updated according to dynamic switching beetwenn "Tn" (Remote HDG Control) and "Ti" (Track Control) modes	AMA
5.1	September 03, 2012	Clarification of the WP presentation from $PNEY,002 sentences is defined as (first three digits or letters)	AMA
5.11	September 5, 2018	Redesigned	OMI

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CONTENTS

GLOSSARY

AC	Alternating current
ADC	Analog to digital converter
AP	Autopilot
APM	Controller module for main control unit
APP	Controller module for all control units except main control unit
AUTO	Automatic ("Heading Control mode")
BAMS	Bridge alarm monitoring system
COM	Serial data port
CU	Control Unit
DC	Direct Current
EEPROM	Electrically Erasable Programmable Read-Only Memory (PCB)
ECS	Electronic chart systems
ECDIS	Electronic chart display and information system
FFU	Full-Follow-Up
GPS	Global Positioning system
HCS	Heading Control System
IMO	International Maritime Organization
INS	Integrated navigational system
JP	Joystick Pilot System
NFU	Non-Follow-Up
RFU	Rudder Feedback Unit
SG	Steering Gear
SMS	Steering Mode Selector
SS	Steering System
TCS	Track Control System
THD	Transmitting Heading Device
MAGN	Magnetic Compass (NMEA sensor)
CALC	Calculated value ("C" in some fields)
SENS	Sensor data ("S" in some fields)
ROT	Rate-Of-Turn
RAD	Steering Radius
HDG	Heading

STW	Speed-Through-Water
SOG	Speed-Over-Ground
COG	Course-Over-Ground
WP	Way Point

1. Remote Heading Control

1. NORMAL MODE: Remote HDG CTRL IS NOT Activated

- **TCS ECDIS TRANSMITTS FOLLOWING SENTENCES TO AP SYSTEM (ONCE PER SEC):**

$EIHTC,V,,,S,N,,,,,,,T,C*hh<CR><LF

- **NAVIS AP SYSTEM RESPONDS TO TCS ECDIS IN THAT CASE (ONCE PER SECOND):**

$AGHTD,V,16.0,R,S,N,16.0,20.0,0.42,028,,,,T,A,A,,216.8*hh<CR><LF
$AGRSA,15.2,A,15.4,A*hh<CR><LF
$AGROR,16.0,A,16.0,A,B*hh<CR><LF>

Note 1.1: **Yellow data** means independent rudder control, otherwise – null field in case of the ship configuration with a single or mechanically linked rudders.

Note 1.2: **Green data** means current mode of AP SYSTEM: **S** – Standalone HDG control, **R** – Rudder Control, **M** – Manual control, **Empty** – AP in installation Menu.

Note 1.3: **028** – ROT in use, or **0.42** – Radius in use – depends on "Steering By" method in AP SYSTEM.

2. NORMAL MODE: Remote HDG CTRL IS Activated

- **TCS ECDIS TRANSMITTS FOLLOWING SENTENCES TO AP SYSTEM (ONCE PER SEC):**

$EIHTC,V,,,H,N or T,,,,028,345.4,,355.0,T,C*hh<CR><LF

Where:

- **H – Remote HDG control is activated**
- **N – Remote HDG control wih "not controlled turn, i.e. on straight leg"**
- **T – Remote HDG control wih "controlled turn, i.e. during the turn"**
- **028 – Commanded ROT (ignored by AP SYSTEM if aforementioned filed is N – turn is not controlled**
- **345.4 – Commanded HTS – should be equal to Commanded track below during the turn in combination of "H","T" above!!!**
- **355.0 – Commanded track (or "virtual route leg", linked to the main route or WP**

- **NAVIS AP SYSTEM RESPONDS TO TCS ECDIS IN THAT CASE (ONCE PER SECOND):**

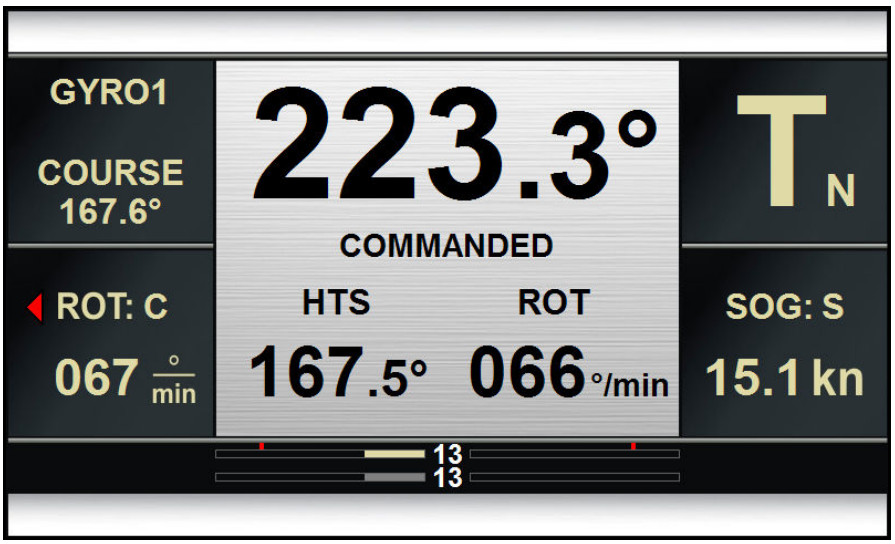
$AGHTD,V,16.0,R,H,N or T,35.0,20.0,,028,345.4,,355.0,T,A,A,,341.8*hh<CR><LF
$AGRSA,15.2,A,15.4,A*hh<CR><LF
$AGROR,16.0,A,16.0,A,B*hh<CR><LF>

Note 2.1: **Yellow data** means independent rudder control, otherwise – null field in case of the ship configuration with a single or mechanically linked rudders.

Note 2.2: **Green data 341.8** means current HDG in Autopiot.

See details also in the Annex A below!!!

Remote HDG Control Screen on AP SYSTEM:



- **"Tn" –** identificator of the Remote HDG Control;
- **"GYRO1"** – Heading Source in AP SYSTEM;
- **"COURSE" 167.6** – Commanded track from incoming **$EIHTC** sentences;
- **"ROT: C** or **ROT: S" –** Current Rate-Of-Turn value in AP SYSTEM, Calculated – **C**, or from GYRO or ROT sensor – **S**;

- **223.3 –** Actual HDG from the Master HDG source;
- **"SOG: C** or **SOG: S** or **STW" –** Speed Over Ground calculated – **C**, or from GPS sensor – **S**;
- **"Commanded HTS" –** Commanded Heading-To-Steer from incoming **$xxHTC** sentences;
- **"Commanded ROT" –** Commanded Rate of Turn from incoming **$xxHTC** sentences;

Note 2.3: when "**Turn mode**" field is "**N**" in the incoming **$xxHTC** sentences (**Turn is not controlled**), the AP SYSTEM shows **Commanded ROT = 000** and uses only **Commanded HTS** on straight leg and own ROT regulator during remote HDG control mode on "straight" (or virtual) leg. See picture below:

2. TRACK Control

2.1.1 NORMAL MODE: TCS IS NOT ACTIVATED IN THE TCS ECDIS ON THE STRAIGHT LEG

- **TCS ECDIS TRANSMITTS FOLLOWING SENTENCES TO AP SYSTEM (ONCE PER SEC):**

$EIHTC,V,,,S,N,,,,,,,T,C*hh<CR><LF
$EIXTE,A,A,0.015,R,N,A*hh<CR><LF (actual XTD according to straight legs and radiuses!)
$PNEY,001,A,A,0.015,R,N,A*hh<CR><LF (actual XTD on straight legs and XTE according to the next leg during sailing on turn radius)
$PNEY,002,,,,,000*hh<CR><LF> (**000** = ID of the NEXT WP in monitoring)
$EIGLL,5345.345,N,12365.635,W,123423,A,A*hh<CR><LF
$EIVTG,234.5,T,,M,10.0,N,18.2,K,A*hh<CR><LF
$EIVHW,235.2,T,238.2,M,11.2,N,19.3,K*hh<CR><LF

Note 3.1: Route may be loaded into monitoring or not loaded at all independently of TCS activation in ECDIS. If Route is not loaded: **Yellow data** (XTE: **0.015** nm Port side) should be empty fields on the example above:

$EIHTC,V,,,S,N,,,,,,,T,C*hh<CR><LF
$EIXTE,A,A,,,N,A*hh<CR><LF
$PNEY,001,A,A,,,N,A*hh<CR><LF
$PNEY,002,,,,,*hh<CR><LF>

Note 3.2: If GPS dats is lost or not valid in ECDIS, - Following sentence shoud change their NavStatus:

$EIGLL, $EIVTG and **$EIXTE,V,A,0.015,R,N,N***hh<CR> and **$PNEY,001,A,A,0.015,R,N,A***hh<CR><LF **if EPFS Status field is invalid**: In that case TCS will be not accepted by AP SYSTEM/ECDIS (when position is not valid in the ECDIS) independently of the command status of the **$EIHTC** sentences, described under item 2) below.

Note 3.3: $EIGLL sentences contain position of **ECDIS Conning Station** (Re-calculated from the Primary GPS data)

Note 3.4: XTE in the **$EIXTE** and **$PNEY,001,** provides from the Ship Centre Line **(Midship line)**.

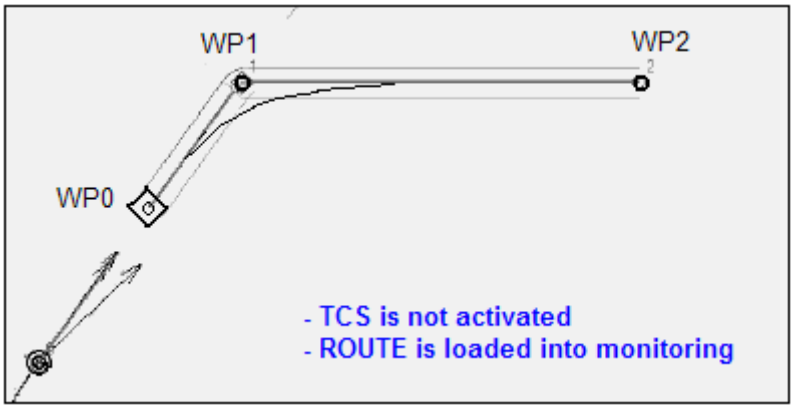
- **NAVIS AP SYSTEM RESPONDS TO TCS ECDIS IN THAT CASE (ONCE PER SECOND):**

$AGHTD,V,16.0,R,S,N,16.0,20.0,0.42,028,,,,T,A,A,,216.8*hh<CR><LF
$AGRSA,15.2,A,15.4,A*hh<CR><LF
$AGROR,16.0,A,16.0,A,B*hh<CR><LF>

Note 3.5: **Yellow data** means independent rudder control, otherwise – null field in case of the ship configuration with a single or mechanically linked rudders.

Note 3.6: **Green data** means current mode of AP SYSTEM: **S** – Standalone HDG control, **R** – Rudder Control, **M** – Manual control, **Empty** – AP in installation Menu.

Note 3.7: **028** – ROT in use, or **0.42** – Radius in use – depends on "**Steering By**" method in AP SYSTEM (Steering by **Radius** or by **Rate-Of-Turn**).



SITUATION 1. NORMAL MODE. TCS IS NOT ACTIVE

2.1.2 TCS ACTIVATION IN THE ECDIS ON THE STRAIGHT LEG (WP0000 is PASSED)

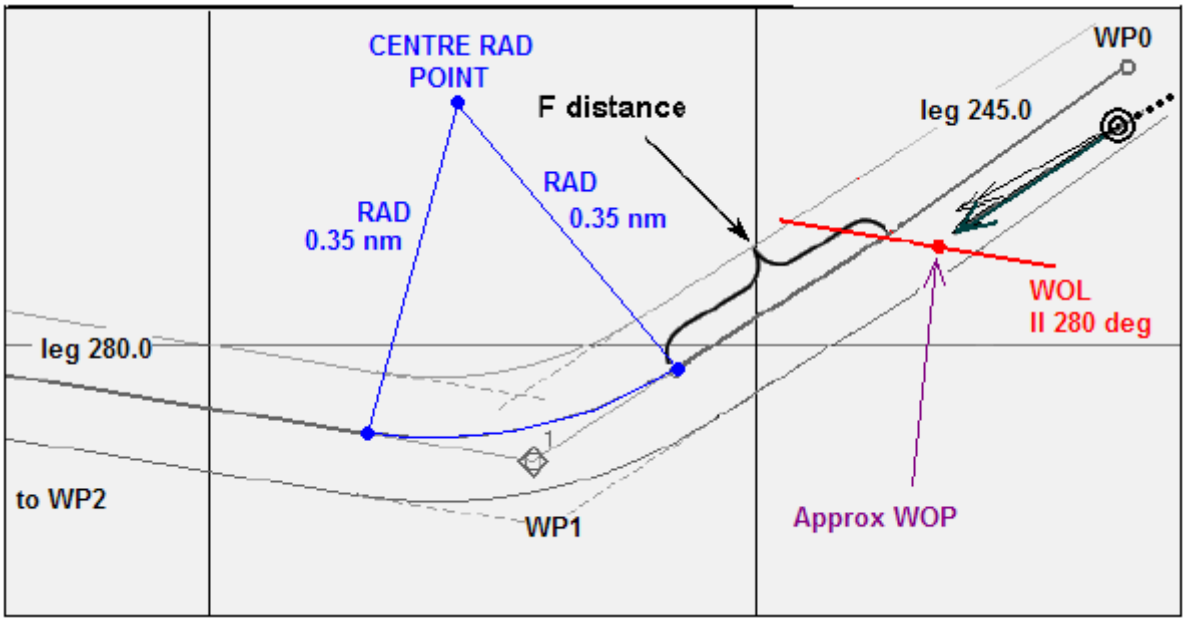
- **TCS ECDIS TRANSMITTS FOLLOWING SENTENCES TO AP SYSTEM (ONCE PER SEC). SEE PICTURE BELOW:**

$EIHTC,V,,,T,R,,,,,,,245.0,T,C*hh<CR><LF
(where R – all the time during TCS mode "Ti")
$EIXTE,A,A,0.07,R,N,A*hh<CR><LF (according to Leg **245.0°**)
$PNEY,001,A,A,0.07,R,N,A***hh<CR><LF (actual XTD on straight legs – equal to XTD in the message **$EIXTE)
$PNEY,002,,,,,001*hh<CR><LF> (ID **001** of the NEXT WP in monitoring)
$EIGLL,5345.345,N,12365.635,W,123423,A,A*hh<CR><LF
$EIVTG,234.5,T,,M,10.0,N,18.2,K,A*hh<CR><LF
$EIVHW,235.2,T,238.2,M,11.2,N,19.3,K*hh<CR><LF

- **NAVIS AP SYSTEM RESPONDS TO TCS ECDIS AFTER TCS CONFIRMATION IN AP SYSTEM (ONCE PER SECOND):**

$AGHTD,V,16.0,R,T,N,35.0,20.0,0.42,,255.5,,245.0,T,A,A,,252.8*hh<CR><LF>
(where N – means "straight leg")
$AGRSA,15.2,A,,V*hh<CR><LF
$AGROR,16.0,A,,V,B*hh<CR><LF>

Note 2.1: RSA and **ROR** shown above in case of the ship configuration with single or mechanically linked rudders.



SITUATION 2. TCS IS ACTIVATED AFTER WP000 ON THE STRAIGHT LEG.

Note 2.2: **F distance** is called as the "**Forwarding Distance**" in the **TCS ECDIS**.

Note 2.3: **AP** transmits **latest Radius in use** in the **outgoing $xxHTD** sentences to ECDIS (**0.42 nm** on the example above). AP SYSTEM using a smooth algorythm to decrease the XTD on the straight leg line.

2.1.3 START OF THE TURN, PASSING OF THE WHEEL OVER LINE. RADIUS IS NOT REACHED YET (SHIP ON F DISTANCE)

- **TCS ECDIS TRANSMITTS FOLLOWING SENTENCES TO AP SYSTEM AFTER PASSING OF THE WOL (ONCE PER SECOND). SEE PICTURE BELOW:**

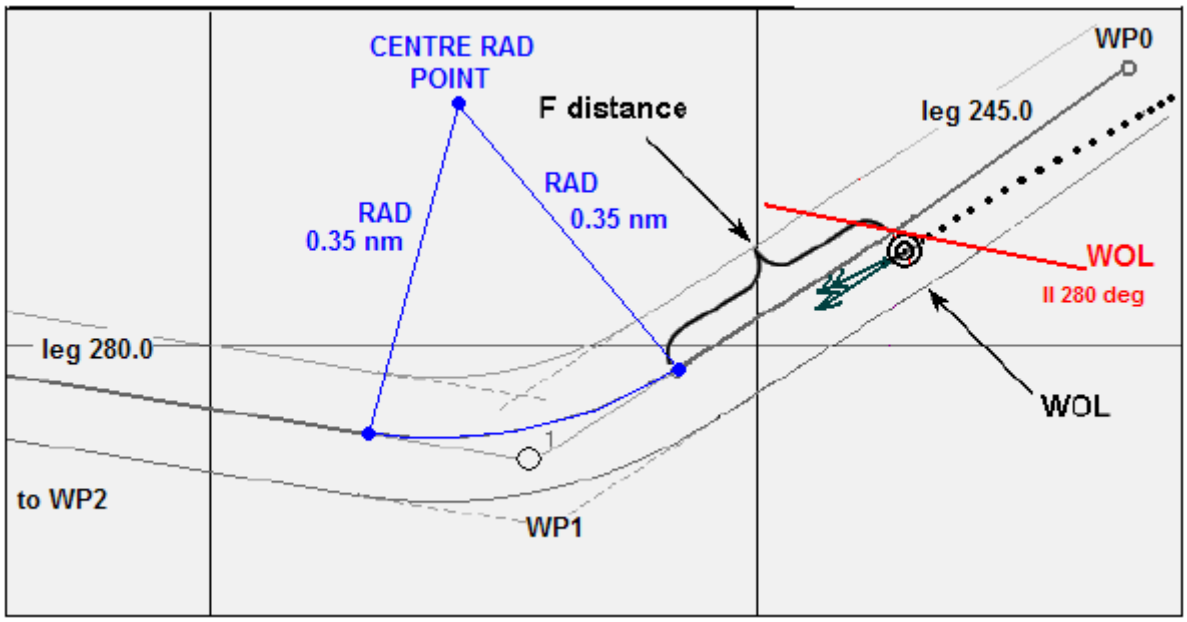
$EIHTC,V,,,T,R,,,0.35,,,,280.0,T,C*hh<CR><LF **(Commanded Radius is appeared now!)**
(where R – all the time during TCS mode "Ti")
$EIXTE,A,A,0.015,R,N,A*hh<CR><LF (according to the **Leg 245.0°** on example below)
$PNEY,001,A,A,0.015,R,N,A***hh<CR><LF (actual XTD on straight legs – equal to XTD in the message **$EIXTE above)
$PNEY,002,6235.234,N,12343.231,W,001*hh<CR><LF> **(**position of **CENTRE RAD POINT)**
$EIGLL,5345.345,N,12365.635,W,123423,A,A*hh<CR><LF
$EIVTG,234.5,T,,M,10.0,N,18.2,K,A*hh<CR><LF
$EIVHW,235.2,T,238.2,M,11.2,N,19.3,K*hh<CR><LF

Note 5.1: $PNEY,002 contains position of the **CENTRE RAD POINT** and waypoint ID is changed to **001** here.

- **NAVIS AP SYSTEM RESPONDS TO TCS ECDIS (ONCE PER SECOND):**

$AGHTD,V,4.0,R,T,R,35.0,20.0,0.35,027.5,275.5,,280.0,T,A,A,,262.2*hh<CR><LF
(where R – means "on turn")
$AGRSA,8.2,A,,V*hh<CR><LF
$AGROR,4.0,A,,V,B*hh<CR><LF>

Note 5.2: AP SYSTEM accepted commanded radius **(0.35 nm)** and **CENTRE RAD POINT** and retransmit accepted radius to ECDIS via **$AGHTD** output sentences.



SITUATION 3. WOL IS PASSED. RADIUS IS NOT REACHED. SHIP IS ON FORWARDING DISTANCE LINE. BEGIN OF TURN. WP IN MONITORING IS CHANGED TO WP#0002 IN ECDIS!!! AP IS STILL PASSING THE TURN OF WP#001.

"$PNEY,002" MESSAGE CONTAINS POSITION OF "CENTRE RAD POINT" (LAT/LON). "$PNEY,001" and "$EIXTE" SENTENCES ARE CONTAINS XTE VALUE ACCORDING TO THE CURRENT LEG OF THE ROUTE.

2.1.4 PASSING BY RADIUS. STEERING ON F DISTANCE IS FINISHED. RADIUS IS REACHED (GREEN PERPEND. LINE)

- **TCS ECDIS TRANSMITTS FOLLOWING SENTENCES TO AP SYSTEM (ONCE PER SEC). SEE PICTURE BELOW:**

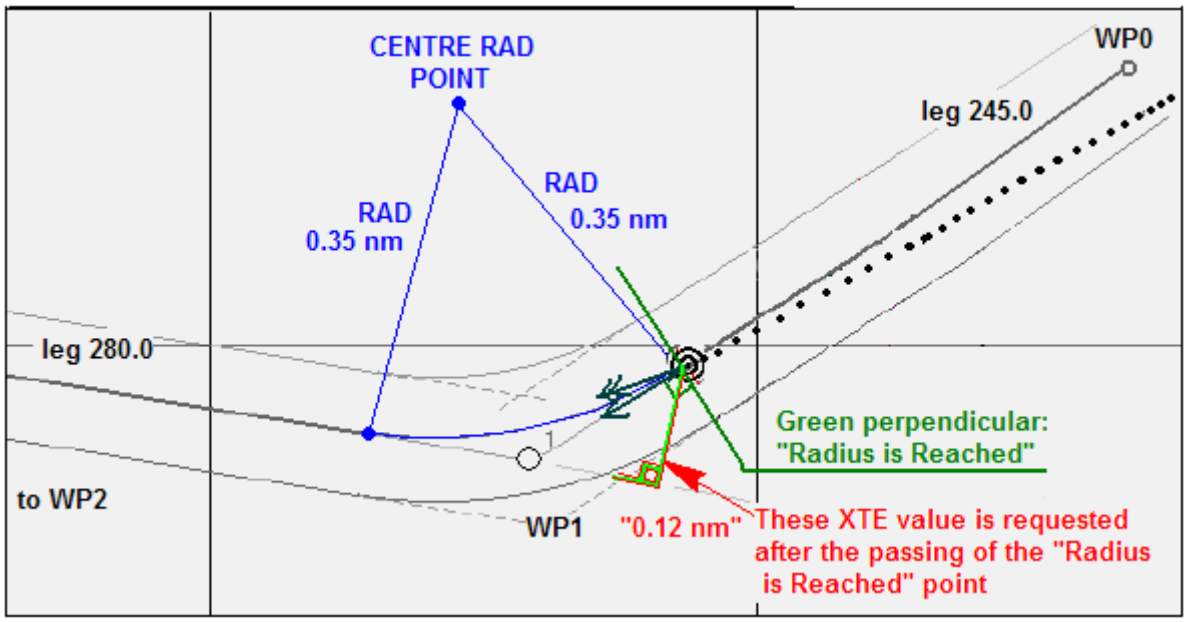
$EIHTC,V,,,T,R,,,0.35,,,,280.0,T,C*hh<CR><LF
(where R – all the time during TCS mode "Ti")
$EIXTE,A,A,0.001,R,N,A*hh<CR><LF **(**actual **XTD** according **RADIUS – for Visualization!)**
$PNEY,001,A,A,0.12,L,N,A*hh<CR><LF **(XTD** according to the **Leg 280.0° - for Mathematic)**
$PNEY,002,6235.234,N,12343.231,W,001*hh<CR><LF> (position of **CENTRE RAD POINT**)
$EIGLL,5345.345,N,12365.635,W,123423,A,A*hh<CR><LF
$EIVTG,234.5,T,,M,10.0,N,18.2,K,A*hh<CR><LF
$EIVHW,235.2,T,238.2,M,11.2,N,19.3,K*hh<CR><LF

Note 6.1: Cross Track Distance value in **$EIXTE** sentences should correspond to the current Radius and will be used for visualization purposes in AP System display. The same value will be displayed on ECDIS, Conning etc.

Note 6.2: Cross Track Distance value in **$PNEY,001,** sentences should correspond to the next route leg (Course **280** degrees on the picture below) after the passing of the "**Radius is Reached**" point, which is located on the Green perpendicular on the picture below.

- **NAVIS AP SYSTEM RESPONDS TO TCS ECDIS (ONCE PER SECOND):**

$AGHTD,V,14.0,R,T,R,35.0,20.0,0.35,017.5,279.5,,280.0,T,A,A,,267.2*hh<CR><LF
(where R – means "on turn")
$AGRSA,11.2,A,,V*hh<CR><LF
$AGROR,14.0,A,,V,B*hh<CR><LF>



SITUATION 4. "F DISTANCE" IS PASSED. RADIUS IS REACHED. WP IN MONITORING STILL WP#0002 IN ECDIS!!! AP PASSING THE TURN OF WP#001. NOW "$PNEY,001" MESSAGE CONTAINS XTE VALUE ACCORDING TO THE NEXT ROUTE LEG. "$EIXTE" MESSAGE CONTAINS XTE VALUE ACCORDING TO RADIUS.

In General: SITUATION #5 is absoulutely the same as SITUATION #2 above. TCS returned to the Steering on the Straight leg (difference is that TCS is already activated and in operational condition).

2.1.5 FINISHING OF THE TURN (GREEN LINE ON THE PICTURE)

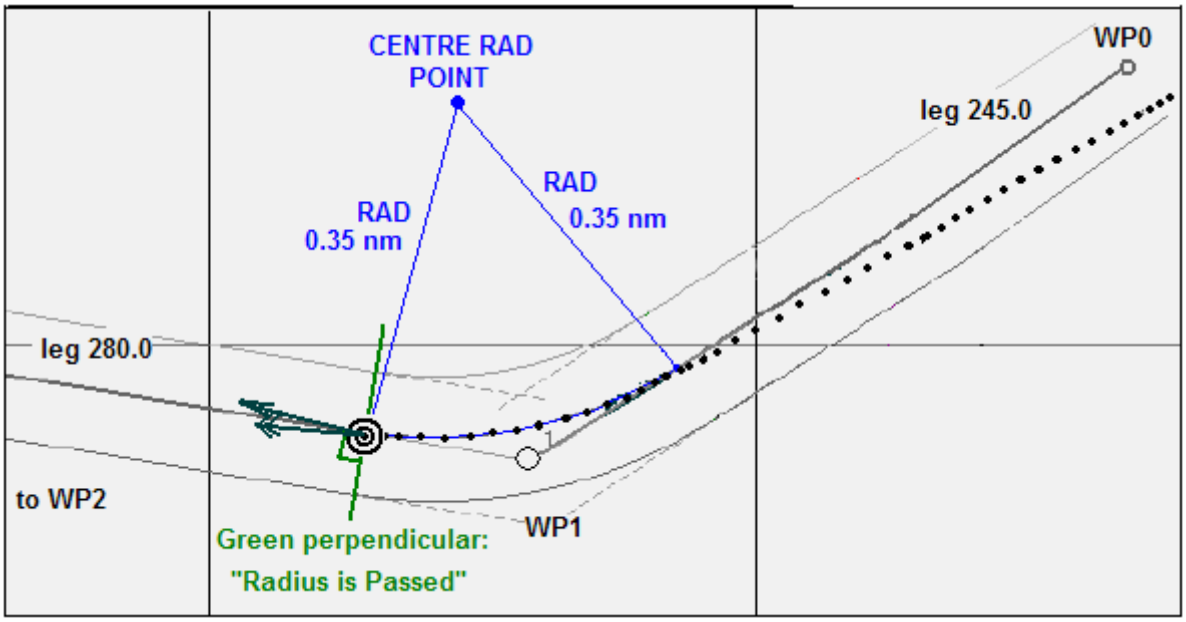
- **TCS ECDIS TRANSMITTS FOLLOWING SENTENCES TO AP SYSTEM (ONCE PER SEC). SEE PICTURE BELOW:**

$EIHTC,V,,,T,R,,,,,,,280.0,T,C*hh<CR><LF
(where R – all the time during TCS mode "Ti")
$EIXTE,A,A,0.001,R,N,A*hh<CR><LF (XTD according to **Leg 280.0°**)
$PNEY,001,A,A,0.001,R,N,A*hh<CR><LF (actual XTD on straight legs – equal to XTD in the message $EIXTE)
$PNEY,002,,,,,002*hh<CR><LF> (ID of the NEXT WP002 in monitoring)
$EIGLL,5345.345,N,12365.635,W,123423,A,A*hh<CR><LF
$EIVTG,234.5,T,,M,10.0,N,18.2,K,A*hh<CR><LF
$EIVHW,235.2,T,238.2,M,11.2,N,19.3,K*hh<CR><LF

- **NAVIS AP SYSTEM RESPONDS TO TCS ECDIS (ONCE PER SECOND):**

$AGHTD,V,2.0,R,T,N,35.0,20.0,0.35,,280.5,,280.0,T,A,A,,281.2*hh<CR><LF
(where N – means on "straight leg")
$AGRSA,03.2,A,,V*hh<CR><LF
$AGROR,02.0,A,,V,B*hh<CR><LF>

Note 7.1: Where **0.35 nm** is the latest accepted radius from ECDIS during the WP0001 turn.



SITUATION 5. FINISHING OF TURN. RADIUS IS COMPLETELY PASSED. TCS RETURNED TO THE SITUATION #2: STEERING ON THE STRAIGHT LEG.

In General: SITUATION #6, End of Route is the similar as SITUATION #1. I.E TCS is disabled automatically in ECDIS after the passing of the latest WP.

2.1.6 END OF ROUTE. LATEST WP (AFTER GREEN LINE)

- **TCS ECDIS TRANSMITTS FOLLOWING SENTENCES TO AP SYSTEM (ONCE PER SEC). SEE PICTURE BELOW:**

$EIHTC,V,,,S,N,,,,,,,T,C*hh<CR><LF
$EIXTE,A,A,,,N,A*hh<CR><LF (No XTD – Route is passed)
$PNEY,001,A,A,,,N,A*hh<CR><LF (No XTD – Route is passed)
$PNEY,002,,,,,*hh<CR><LF> (No **WP ID** and **CENTRE RAD POINT** – Route is passed)
$EIGLL,5345.345,N,12365.635,W,123423,A,A*hh<CR><LF
$EIVTG,234.5,T,,M,10.0,N,18.2,K,A*hh<CR><LF
$EIVHW,235.2,T,238.2,M,11.2,N,19.3,K*hh<CR><LF

- **NAVIS AP SYSTEM RESPONDS TO TCS ECDIS (ONCE PER SECOND):**

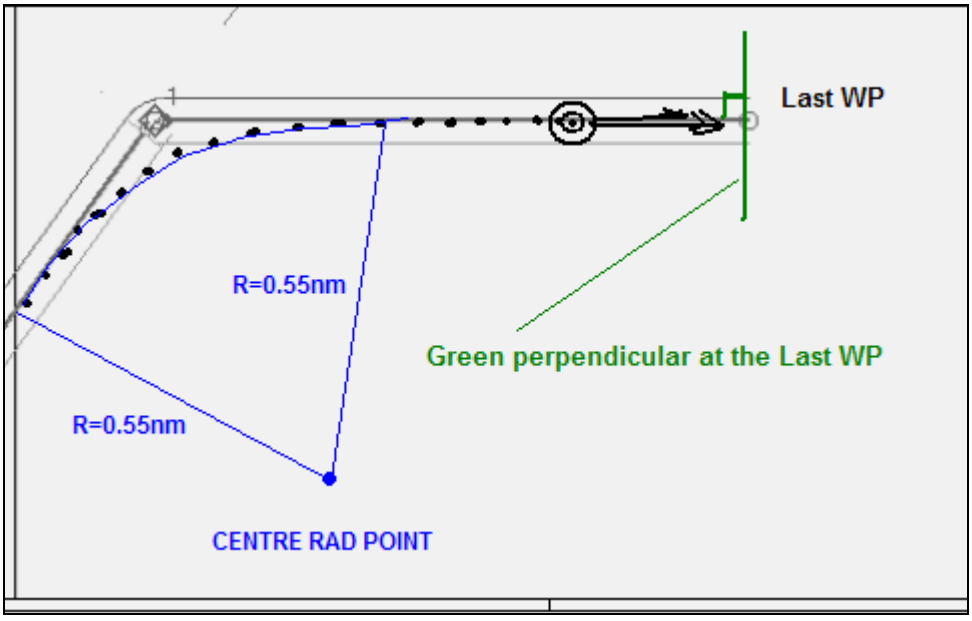
$AGHTD,V,16.0,R,S,N,16.0,20.0,0.42,028,,,,T,A,A,,216.8*hh<CR><LF
$AGRSA,15.2,A,15.4,A*hh<CR><LF
$AGROR,16.0,A,16.0,A,B*hh<CR><LF>

Note 8.1: "**TRACK FAIL**" alarm is appeared in AP SYSTEM Autopilot and AP is switched automatically to "**AUTO**" mode (i.e. to Heading Control mode) keeping latest set HDG.

Note 8.2: **Yellow data** means independent rudder control, otherwise – null field in case of the ship configuration with a single or mechanically linked rudders.

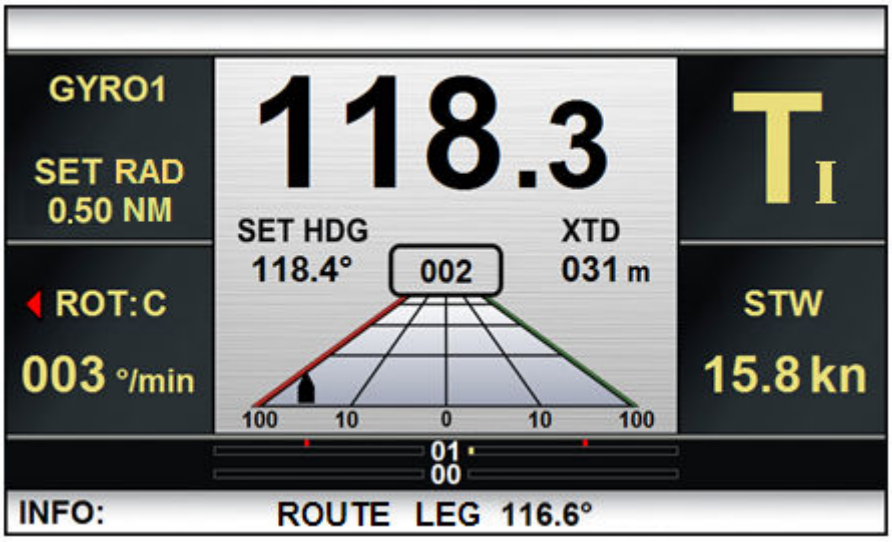
Note 8.3: **Green data** means current mode of AP SYSTEM: **S** – Standalone HDG control, **R** – Rudder Control, **M** – Manual control, **Empty** – AP in installation Menu.

Note 8.4: **028** – ROT in use, or **0.42** – Radius in use – depends on "**Steering By**" method in "**AUTO**" mode of the AP SYSTEM (Steering by **Radius** or by **Rate-Of-Turn**).



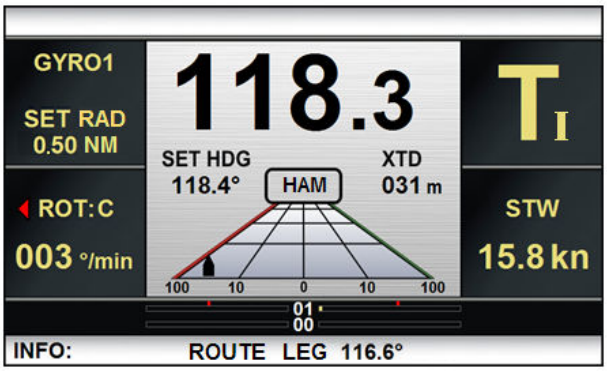
SITUATION 6. END OF ROUTE. LATEST WP.

Track Control Screen on AP SYSTEM:



- **"Ti" –** identificator of the Track Control category C;
- **"GYRO1"** – Heading Source in AP SYSTEM;
- **"SET RAD" 050** – Commanded Radius from incoming **$EIHTC** sentences;
- **"ROT: C** or **ROT: S" –** Current Rate-Of-Turn value in AP SYSTEM, Calculated – **C**, or from GYRO or ROT sensor – **S**;
- **118.3 –** Actual HDG from the Master HDG source;
- **"SOG: C** or **SOG: S** or **STW" –** Speed Over Ground calculated – **C**, or from GPS sensor – **S**;
- **"SET HDG" –** Calculated HTS by AP SYSTEM in TCS "**Ti**" mode;
- **"XTD" –** Cross Track distance value (in meters) from incoming **$EIXTE** sentences;
- **"[ ]" –** WP in monitoring from incoming **$PNEY,002** sentences – here is **002**;

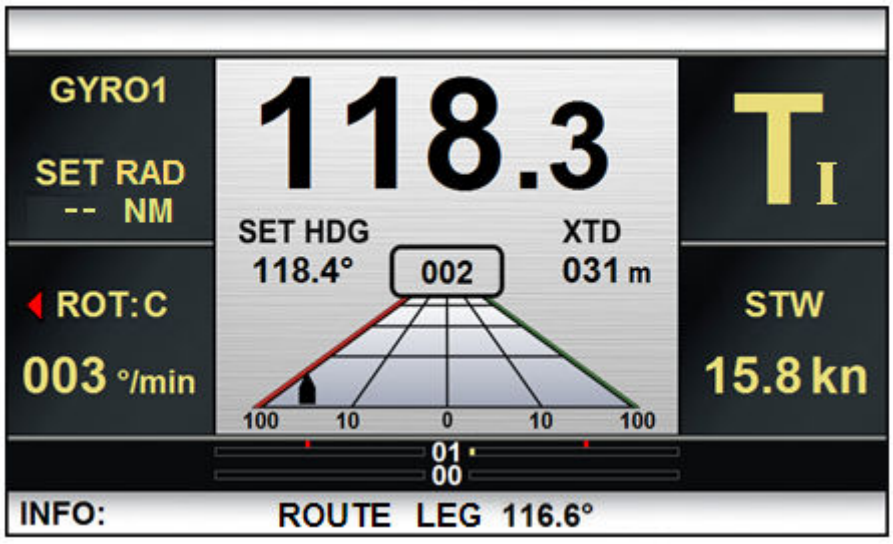
NOTE: Only three digits are shown on the display, of three first letters are shown instead of digits, if WP NAME (Alias) is entered in the ECDIS:



Example: WP Name is **"HAM"** from incoming **$PNEY,002,,,,,HAMBURG***Chksum

- **"INFO: ROUTE LEG" –** Commanded track direction from incoming **$EIHTC** sentences;

Note 8.5: during TCS on straight leg – AP System showing "- -" in the **"SET RAD"** field, as new radius will be acccpted only after passing of the Wheel Over Line, from incoming **$EIHTC** sentences during the turn. See picture below:



Appendix A. Navis AP SYSTEM. TCS (Category C) NMEA interfaces with ECDIS.

Table A.1 – Sentences supported by AP system via MCU (Central Control Unit)		
Virtual Port	**Input**	**Output**
"ECDIS OUT" **(INS, ECDIS)**	*APB*, *BWC (or BWR)*, *HTC*, *XTE*, *HSC*, plus if available: *VTG*, *GGA*, *VHW*, *VBW*). Prepriatory: *$PNEY,001*, *PNEY,002*	*HDT*, *RSA*, *HTD*, *ROR*, *ALR*, *ALA*, *HMS*, *HMR*

AP SYSTEM: Output NMEA messages from Control Unit "CU-M"

Table A.2 – Data sentence "RSA" sent by the AP System Talker identifier – AG			
Field	**Field label (and operational state)**		**Value sent from AP in the data sentence**
1	Starboard (or single) rudder sensor		**Actual value**
2	Status	Valid	**A**
		Not valid (Feedback failure)	**V**
3	Port rudder sensor (***for AP SYSTEM configurations for ships with independent rudders***)		**Actual value**
4	Status	Valid	**A**
		Not valid (Feedback failure) or single rudder configuration	**V**

Table A.3 – Data sentence "ROR" sent by the AP SYSTEM Talker identifier – AG		
Field	**Field label (and operational state)**	**Value sent from AP in the data**

			sentence
1	Starboard (or single) rudder order		**Actual value**
2	Status	Valid	**A**
		Not valid	**Unused**
3	Port rudder order (for AP SYSTEM configurations with independent rudder control)		**Actual value**
4	Status	Valid	**A**
		Not valid	**Unused**
5	Command source location		**B** **(always Bridge)**

Table A.4 – Data sentence "HTD" sent by the AP SYSTEM
Talker identifier - AG

Field	Field label (and operational state)		Value sent from AP in the data sentence
1	Override status	In use (means conventional NFU manual control), if **NFU Override** button is connected to the **IB-AVN-2** interface box via DIN port	**A**
		Not in use (all other control modes of AP SYSTEM)	**V**
2+3	Commanded rudder angle (degrees), L/R (port/starboard)		**Actual value**
4	Selected steering mode	**Manual** *(AP SYSTEM is in "**STBY**" or "**NFU Override**" control modes)*	**M**
		Standalone heading control *(AP SYSTEM steering mode is "**AUTO**")*	**S**
		Heading control by an external heading controller (Quick Route) *(AP SYSTEM is in*	**H**

		*"**AutoNAV"** – **Tn** control mode)*	
		Track control *(AP SYSTEM is in "**AutoNAV"** – **Ti** control mode)*	**T**
		Rudder control (commanded rudder angle) *(AP SYSTEM is in **FFU Override** , **Dodge**, **River Pilot**, **Wind Vane**, control modes)* ***Note:** also during critical failure also, when rudders are frozen by AP SYSTEM*	**R**
		*AP SYSTEM is in "**Installation"** or "**Autotuning"** modes.*	**… (Empty)**
5	Turn mode	Radius controlled *(Used during turns in the "**AutoNAV"** – **Ti** control mode)*	**R**
		Turn rate controlled *(Used during turns in the "**AutoNAV"** – **Tn** control mode)*	**T**
		Turn is not controlled *(Used during sailing on straight leg in "**AutoNAV"** – **Tn or Ti** control modes)*	**N**
6	Commanded rudder limit (degrees) *(In **AUTO**, **River Pilot**, **Wind Vane**, **TRACK** control modes – actual set Rudder Limit)* *(In all other autopilot and joystick control modes, including **"AutoNAV" Ti** and **Tn** modes – **Maximum Rudder Angle)***		**Actual limit value or Max rudder angle**
7	Commanded off-heading limit (degrees)		**Actual Off heading value**

8	Commanded radius of turn for heading changes (n.m.) *(Used in **AutoNAV "Ti"** mode only)*		**Commanded RAD**
9	Commanded rate of turn for heading changes (°/min) *(Used in **AutoNAV "Tn"** mode only during turns)*		**Commanded ROT**
10	Commanded heading to steer (degrees) *(Used in **AutoNAV "Tn"** mode during sailing on straight leg or turns to the new leg)*		**Commanded HTS**
11	Commanded off-track limit (n.m.) **TBD on meeting**		**Unused at the monet, can be used later for AutoNAV – "Ti" control mode as accepted limit for "Auto Precision"**
12	Commanded track (degrees) *(Used in **TRACK** or **AutoNAV – "Ti"** control modes)*		**Commanded Track**
13	Heading reference in use, T/M *(depends on the heading source of Master compass: true/magnetic)*		**T/M**
14	Rudder status	within limits	**A**
		limit reached or exceeded	**V**
15	Off-heading status	within limits	**A**
		limit reached or exceeded	**V**
16	Off-track status	within limits	**Unused**
		limit reached or exceeded	**Unused**
17	Vessel heading (degrees)		**Actual Heading value from the Master Compass of AP SYSTEM**

Table A.5 – Data sentence "HMS" sent by the AP System Talker identifier – AG AP System is operating as HMS system for other listeners		
Field	**Field label (and operational state)**	**Value sent from AP/JP in the data sentence**
1	Heading sensor 1, ID	**GYRO1, GYRO2, THD, MAGN**
2	Heading sensor 2, ID	**GYRO1, GYRO2, THD, MAGN**
3	Maximum differences, degrees	**"HDG Monitor" value**

Table A.6 – Data sentence "HMR" sent by the AP System Talker identifier - AG when AP System is operating as HMS system for other listeners			
Field	**Field label (and operational state)**		**Value sent from AP/JP in the data sentence**
1	Heading sensor 1, ID		**GYRO1, GYRO2, THD, MAGN**
2	Heading sensor 2, ID		**GYRO1, GYRO2, THD, MAGN**
3	Set differences by HMS, degrees		**"HDG Monitor" value set in AP SYSTEM**
4	Actual hedaing differences, degrees		**Calculated value**
5	Warning flag	Differences within set limit	**A**
		Differences exceeds set limit	**V**

5	Actual hedaing reading sensor 1, degrees		**Actual Heading value**
6	Status heading sensor 1	Data valid	**A**
		Data invalid	**V**
7	Sensor 1 type, T=True, M=Magnetic		**"T" = GYRO1, GYRO2, THD "M" = MAGN**
8+9	Deviation sensor 1, degrees E/W (for magnetic sensor only, otherwise or unknown – null field)		**Actual deviation value or empty field (only from incoming HDG sentences, ID = MAGN)**
10	Actual hedaing reading sensor 2, degrees		**Actual Heading value**
11	Status heading sensor 2	Data valid	**A**
		Data invalid	**V**
12	Sensor 2 type, T=True, M=Magnetic		**"T" = GYRO1, GYRO2, THD "M" = MAGN**
13+14	Deviation sensor 2, degrees E/W (for magnetic sensor only, otherwise or unknown – null field)		**Actual deviation value or empty field (only from incoming HDG sentences, ID = MAGN)**
15+16	Variation degrees E/W (for magnetic sensor only, otherwise or unknown – null field)		**Actual variation value or empty field (only from incoming HDG sentences, ID = MAGN)**

Table A.7 – Data sentence "ALR" sent by the AP SYSTEM Talker identifier – AG Transmission rate: by System Startup - all alarms and their statuses and by event		
Field	**Field label (and operational state)**	**Value sent from AP in the data sentence**
1	Time of alarm condition, UTC	**Empty**
2	Alarm number (ID) at alarm source	**See ALR ID's in the "Installation Guide" document (Alarm List)**
3	Alarm condition A = threshold exceeded V = threshold not exceeded	**V / A**
4	Alarm acknowledge state A = acknowledged V = unacknowledged	**V / A**
5	Alarm's description text	**Empty, see Field 2 above**

Table A.8 – Data sentence "ALA" sent by the AP SYSTEM Talker identifier – AG Transmission rate: by System Startup - all alarms and their statuses and by event		
Field	**Field label (and operational state)**	**Value sent from AP in the data sentence**
1	Event time	**Empty**
2	System indicator of original alarm source (**OT** always, Other's system)	**OT**
3	Sub system equipment indicator of original alarm source (**JP** always, -	**JP**

	Joystick & Autopilot system)	
4	Instance number of equipment/unit/item (**01** – Autopilot unit / alarm, **02** – Joystick unit / alarm **00** – AP system is in **STBY** mode, **03** – Alarm happened during AP operation in the **Installation menu / tuning procedure**)	**00 / 01 / 02 / 03**
5	Type of Alarm (**ID 000 – 999**)	**See ALR ID's in the "Installation Guide" (Alarm List)**
6	Alarm condition N = normal state H = alarm state (threshold exceeded) J = alarm state (extreme threshold exceeded, - **Unused**) L = alarm state (low threshold exceeded, i.e not reached - **Unused**) K = alarm state (extreme low threshold exceeded, i.e not reached - **Unused**) X = Other (**Unused**)	**N / H**
7	Alarm acknowledge state A = acknowledged V = not acknowledged B = Broadcast (acknowledgement not applicable) H=harbor mode (**Unused**) O=Override (**Unused**)	**A / V**
8	Alarm's description text	**Empty, see Field 5 above**

Table A.9 – Data sentence "HDT" re-transmitted by the AP SYSTEM **Talker identifier - HE / HC / HF, depends on connected Master compass**		
Field	**Field label (and operational state)**	**Value sent from AP in the data sentence**

1	True Heading (degrees)	**Actual value**
2	Status	**T**

AP SYSTEM: Input NMEA messages, processed by the Control Unit CU-M

Table A.10 – Data sentence "HDT" received by the AP SYSTEM from GYRO1 / GYRO2 / THD		
Field	**Field label**	**Value sent to AP in the data sentence**
1+2	Heading (degrees), True	**Actual value**

Table A.11 – Data sentence "THS" received by the AP SYSTEM from TRUE HEADING DEVICE or GYRO1 / GYRO2		
Field	**Field label**	**Value sent to AP in the data sentence**
1	True heading, (degrees)	**Actual value**
2	Mode Indicator (A, E, M, S, V). Status "**A**" – valid heading. Other statuses: Data is not acceptable.	**A (Valid status)**

Table A.12 – Data sentence "HDG" received by the AP SYSTEM from the NMEA MAGNETIC COMPASS		
Field	**Field label**	**Value sent to AP in the data sentence**
1	Magnetic sensor heading, (degrees)	**Actual value**

2	Magnetic deviation E/W, (degrees)	**Actual value**
3	Magnetic variation E/W, (degrees)	**Actual value**

NOTE: AP SYSTEM uses both - variation and deviation from incoming "HDG" sentences when NMEA sensor MAGN in use!

Table A.13 – Data sentence HDM received by the AP SYSTEM from MAGNETIC COMPASS (Not recommended)		
Field	**Field label**	**Value sent to AP in the data sentence**
1	Magnetic sensor headaing, (degrees)	**Actual value**
2	Mode Indicator	**M**

Table A.14 – Data sentence "VHW" received by the AP SYSTEM from the Water referenced LOG sensor		
Field	**Field label**	**Value sent to AP in the data sentence**
1+2	Direction (degrees), T(rue)	**Unused**
3+4	Direction (degrees), M(Magnetic)	**Unused**
5+6	Speed, N (knots)	**Actual value**
7+8	Speed, K (km/m)	**Unused**

Table A.15 – Data sentence "VBW" received by the AP SYSTEM from BTLOG (Bottom tracking Log)		
Field	**Field label**	**Value sent to AP in the data sentence**
1	Longitudual water speed (knots)	**Actual value**

2	Transverse water speed (knots)		**Unused**
3	Water speed status	Valid	**A**
		Invalid	**V**
4	Longitudual ground speed (knots)		**Unused**
5	Transverse ground speed (knots)		**Unused**
6	Ground speed status	Valid	**Unused**
		Invalid	**Unused**
7	Stern transverse water speed (knots)		**Unused**
8	Stern water speed status	Valid	**Unused**
		Invalid	**Unused**
9	Stern transverse ground speed (knots)		**Unused**
10	Stern ground speed status	Valid	**Unused**
		Invalid	**Unused**

Table A.16 – Data sentence "ROT" received by the AP SYSTEM from GYRO, THD or IMO Rate-Of-Turn sensor

Field	Field label	Value sent to AP/JP in the data sentence
1	Rate of turn, (degrees per minute) "+" or without "+" symbol – to Stbd direction. "-" symbol – Bow turns to Port direction.	**Actual value**
2	Status (A=data valid, V=data invalid)	**A (valid)**

Table A.17 – Data sentence "VTG" received by the AP SYSTEM from GPS or ECDIS

Field	Field label	Value sent to AP in the data sentence

1+2	Course over ground (degrees), **T** (True)		**Actual COG**
3+4	Course over ground (degrees), **M** (Magnetic)		**Unused**
6+7	Speed over ground, **N** (knots)		**Actual SOG**
8+9	Speed over ground, **K** (km/h)		**Unused**
10	Mode indicator	Autonomous mode *(Data valid)*	**A**
		Differential mode *(Data valid)*	**D**
		Precise mode *(Data valid)*	**P**
		Estimated mode *(Data not valid)*	**E**
		Manual input mode *(Data not valid)*	**M**
		Simulator mode *(Data not valid)*	**S**
		Data not valid *(Data not valid)*	**N**

Table A.18 – Data sentence "GGA" received by the AP SYSTEM from GPS or ECDIS

Field	Field label	Value sent to AP in the data sentence
1	UTC of position	**(Unused)**
2+3	LAT, N/S	**Latitude, Pivot point**
4+5	LON, E/W	**Longitude, Pivot point**
6	Mode indicator	**0 (Not Valid)**
		1 (Valid, GPS SPS mode)
		2 (Valid, DGPS SPS mode)
		3 (Valid, GPS PPS mode)

		4 (Valid, Real RTK mode)
		5 (Valid, Float RTK mode)
		6 (Estimated DR - Not Valid)
		7 (Manual input - Not Valid)
		8 (Simulator - Not Valid)
7	Number of satellites in use	**(Unused)**
8	Horizontal delution of precision	**(Unused)**
9+10	Antenna altitude above/below mean sea level, M(metres)	**(Unused)**
11+12	Geoidal separation, M	**(Unused)**
13	Age of differential GPS data (sec)	**(Unused)**
14	Differential reference station ID	**(Unused)**

Table A.19 – Data sentence "GLL" received by the AP SYSTEM from GPS or ECDIS

Field	Field label	Value sent to AP in the data sentence
1+2	LAT, N/S	**Latitude, Pivot point**
3+4	LON, E/W	**Longitude, Pivot point**
5	UTC of position	**(Unused)**
6	Status field	**A=data valid** **V=data invalid**
7	Mode indicator	**"A" - Autonomous (Valid)**
		"D" - Differentional (Valid)
		"E" - Estimated (Not Valid)
		"M" - Manual (Not Valid)
		"S" - Simulator (Not Valid)
		"N" - (Data Not Valid)

TRACK CONTROL NMEA SENTENCES

Table A.20 – Data sentence "HTC" received by the AP SYSTEM from an external ECDIS/INS/GPS (i.e track controller Category C)			
Field	**Field label**		**Value sent to AP in the data sentence**
1	Override status	In use (**TCS stopped!**)	**A**
		Not in use	**V**
2+3	Commanded rudder angle (degrees), L/R (port/stbd)		**(Unused)**
4	Selected steering mode	Manual	**M**
		Stand-alone	**S**
		Heading control *(valid for **AutoNAV "Tn"** mode!)*	**H (Remote HDG Control)**
		Track control *(valid for **AutoNAV "Ti"** track control mode!)*	**T (Track Control)**
		Rudder control	**R**
5	Turn mode	Radius controlled *(valid for the new phylosofy in **AutoNAV "Ti"** track control mode!)*	**R**
		Turn rate controlled *(valid for the **AutoNAV "Tn"** track control mode during turns!)*	**T**
		Turn is not controlled *(valid for the **"Tn"** track control mode during sailing on straight legs!)*	**N**
6	Commanded rudder limit (degrees)		**(Unused)**
7	Commanded off-heading limit (degrees)		**(Unused)**

8	Commanded radius of turn for heading changes (n.m.) *(valid for the new **AutoNAV "Ti"** track control mode during turns!!!)*	**Actual commanded RADIUS**
9	Commanded rate of turn for heading changes (°/min) *(valid for the **AutoNAV "Tn"** track control mode during turns)*	**Actual commanded ROT**
10	Commanded heading to steer (degrees) *(valid for the **AutoNAV "Tn"** track control mode during sailing on straight legs and turns as new **HTS = New Route Leg**!!!)*	**Actual commanded HTS**
11	Commanded off-track limit (n.m.) **CAN BE USED LATER for "Auto Precision" value during AutoNAV – "Ti" control mode**	**Unused at the moment**
12	Commanded track (degrees) *(valid for the **AutoNAV "Tn "**and **"Ti"** track control modes!)*	**Actual COURSE = Active Route Leg**
13	Heading reference in use, T/M (true/magnetic)	**(Unused)**
14	Sentence status flag	**Empty or "C" – Commanded sentence** **"R" – status report, ignored by AP000**

Table A.21 – Data sentence XTE received by the AP SYSTEM from TCS ECDIS

Field	Field label	Value sent to AP in the data sentence
1	EPFS Status of ECDIS: **A** if valid, **V** if invalid	**A or V**
2	Loran-C Status: Always - **A**	**A**

3	Magnitude of XTD value **Empty field if route is not loaded into monitoring or Latest WP is passed**	**Actual value according to straight legs and radiuses during the turn** Used for visulalization on Control Panel always during TCS **AutoNAV – "Ti"** control mode!
4	Direction to steer, L/R **L** – means steer to Port to decrease XTD **R** – means steer to Stbd to decrease XTD	**L or R**
5	Units. Always Nautical Miles - **N**	**N**
6	Mode indicator of EPFS, may be **A, D, E, M, S, N** Field 1) above should be **V** in case of **E**, **M**, **S** or **N** mode indicator	**Actual value**

Table A.22 – Data sentence $PNEY,001 received by the AP SYSTEM from TCS ECDIS

Field	Field label	Value sent to AP in the data sentence
1	ID of the proprietary sentences **$PNEY**	**001**
2	EPFS Status of ECDIS: **A** if valid, **V** if invalid	**A or V**
3	Loran-C Status: Always - **A**	**A**
4	Magnitude of XTD value **Empty field if route is not loaded into monitoring or Latest WP is passed**	**Actual value on straight leg and according to the new leg during the turn on Radius curve** Used for mathematic algorithms of AP SYSTEM during TCS **AutoNAV – "Ti"** control mode!

5	Direction to steer, L/R **L** – means steer to Port to decrease XTD **R** – means steer to Stbd to decrease XTD	**L or R**
6	Units. Always Nautical Miles - **N**	**N**
7	Mode indicator of EPFS, may be **A, D, E, M, S, N** Field 1) above should be **V** in case of **E**, **M**, **S** or **N** mode indicator	**Actual value**

Table A.23 – Data sentence $PNEY,002 received by the AP SYSTEM from TCS ECDIS

Field	Field label	Value sent to AP in the data sentence
1	ID of the proprietary sentences **$PNEY**	**002**
2+3	WP: Centre of radius point, **Latitude**, (degrees and minutes) + N/S **Empty field on the straight leg steering**	**Actual value or empty field**
4+5	WP: Centre of radius point, **Longitude**, (degrees and minutes) + E/W **Empty field on the straight leg steering**	**Actual value or empty field**
6	WP identifier (Number 000-999) **Empty field if route is not loaded into monitoring or Latest WP is passed**	**Actual value or empty field. NOTE: Only 3 first digits or letters are displayed on Control panel during "Ti" track control mode!**

Appendix B. Navis AP SYSTEM. Operation in “AutoNAV” control mode (TCS Category C).

2.2 ”AutoNAV” – Track Control mode (TCS Cat. C)

This functionality is not compliant to the SOLAS convention before approved as part of a Track Control System, Category C. Otherwise, “AutoNAV” mode can be only used on non-SOLAS ships and leisure crafts.

2.2.1 Switchover to «AutoNAV»

This mode is available if “**ExtTCS**” parameter is selected in “**DOCKTRIAL**” installation menu by the service engineer. Switchover to **“AutoNAV”** mode is only possible from autopilot control mode by command from **AP** control panel. In order to switch over to **AutoNAV** mode, press **«MODE»** button until “**AUTONAV**” indicator is displayed in the **«SET MODE»** field. Press **«SET»** to confirm. AP SYSTEM switches over to “**AutoNAV**” mode and **«MODE»** field shows active mode symbol «**Ti**». If no confirmation is received within 20 seconds, AP SYSTEM exits mode selection state.

Confirmation could be done by ECDIS as activation of the Remote Heading Contrl mode (“**Tn**”) or Track Control Category C (“**Ti**”).

2.2.2 Operation in «AutoNAV» mode

Commanded Heading-To-Steer and Rate-Of-Turn (**HTC, HSC, XTE** and proprietary messages **$PNEY,001** and **$PNEY,002**) set by an external TCS Category C. The validity (age), format and check sum of **HTC / HSC / XTE / PNEY**” messages are monitored in this mode. In case if these messages are missing, the “**TRACK FAIL**” alarm is generated and “**SWITCH TO AUTO**” prompt message appears on the control panel display. In that case:

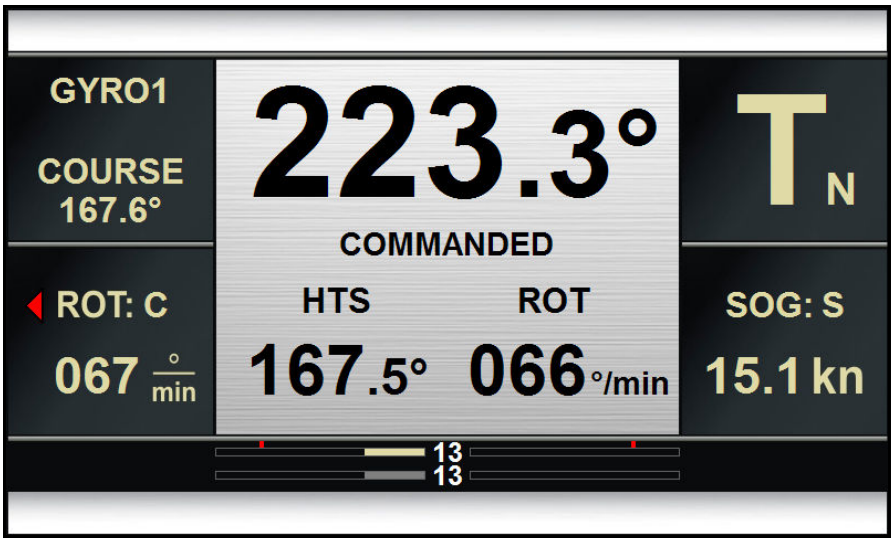
In this case:

- If sailing was on a curved path, the turn is completed with the latest commanded rate of turn and the track course of the next straight leg is taken over as present heading for heading control;

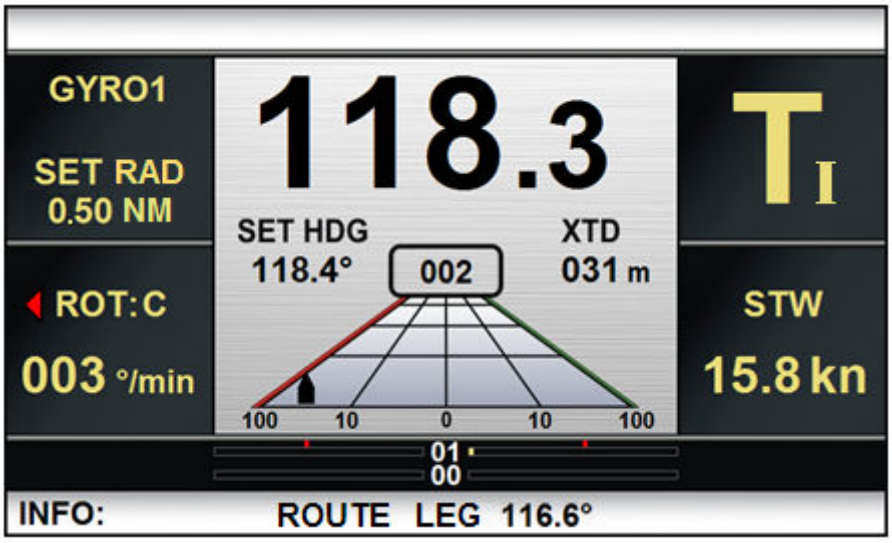
- If sailing on a straight leg, the actual heading is taken over as the preset heading for the heading control.

"Rudder Limit", "SET ROT" and "SET RAD" parameters are not used during operation in "AutoNAV" track control mode! AP SYSTEM uses Commanded Heading-To-Steer, Commanded Rate-Of-Turn or Commanded Radius from an external TCS system in "AutoNAV" track control mode – "Tn" or "Ti"

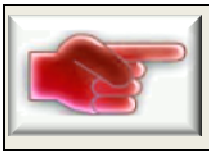
"CHANGE SPEED SOURCE" alarm may be triggered ON when the Manual Speed was set before the activation of the "AutoNAV" mode. Switch back into STANDBY mode and re-select a Speed source to "LOG" or "SOG" in the "Set devices" operational menu before the next activation of the "AutoNAV" control mode.



"AutoNAV" control mode – Remote HDG Control "Tn"



“AutoNAV” control mode – TCS Category C ”Ti”



Some AP SYSTEM configurations operate with independent rudders. Both scales: Port side “Set” and “Feedback” rudder scales, Starboard side “Set” and “Feedback” rudder scales - are shown on the display in that case.

Valid D-GPS position and speed are required for operation in “AutoNAV” control mode (especially for “Ti”).