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## **SNI - API SYNCHRO – NMEA Interface board**



The SNI - API electronic card is a Synchro signals acquisition unit, data processing and transmission on serial line. The primary application is in marine environment (on board installation) in interfacing devices and sensors with output in synchro signals, single and dual-speed (1x/2x + 36x), data conversion and digital distribution with transmission protocol MNEA 0183 (IEC 61162-1), electrical format opto-isolated RS422 or RS232.

The purpose of these units is interfacing modern systems, which communicate with digital data (typically NMEA 0183), and old systems (indicators, stabilisers, sensors, weapon systems, radar, navigation, tracking, etc) which accept and transmit data in Synchro format (angles: azimuth, tilt, roll, pitch, rudder, single or double speed (Coarse + Fine), or linear data such as log speed: 30 or 40 or 120 knots / rev).

These units are typically used in replacement and modernisation retrofit.

Various types of transmission configurations and MNEA messages are selectable on the board.

A second use is as diagnostic tool or as an API (Angle Position Indicator) instrument to measure synchro signals, usable on field or in laboratory.

## Conversion modules

The Synchro to Digital conversion is performed by SD Converter modules installed on the card.

The modules have Industry Standard mechanical format and pinout and TTL angular data in positive natural binary coding.

The modules are available from various manufacturers with different characteristics to suit the synchro signal (frequency, voltage, tracking rate, resolution and accuracy).

Typically they are distinguished in 90VII or 11,8VII (references 115V or 26V), 60 or 400Hz, 10 or 12 or 14 bits.

The conversion modules are tracking type and then, if not inhibited, always updated.

Reading data on the card is accomplished with circuitry that doesn't suspend the run in order to read the data stable so the converter is always joined to allow maximum performance dynamics.

The conversion modules can also be Resolver type.

The board can accommodate 1 or 2 conversion modules.

The synchro signals are connected to the two modules separately and then the modules can be totally different (in frequency, voltage).

The card detects the presence of the S and R signals and valid data reading from the module only when all signals are present. (The converter module has a valid TTL output even in case of total or partial fault of synchro signals).

The detection circuitry is suited to any type of signal (amplitude and frequency).

The card automatically detects the number of valid bit (10, 12, 14, 16).

## Accuracy

The accuracy of the acquired data depends on the converter modules adopted

# bit	resolution (°)	accuracy 1x (°)	accuracy 2x (°)	accuracy 36x (°)
10	0,352	0,50	0,250	0,014
12	0,088	0,142	0,071	0,004
14	0,022	0,086	0,043	0,002

The 16-bit converters are very unusual and difficult to find.

## 1SD and 2SD modes

The board can accommodate 1 or 2 conversion modules and by a jumper JP6 can be set in 1-SD (pin 4-6 ON) or 2-SD (pin 4-6 OFF) operating mode.

1-SD mode considers only the signals of the synchro channel 1 and related data are transmitted in NMEA message. If a message with two data is selected the second field is null and void.

2-SD mode considers both the two channels for the transmission of messages with 2 data or for the formation of a unique data deriving from the slow / fast correction of the double speed synchro transmission.

## Display

On the card a one digit bright display is present that shows scrolling writings with operational and diagnostics functions. Display timing is about 2Hz with a duty cycle of 2/3 ON and 1/3 OFF so the visualisation seem to be a flashing that helps to distinguish the letters.

In order to well interpret the notice synchronise attention to the visualisation of the initials dashes of writing that appear as 4 flashes of the middle line, then in sequence take the following letters shown to compose the notice.

Because of the 7-segment limitations graphic some letters are formed with configurations of not immediate interpretation. The following are the letters that don't have a direct visual match, and that must be known to be interpreted.



The display shows:

- The NMEA message type and conformation (see tables).
- The message transmission frequency and baud rate (see table).
- The notice "- - fault 1" (channel 1), "- - fault 2" (channel 2), "- - fault 1 2" (both channels) in case of failure due to synchro signals lack.
- The notice "- - 2 sd" in 2-SD mode.

**Data Transmission Standard MNEA 0183 (IEC 61162-1)**

Opto-isolated RS422 serial line - connector JX4 - RS232C serial line - connector JX6 (if any)  
 baud rate 4800 or 38400, 8bit /data, no parity, 1 bit stop. Frequency 1, 5, 10, 30 Hz (only 38400 baud)

- 1) Heading            \$--HDT,x.x,T\*hh<CR><LF>            Heading, Degrees True
- 2) Roll                \$--XDR,A,xx.xx,D,R\*hh<CR><LF>  
                          \$--XDR,A,-xx.xx,D,R,\*hh<CR><LF>    negative values (counterclockwise)  
                          A: Angular displacement, D: Degree, R: Roll
- 3) Pitch              \$--XDR,A,xx.xx,D,P\*hh<CR><LF>  
                          \$--XDR,A,-xx.xx,D,P\*hh<CR><LF>    negative values (counterclockwise)  
                          A: Angular displacement, D: Degree, P: Pitch
- 4) Roll, Pitch        \$--XDR,A,xx.xx,D,R,A,xx.xx,D,P\*hh<CR><LF>  
                          \$--XDR,A,-xx.xx,D,R,A,-xx.xx,D,P\*hh<CR><LF>    negative values (counterclockwise)  
                          A: Angular displacement, D: Degree, R: Roll, P: Pitch
- 5) Speed             \$ - VBW, xx.x, 0, Z, yy.y, 0, Z, 0, V-0, V \* hh <CR> <LF>    knots  
                          Only longitudinal, only positive values  
                          xx.x = water referenced speed / yy.y = ground referenced speed  
                          Z = A: valid data, Z = V: NOT given valid data

Data from single-speed conversion is transmitted in NMEA message with 2 decimals.  
 Data from double-speed conversion is transmitted in NMEA message with 3 decimals.  
 Roll and pitch data are transmitted in central zero format, unsigned if positive, with a "minus" sign if negative.

**Operating modes selection**

By dip-switch different NMEA messages and Synchro configuration and transmission parameters can be selected.

SELECTABLE OPERATING MODES - Card with 1 conversion module.

N.	Dip – switch 1				NMEA message	Converted data	Display notice
	1	2	3	4			
1	off	off	off	off	VBW	Speed - Water-referenced - 25 Knots/revolution	---- v b w _ 2 5
2	on	off	off	off	VBW	Speed - Water-referenced - 30 Knots/revolution	---- v b w _ 3 0
3	off	on	off	off	VBW	Speed - Water-referenced - 40 Knots/revolution	---- v b w _ 4 0
4	on	on	off	off	VBW	Speed - Water-referenced - 120 Knots/revolution	---- v b w _ 1 2 0
5	off	off	on	off	HDT	Heading 1x	---- h d t
6	on	off	on	off	XDR	Roll 1x	---- x d r _ r _ 1.
7	off	on	on	off	XDR	Roll 2x	---- x d r _ r _ 2.
8	on	on	on	off	XDR	Pitch 1x	---- x d r _ p _ 1.
9	off	off	off	on	XDR	Pitch 2x	---- x d r _ p _ 2.
10	on	off	off	on	XDR	Roll 1x - Pitch 1x	---- x d r _ 1. 1.
11	off	on	off	on	XDR	Roll 2x - Pitch 2x	---- x d r _ 2. 2.

Modes 10 and 11 are not to be used as equivalent to 6 and 7, but transmit the "pitch" field empty.  
 The message VBW transmits the ground referenced speed data as 0 and marked with status V = data NOT valid.  
 If there is no synchro signal the display shows the message "- - 1 fault" and the NMEA sentence is still transmitted with missing data field empty (no characters between the two field separating comma), for messages HDT and XDR, and the missing data as 0 with status flag V = data NOT valid, for VBW messages.

SELECTABLE OPERATING MODES - Card with 2 conversion modules.

N.	Dip – switch 1				NMEA message	Converted data	Synchro signals		Display notice
	1	2	3	4			Channel 1	Channel 2	
1	off	off	off	off	VBW	Speed – 25 Knots/revolution	Water-referenced	Ground-referenced	---- 2 s d -- v b w _ 2 5
2	on	off	off	off	VBW	Speed – 30 Knots/revolution	Water-referenced	Ground-referenced	---- 2 s d -- v b w _ 3 0
3	off	on	off	off	VBW	Speed – 40 Knots/revolution	Water-referenced	Ground-referenced	---- 2 s d -- v b w _ 4 0
4	on	on	off	off	VBW	Speed – 120 Knots/revolution	Water-referenced	Ground-referenced	---- 2 s d -- v b w _ 1 2 0
5	off	off	on	off	HDT	Heading 1x	1x	36x	---- 2 s d -- h d t
6	on	off	on	off	XDR	Roll 1x	1x	36x	---- 2 s d -- x d r _ r _ 1.
7	off	on	on	off	XDR	Roll 2x	2x	36x	---- 2 s d -- x d r _ r _ 2.
8	on	on	on	off	XDR	Pitch 1x	1x	36x	---- 2 s d -- x d r _ p _ 1.
9	off	off	off	on	XDR	Pitch 2x	2x	36x	---- 2 s d -- x d r _ p _ 2.
10	on	off	off	on	XDR	Roll 1x - Pitch 1x	1x	1x	---- 2 s d -- x d r _ 1. 1.
11	off	on	off	on	XDR	Roll 2x - Pitch 2x	2x	2x	---- 2 s d -- x d r _ 2. 2.

In case of lack of synchro signals:

- The display depicts the notice "-- fault 1" (channel 1), OR "-- fault 2" (channel 2), Or "-- fault 1 2" (both channels).
- NMEA messages with two data are transmitted with the missing data field empty (no characters between the two field separator commas) for XDR sentences, and the missing data equal to 0, with status flag at V = " NOT valid data", for VBW sentences.
- NMEA messages with data resulting from the slow / fast correction in double speed synchro format, if the fast data is missing, the slow data is transmitted, that, although not precise, is complete; if the slow data is missing, since there is no reference data for correction, the null field (no characters between the two field separator commas) is sent.

Also with all data lack the NMEA message is still sent with the missing data fields empty or with status NOT valid.

TRANSMISSION PARAMETERS SELECTION

Dip – switch 2				Baud Rate	Transmission frequency	Display notice
1	2	3	4			
off	off	off	off	4800	1 Hz	-- 1 h z -- 4 8 0 0
off	off	on	off	4800	5 Hz	-- 5 h z -- 4 8 0 0
off	off	off	on	4800	10 Hz	-- 1 0 h z -- 4 8 0 0
off	off	on	on	4800	10 Hz	-- 1 0 h z -- 4 8 0 0
off	on	off	off	38400	1 Hz	-- 1 h z -- 3 8 4 0 0
off	on	on	off	38400	5 Hz	-- 5 h z -- 3 8 4 0 0
off	on	off	on	38400	10 Hz	-- 1 0 h z -- 3 8 4 0 0
off	on	on	on	38400	30 Hz	-- 3 0 h z -- 3 8 4 0 0

A dip-switch configuration not shown in the tables selects the operating mode n. 1.

### Monitor visualisation: API (Angle Position Indicator) functionality

On the JX5 connector serial line, with electrical format RS232C, baud rate 38400, 8bit / data, no parity, 1 bit stop, the board continuously transmits the operation report described.

Data are in ASCII, VT100 mode, so they can be viewed with any terminal emulator program present on all PC. 1Hz data refresh frequency, mask refresh time 3 minutes.

The board, in conjunction with a PC or laptop, has the function of measuring and analysis instrument for verification and interpretation of data, to be used on board or in laboratory. There is the measurement and the control of the synchro signals, the display of the possible data obtainable from them, and the board operating modes.

#### Screenshot 2 channels

```
Synchro-Digital interface - SW P58-005-00.00

SDch1   bit 12   Signal ON   Ref.   ON   Angle 271.143
SDch2   bit 12   Signal ON   Ref.   ON   Angle 271.055

Converted Data Synchro format          ch1          ch2          overall data
Speed (Knots)  25 Knots/rev.   (W)  18.8      (G)  18.8
"             30 Knots/rev.   (W)  22.6      (G)  22.6
"             40 Knots/rev.   (W)  30.1      (G)  30.1
"             120 Knots/rev.  (W)  90.4      (G)  90.4
Angle (Degrees) Double speed +   (1x) 271.143 (36x) 007.529 *** 267.529
"             Double speed +- (1x) -088.857 (36x) -002.471 *** -092.471
"             Double speed +- (2x) -044.429 (36x) -002.471 * -042.471
"             TWO data +-   (1x) -088.857 (1x) -088.945
"             TWO data +-   (2x) -044.429 (2x) -044.473

NMEA selection VBW 30K/r.   TX frequency 1Hz   Baud Rate 38400
Transmitted data water referenced speed + ground referenced speed

- Message $--VBW,22.6,0,A,22.6,0,A,0,V,0,V*43<LF><CR>
```

#### Screenshot 1 channel

```
Synchro-Digital interface - SW P58-005-00.00

SDch1   bit 12   Signal ON   Ref.   ON   Angle 271.143

Converted Data Synchro format          ch1
Speed (Knots)  25 Knots/rev.   (W)  18.8
"             30 Knots/rev.   (W)  22.6
"             40 Knots/rev.   (W)  30.1
"             120 Knots/rev.  (W)  90.4
Angle (Degrees) Single speed +   (1x) 271.143
"             Single speed +- (1x) -088.857
"             Single speed +- (2x) -044.429

NMEA selection XDR Roll 1x   TX frequency 10Hz   Baud Rate 4800
Transmitted data Roll

- Message $--XDR,A,-88.86,D,R*14<LF><CR>
```

In case of missing signal the related data are not displayed (dashes).

ESC key resets the program and returns the entire screen.

The screen shows:

The SW version

For each module:

The number of bits detected: 10, 12, 14, 16.

The presence ON or the absence OFF of the signals S1, S2, S3.

The presence ON or the absence OFF of the references R1 - R2.

The angle detected on 360 ° range and displayed with three decimals.

The values obtainable from the read data in all the combinations selectable for NMEA messages.

The speed values related to knots / revolution gear ratio.

For dual-speed synchro formats the coarse data, the fine data and the overall data resulting from the slow / fast correction.

Data 1x / 36x are displayed both with positive indication (0-360) and with central zero ( $\pm$  0-180).

Data 2x / 36x are displayed with central zero indication.

Near the overall data resulting from the slow / fast correction 0 to 3 asterisks are displayed indicating the degrees of the difference between slow and fast angles (misalignment of the two channels).

The configuration selected on the board by the dip-switches.

NMEA Message Selection, transmission frequency, baud rate.

The data actually transmitted.

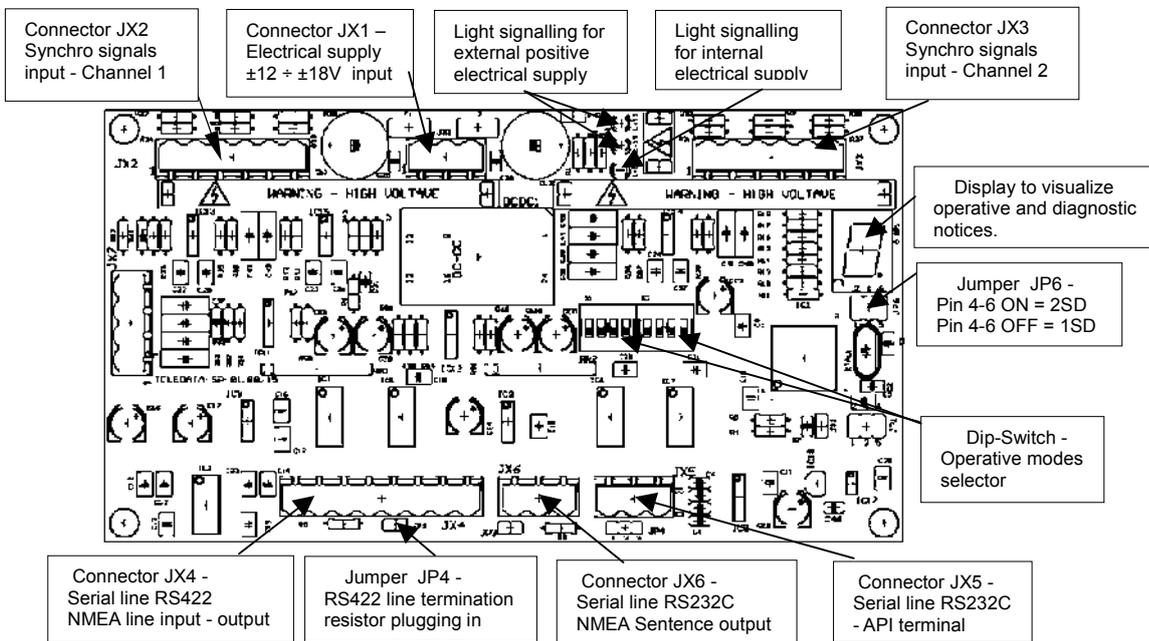
The NMEA message transmitted.

### Mechanical features

Board Size: 165x90mm, max components height: 20mm, max connectors height: 26mm (+ 4mm cabling).

Temperatures: Operating 0 ° C to + 50 ° C - Storage - 10 ° C to + 60 ° C.

5.08mm pitch terminal connectors.



### Safety instructions

On the board there are signals with voltage max. 115Vac on the converter modules pins which, being mounted on the back, can be accessed. To prevent direct contact specified guards are mounted.

Nevertheless extreme caution must be paid in handling the card connected to the voltage signals.

## References in common

The synchro signals for the two conversion modules are brought to the connectors JX2 (ch1) and JX3 (ch2). The signals are led to two independent conversion modules and therefore can be different, but normally they come from the same device, and then have the same references.  
To facilitate cabling, by jumpers PZ4 and PZ5, the references can be connected together, thus one cable RH-RL is sufficient to one connector.

## Voltages presence bright signalling

The card uses a dual voltage  $\pm 15\text{Vdc}$  (12 to 18) from which a 5Vdc voltage is derived.  
For every voltage there is a presence signal led.

## TERMINAL PINOUT

JX1 CONNECTOR: Electrical supply  $\pm 12\div 18\text{V}$ , 0,3Amax - 0,5A Resettable fuses  
1- +15Vdc  
2- -15Vdc  
3- 0V

JX2 CONNECTOR: Synchro channel 1 input  
JX3 CONNECTOR: Synchro channel 2 input  
1- S1  
2- S2  
3- S3  
4- S4  
5- R1 / RH  
6- R2 / RL

JX4 CONNECTOR: RS422 serial line (data users / NMEA messages)  
1- Output NMEA line True  
2- Output NMEA line Complement  
3- Serial line GND  
4- Input line Complement as an alternative to RS232C RX (JP4 jumper)  
5- Input line True as an alternative to RS232C RX (JP4 jumper)  
6- Serial line GND  
7- Connection to input line Complement (to connect the line to an additional user)  
8- Connection to input line True (to connect the line to an additional user)

Note: Near the connector a two pins header is present (JP5) which, when shunted, inserts on the RS422 input serial line a termination resistor. To be applied if the device is the unique or the last user in the line.

JX5 CONNECTOR: RS232C serial line 1 - terminal / API functionality  
JX6 CONNECTOR: RS232C serial line 2 (if any) - data users / NMEA messages  
1- TX  
2- RX as an alternative to RS422 RX (JP4 jumper)  
3- GND

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