GSG-7 & 8 Series

Advanced GNSS Simulator

This NMEA-Decoder technical note explains how to analyze and replay NMEA data in Skydel.

The NMEA file must contain specific messages to ensure SKYDEL simulation (see section 1.3 for more details)

To download the tool, go to the following link:

skydel-tools/Skydel-NMEA-Decode & PlayBack at main · learn-safran-navigation-timing/skydel-tools (github.com)

To request technical assistance, ask questions, or provide feedback on how to improve this tool, please contact us at simulationsupport@nav-timing.safrangroup.com.

Contents

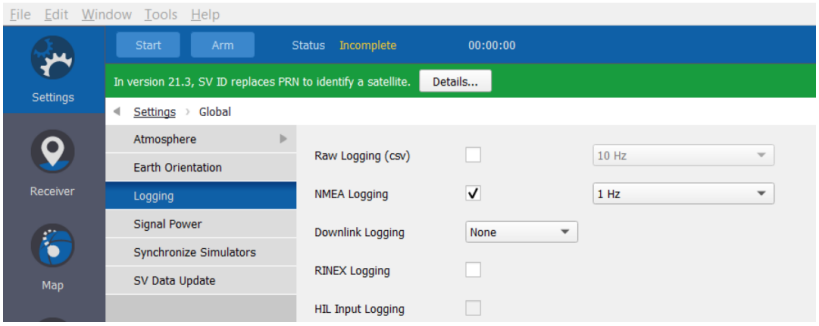
1. NMEA Parser tool

1.1. NMEA definition

The NMEA format is a standard file format maintained by the National Marine Electronics Association for storing GPS-related data. It contains information that can be exchanged between various electronic equipment. NMEA files include latitude, longitude, time values and other relevant data in ASCII format.

1.2. Skydel NMEA file logging

Skydel is optimized for *NMEA 0183 Version 4.1*. Go to ***Settings -> Global*** and enable *NMEA Logging*:



When this option is activated, Skydel will generate two files:

- *NMEA simulator*
- *NMEA receiver*

The *NMEA simulator* is similar to the output of a receiver but does not contain information regarding satellite C/N0.

When a receiver is connected, the *NMEA receiver* file contains data useful for testing or connecting Skydel to another device that accepts NMEA data.

N.B: Skydel uses GPS time in its NMEA output. Additionaly, the altitude in the GGA sentence is based on the ellipsoid model.

1.3. NMEA Decoder

The NMEA Decoder tool offers the ability to replay any NMEA trajectory and satellite information recorded by a GPS receiver in Skydel.

The script first parses the NMEA file and saves the data to CSV files. Then the generated data can be used to configure a Skydel scenario. The tool analyzes the following NMEA sentences: GGA, RMC, GSV et GSA. The RMC and/or GGA decoded sentences are recorded in a trajectory file. GSV data is used to parametrize the satellite CN0 in Skydel.

2. Starting the NMEA Decoder

2.1. Python installation:

This tool uses the pynmea2 library to parse NMEA sentences.

Make sure python is installed (from version 3.8) or download the latest python from *https://www.python.org/downloads/*.

1. Open a terminal and check the python version:

   $ python –version

2. Save the NMEA Decoder folder and open this folder in the terminal.

Add the Skydel-sdx directory in the same folder to have access to the Skydel API library.

3. Packages installation:

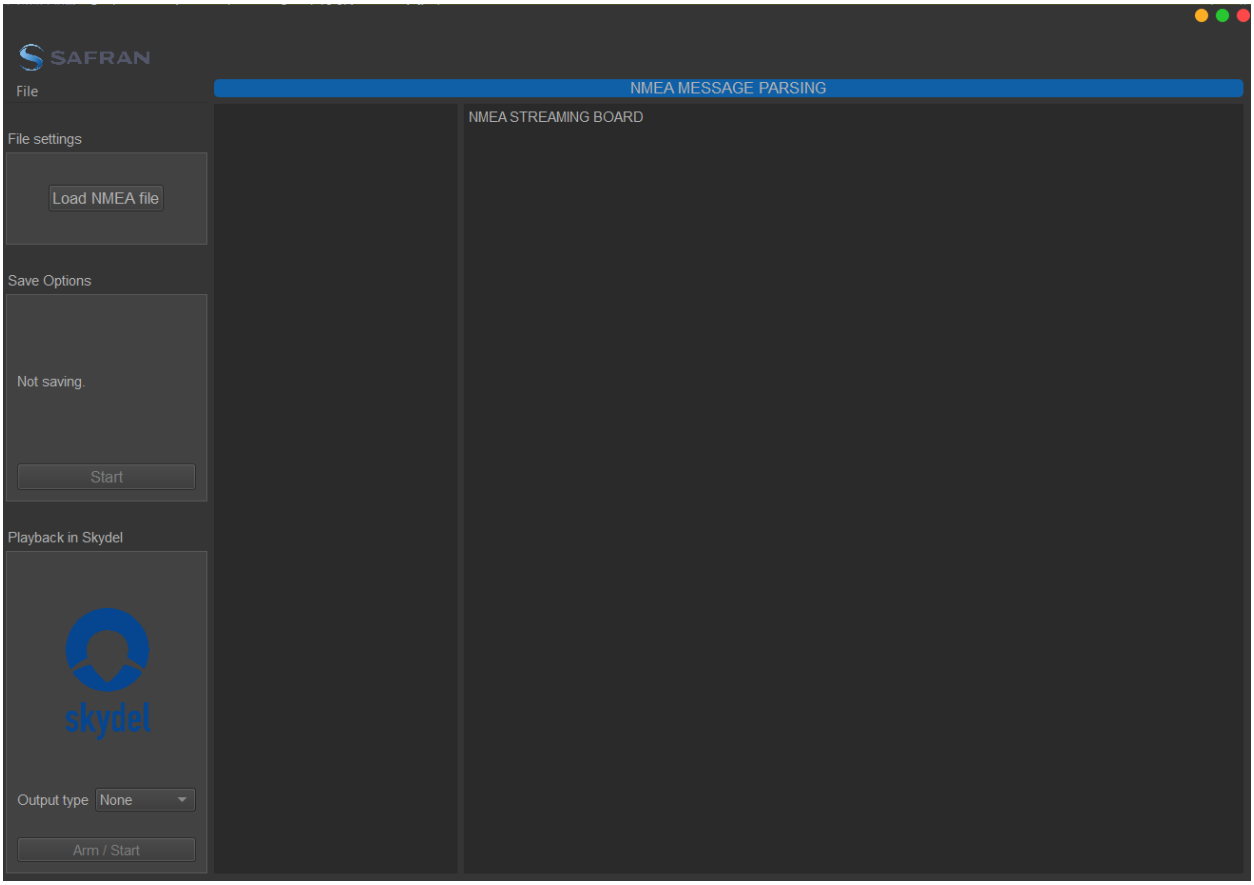
   $ pip install -r requirements.txt.

4. Run Antenna Convertor script:

   $ python main.py

2.2. Main window

After running the main script, the welcome screen will appear as described below:



The NMEA Decoder tool contains 5 areas:

File Settings:

The ***File Settings*** section allows you to load new NMEA files to be parsed.

Save options:

The ***Save options*** section contains the button to store decoded NMEA data into CSV files.

Decoder in Skydel:

Clicking on *Arm/Start* will automatically start the process to replay the trajectory and satellite information (if available) in Skydel.

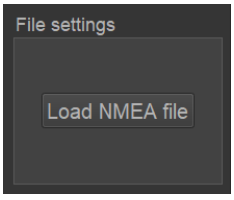
Display:

The display menu shows valuable information about the tool's progress when a simulation is running.

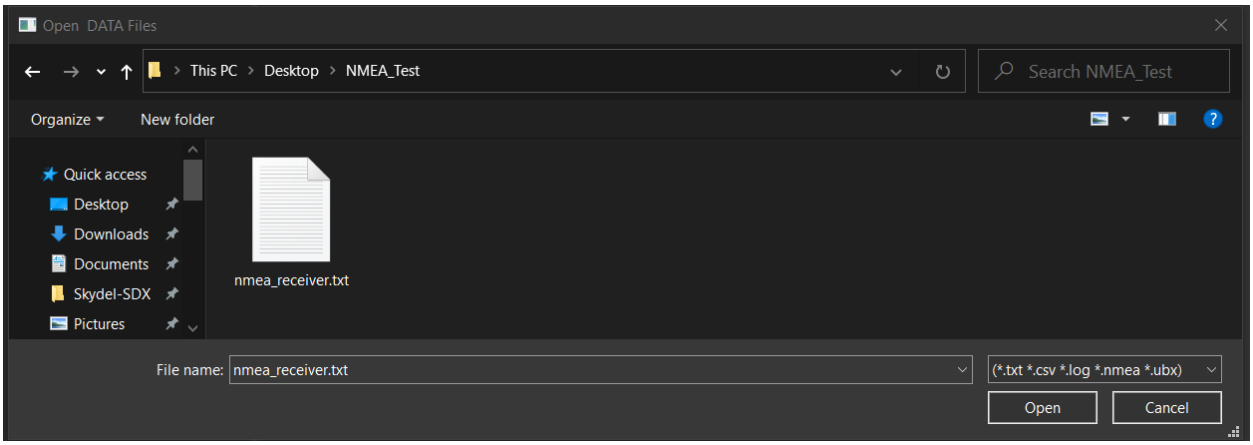
2.3. Run an example

2.3.1. File input

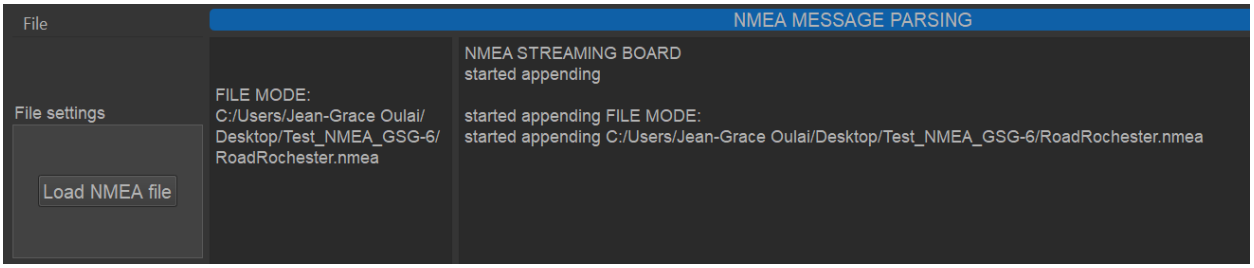
To decode a new NMEA file, go to File section and click *Load NMEA file*:



In the open dialog file, select the NMEA file analyze and click *Open*.



The following information will be displayed in the NMEA Message section:



2.2.2. Save CSV

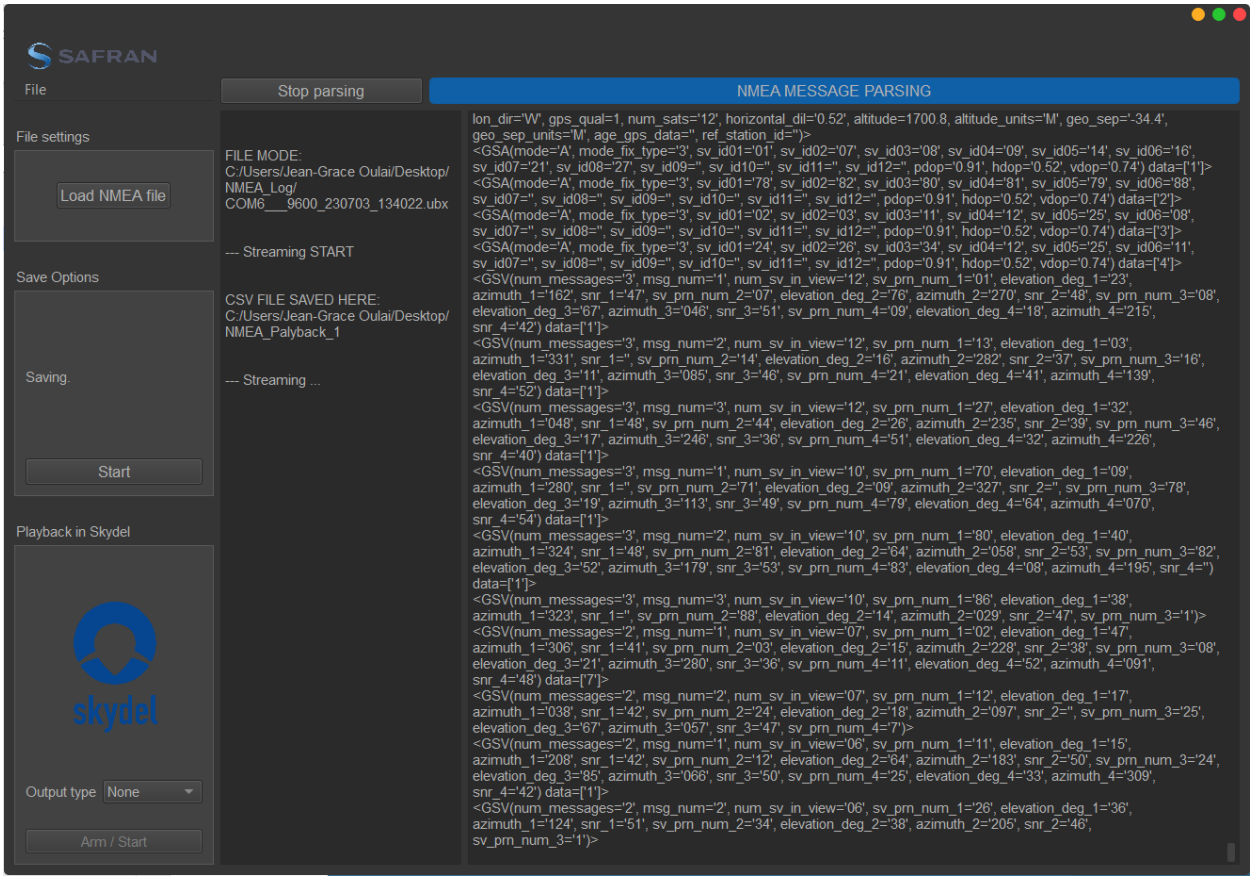
This section allows the user to start and save the NMEA data in csv files:

The *Start* button will be accessible only when a NMEA file has been loaded.

Clicking *Start* will open a dialog box that will allow the user to choose where to store the decoded data.

Click *Select folder* to continue.

You will then see the NMEA streaming details appear in the display section:

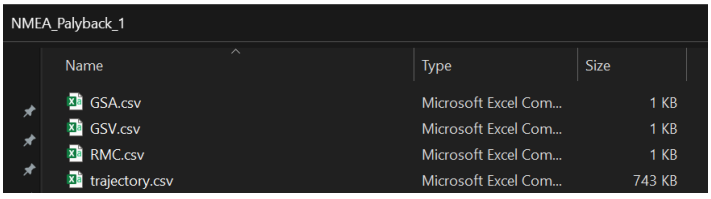


Interrupt the parsing process at any time by clicking "*Stop parsing*".

The tool will read the entire NMEA file line by line if there is no interruption.

At the end of the parsing process, the "*Streaming END*" notification will appear on the NMEA display section.

The NMEA log data will then be available on the selected folder as described below:



a. GSA: GNSS DOP and active satellites

The GSA file will provide information on the mode of operation of the GPS receiver, the satellites used for position fix reported by the GGA or GNS sentence and DOP:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	Mode	sv_id_1	sv_id_2	sv_id_3	sv_id_4	sv_id_5	sv_id_6	sv_id_7	sv_id_8	sv_id_9	sv_id_10	sv_id_11	sv_id_12	Mode fix type	PDOP (Dilution of precisio	HDOP (Ho	VDOP (Vertical DOP)
2	Automatic	14	7	8	9	27	16	1	21	30				3D fix	0.9	0.5	0.7
3	Automatic	79	78	88	82	81	80							3D fix	0.9	0.5	0.7
4	Automatic	24	11	2	3	25	12	8	36					3D fix	0.9	0.5	0.7
5	Automatic	24	26	35	41	42	43	44						3D fix	0.9	0.5	0.7
6	Automatic	14	7	8	9	27	16	1	21	30				3D fix	0.9	0.5	0.7
7	Automatic	79	78	88	82	81	80							3D fix	0.9	0.5	0.7
8	Automatic	24	11	2	3	25	12	8	36					3D fix	0.9	0.5	0.7

GSA sentence definition:

Field	Meaning
0	Message ID (header)
1	Selection mode: M = Manual A = Automatic
2	Mode: 1 = not available 2 = 2D 3 = 3D
3	PRN number (of satellites used for fix): 1 to 32 GPS 33 to 64 SBAS 64+ Glonass
4	Position dilution of precision: 0.00 to 99.9
5	Horizontal dilution of precision: 0.00 to 99.9
6	Vertical dilution of precision: 0.00 to 99.9
7	Checksum

If NMEA standard is If NMEA-0183 version 4.10 is the 7th and 8th fields become:

Field	Meaning
7 Constellation ID: **GPS** **GLONASS** **Galileo** **Beidou**	 1 2 3 4

QZSS	5
Checksum	

b. GSV: Satellite in view

The GSV file contains the number of GNSS SVs in view, PRN numbers, elevation, azimuth and SNR value:

	Elapsed tii	GNSS ID	Number o	Message I	Total num	sv_prn_nu	elevation_	azimuth_1	snr_1	sv_prn_nu	elevation_	azimuth_2	snr_2	sv_prn_nu	elevation_	azimuth_3	snr_3	sv_prn_nu	elevation_	azimuth_4	snr_4
2	0	GPS	3	1	9	7	76	272	52	1	22	162	45	9	18	216	44	16	12	84	43
3	0	GPS	3	2	9	14	16	282	45	27	33	48	48	21	41	139	48	30	39	309	50
4	0	GPS	3	3	9	8	68	46	52												
5	0	GLONASS	2	1	6	17	64	60	54	16	39	323	52	24	15	29	47	14	19	112	47
6	0	GLONASS	2	2	6	18	51	179	52	15	64	68	54								
7	0	BeiDou	2	1	8	25	68	56	48	36	36	166	44	24	19	97	41	12	18	39	42
8	0	BeiDou	2	2	8	8	21	280	43	3	16	228	41	2	47	306	47	11	52	92	46
9	0	BeiDou	2	1	7	24	85	59	51	43	14	125	42	35	27	46	46	26	37	123	47
10	0	BeiDou	2	2	7	41	56	312	51	44	61	120	50	42	81	328	51				
11	1000	GPS	3	1	9	7	76	272	52	1	22	162	45	9	18	216	44	16	12	84	43
12	1000	GPS	3	2	9	14	16	282	45	27	33	48	48	21	41	139	48	30	39	309	50
13	1000	GPS	3	3	9	8	68	46	52												
14	1000	GLONASS	2	1	6	17	64	60	54	16	39	323	52	24	15	29	47	14	19	112	47
15	1000	GLONASS	2	2	6	18	51	179	52	15	64	68	54								
16	1000	BeiDou	2	1	8	25	68	56	48	36	36	166	44	24	19	97	41	12	18	39	42
17	1000	BeiDou	2	2	8	8	21	280	43	3	16	228	41	2	47	306	47	11	52	92	46
18	1000	BeiDou	2	1	7	24	85	59	51	43	14	125	42	35	27	46	46	26	37	123	47
19	1000	BeiDou	2	2	7	41	56	312	51	44	61	120	50	42	81	328	52				

GSV sentence definition:

Filed	Meaning
0	Message ID (header)
1	Total number of messages of this type in this group (1-9)
2	Message number within current group (1-9)
3	Total number of SVs visible
4	SV PRN number: GPS = 1 to 32 Galileo = 1 to 36 BeiDou = 1 to 63 NavIC = 1 to 14 QZSS = 1 to 10 SBAS = 33 to 64 (add 87 for PRN#s) GLONASS = 65 to 96 (ID is slot number + 64)
5	Elevation, in degrees, 90° maximum
6	Azimuth, degrees from True North, 000° through 359°
7	SNR (C/N0), 00 through 99 dB (null when not tracking)
8–11	Information about second SV, same format as fields 4 through 7
12–15	Information about third SV, same format as fields 4 through 7
16–19	Information about fourth SV, same format as fields 4 through 7

20	The checksum data, always begins with *

c. *RMC: Position, velocity, and time*

The RMC file provides information regarding the time, date, position, track and speed data provided by a GPS navigation receiver:

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Elapsed time (ms)	Timestamp	Status	Latitude	Latitude D	Longitude	Longitude	Speed Over Grou	True Course	Datestamp	Magnetic V	Magnetic V	Mode Indicator
2	0	12:01:12	A	40.60334	N	-73.7559	W	178.9	152.9	6/24/2021	12.9	W	A
3	1	12:01:13	A	40.6026	N	-73.7554	W	178.9	152.9	6/24/2021	12.9	W	A
4	1	12:01:13	A	40.6026	N	-73.7554	W	178.9	152.9	6/24/2021	12.9	W	A
5	2	12:01:14	A	40.60186	N	-73.7549	W	178.9	152.9	6/24/2021	12.9	W	A
6	3	12:01:15	A	40.60112	N	-73.7544	W	178.9	152.9	6/24/2021	12.9	W	A
7	4	12:01:16	A	40.60039	N	-73.7539	W	178.9	152.9	6/24/2021	12.9	W	A
8	5	12:01:17	A	40.59965	N	-73.7534	W	178.9	152.9	6/24/2021	12.9	W	A
9	6	12:01:18	A	40.59891	N	-73.7529	W	178.9	152.9	6/24/2021	12.9	W	A
10	7	12:01:19	A	40.59817	N	-73.7524	W	178.9	152.9	6/24/2021	12.9	W	A
11	8	12:01:20	A	40.59744	N	-73.7519	W	178.9	152.9	6/24/2021	12.9	W	A
12	9	12:01:21	A	40.5967	N	-73.7514	W	178.9	152.9	6/24/2021	12.9	W	A

The RMC is a recommended minimum navigation data provided by a GNSS receiver. See description below:

Field	Meaning
0	Message ID (header)
1	UTC of position fix
2	Position status A=active or V=void
3	Latitude
4	Latitude direction: (N = North, S = South)
5	Longitude
6	Longitude direction: (E = East, W = West)
7	Speed over the ground in knots
8	Track angle in degrees (True)
9	Date (dd/mm/yy)
10	Magnetic variation, in degrees
11	Magnetic variation direction E/W
12	Magnetic variation direction E/W
13	Mode indicator A = Autonomous D = Differential E = Estimated 9dead reckoning) M = Manual input N = Data not valid
14	The checksum data, always begins with *

d. TRAJECTORY (GGA): Global positioning system (GPS) fix data

The trajectory file will contain the vehicle position based on the data parsed from the GGA NMEA sentence:

	A	B	C	D	E
1	Elapsed time (ms)	TimeStamp	Latitude	Longitude	Antenna Alt above sea level (mean)
2	0	12:01:13+00:00	40.6026	-73.755373	542.13
3	1000	12:01:14+00:00	40.60186233	-73.754877	552.3
4	2000	12:01:15+00:00	40.60112467	-73.75438117	562.47
5	3000	12:01:16+00:00	40.60038717	-73.75388517	572.63
6	4000	12:01:17+00:00	40.59964983	-73.75338967	582.79
7	5000	12:01:18+00:00	40.5989125	-73.75289383	592.95
8	6000	12:01:19+00:00	40.59817483	-73.75239817	603.12
9	7000	12:01:20+00:00	40.59743717	-73.7519025	613.29
10	8000	12:01:21+00:00	40.5966995	-73.75140683	623.46
11	9000	12:01:22+00:00	40.59596217	-73.75091117	633.64

GGA contains time, position and fix related data of the GNSS receiver.

Field	Meaning
0	Message ID $GPGGA
1	UTC of position fix (hours/minutes/seconds/ decimal seconds))
2	Latitude (DDmm.mm)
3	Direction of latitude: N: North S: South
4	Longitude
5	Direction of longitude: E: East W: West
6	GPS Quality indicator: 0: Fix not valid or not available 1: GPS fix – converging PPP 2: Differential GPS fix (DGNSS), SBAS, OmniSTAR VBS, Beacon, RTX in GVBS mode 3: Not applicable 4: RTK Fixed, xFill 5: RTK Float, OmniSTAR XP/HP, Location RTK, RTX 6: INS Dead reckoning 7: Manual input mode 8: Simulator mode 9: WAAS

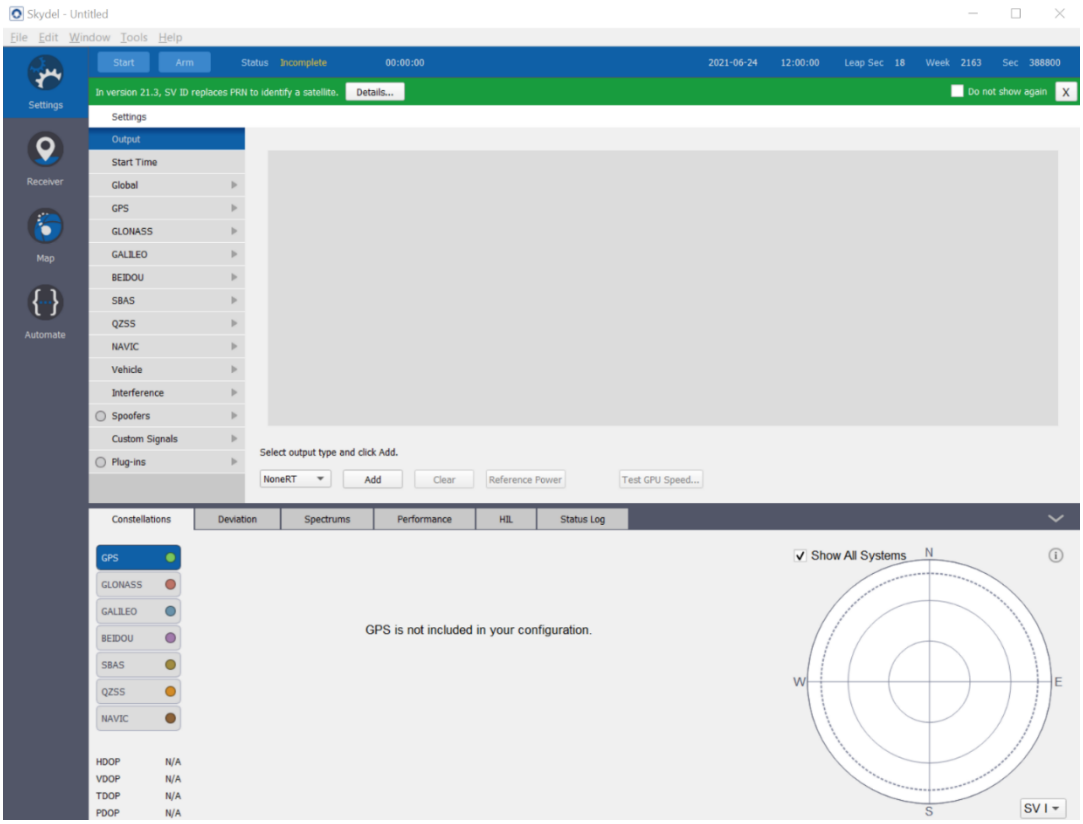
7	Number of SVs in use, range from 00 through to 24+
8	HDOP
9	Orthometric height (MSL reference)
10	M: unit of measure for orthometric height is meters
11	Geoid separation
12	M: geoid separation measured in meters
13	Age of differential GPS data record, Type 1 or Type 9. Null field when DGPS is not used.
14	Reference station ID, range 0000 to 4095. A null field when any reference station ID is selected, and no corrections are received. See table below for a description of the field values.
15	The checksum data, always begins with *

2.2.3. Replay NMEA in Skydel

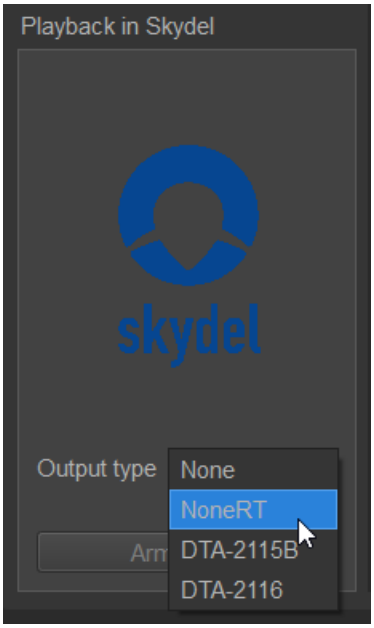
2.2.3.1. Set Skydel

This feature allows you to replay NMEA data that has been decoded and saved in CSV files.

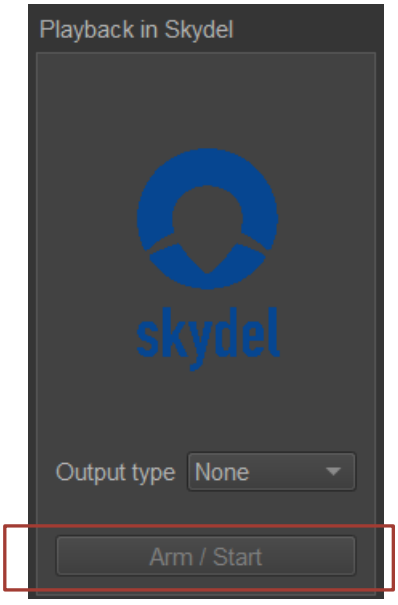
To get started, make sure a Skydel instance is open, and no simulations are running.



Select the Skydel “Output Type” using the combo box:



Click on Arm/Start:



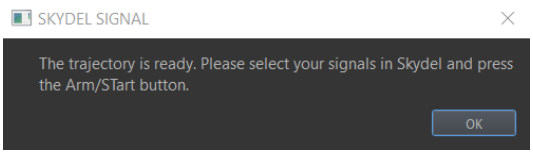
Select the folder which contains the generated csv files:

A dialog box will open to allow you to select the CSV data location. Make sure the selected folder contains the following files:

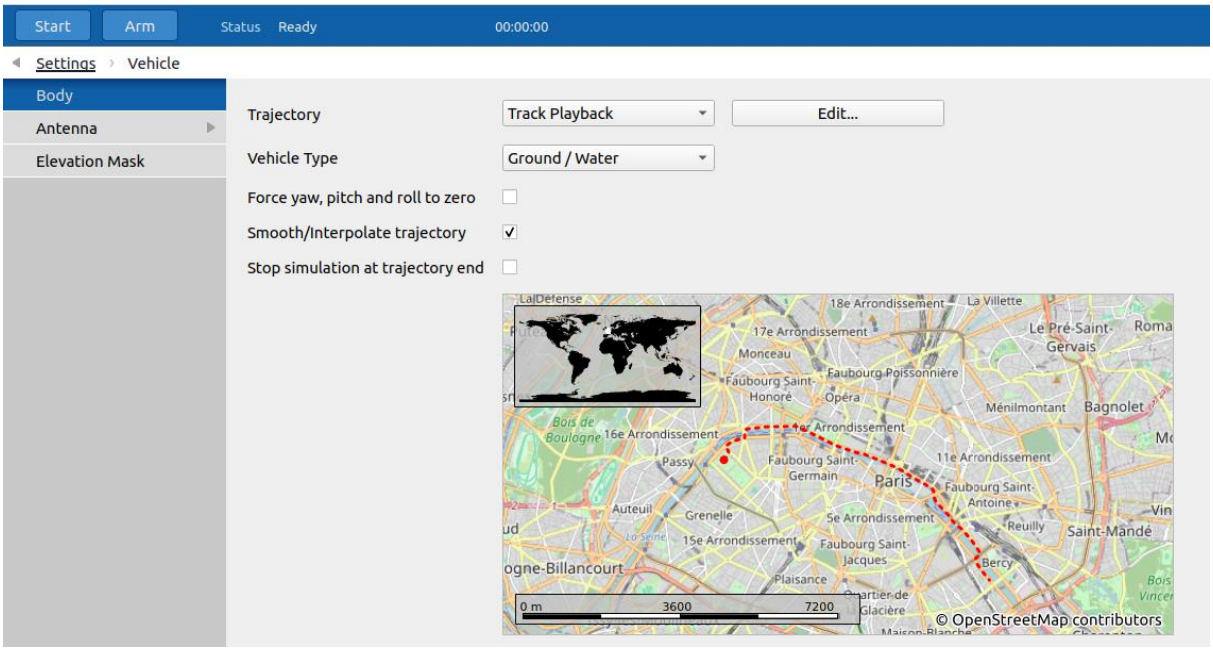
- Trajectory.csv
- GSV.csv

Click *the Select folder* button to continue.

The following message will pop up:



Click “OK” and go to the Skydel instance. Check that the trajectory has been set correctly in ***Settings -> Vehicle -> Body***. The Track PLayback option should be selected as the Trajectory type.

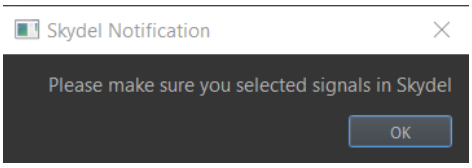


The Arm/Start button will allow you to set the SNR information available on the GSV file in Skydel for each visible satellite.

If the GSV file is empty, it means that no SNR data is available for the satellite information.

In this case, Skydel will only replay the trajectory.

A second pop-up windows will appear:



Users can then start the simulation by clicking “Yes” in the window below or add other changes to the current Skydel configuration by clicking “No”.

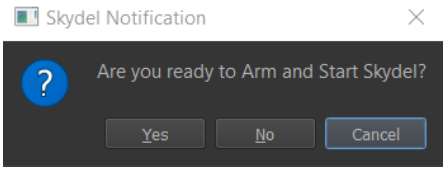
Default signals with the “*None RT*” option will be automatically added into the Skydel instance if the GSV file is not empty.

Additionally, the vehicle antenna gain will be set to NONE for all frequencies.

It is possible to add other settings to the Skydel instance at this step.

If everything looks good, return to the NMEA Decoder tool and click Ok.

This window will appear:



Click “Yes” to set the CN0 of each visible satellite on Skydel in the *Arm* mode.

Skydel will then automatically Arm and/or start the simulation.

References

- Safran Skydel User Manual (spectracom.com)
- GNSS Logs (novatel.com)
- GPS - NMEA sentence information (gids.nl)

Skydel NMEA Decoder ™ Version 24.6

ANNEX A

1. **GSA: GNSS DOP and active satellites**

GSA gives GPS receiver operating mode, satellites used for position fix reported by the GGA or GNS sentence and DOP.

Field	Meaning
0	Message ID (header)
1	Selection mode: M = Manual A = Automatic
2	Mode: 1 = not available 2 = 2D 3 = 3D
3	PRN number: 1 to 32 GPS 33 to 64 SBAS 64+ Glonass
4	Position dilution of precision: 0.00 to 99.9
5	Horizontal dilution of precision: 0.00 to 99.9
6	Vertical dilution of precision: 0.00 to 99.9
7	Checksum

If NMEA standard is If NMEA-0183 version 4.10 is the 7th and 8th fields become:

Field	Meaning
7 Constellation ID: **GPS** **GLONASS** **Galileo** **Beidou** **QZSS**	 1 2 3 4 5
8 Checksum	

2. GSV: Satellite in view

GSV contains the number of GNSS SVs in view, PRN numbers, elevation, azimuth and SNR value.

Filed	Meaning
0	Message ID (header)
1	Total number of messages of this type in this group (1-9)
2	Message number within current group (1-9)
3	Total number of SVs visible
4	SV PRN number: GPS = 1 to 32 Galileo = 1 to 36 BeiDou = 1 to 63 NavIC = 1 to 14 QZSS = 1 to 10 SBAS = 33 to 64 (add 87 for PRN#s) GLONASS = 65 to 96 (ID is slot number + 64)
5	Elevation, in degrees, 90° maximum
6	Azimuth, degrees from True North, 000° through 359°
7	SNR (C/N0), 00 through 99 dB (null when not tracking)
8–11	Information about second SV, same format as fields 4 through 7
12–15	Information about third SV, same format as fields 4 through 7
16–19	Information about fourth SV, same format as fields 4 through 7
20	The checksum data, always begins with *

3. RMC: Position, velocity, and time

Field	Meaning
0	Message ID (header)
1	UTC of position fix
2	Position status A=active or V=void
3	Latitude
4	Latitude direction: (N = North, S = South)
5	Longitude
6	Longitude direction: (E = East, W = West)
7	Speed over the ground in knots
8	Track angle in degrees (True)
9	Date (dd/mm/yy)
10	Magnetic variation, in degrees
11	Magnetic variation direction E/W
12	Magnetic variation direction E/W
13	Mode indicator A = Autonomous

	D = Differential E = Estimated 9dead reckoning) M = Manual input N = Data not valid
14	The checksum data, always begins with *

4. GGA: Global positioning system (GPS) fix data

GGA contains time, position and fix related data of the GNSS receiver.

Field	Meaning
0	Message ID $GPGGA
1	UTC of position fix (hours/minutes/seconds/ decimal seconds))
2	Latitude (DDmm.mm)
3	Direction of latitude: N: North S: South
4	Longitude
5	Direction of longitude: E: East W: West
6	GPS Quality indicator: 0: Fix not valid or not available 1: GPS fix – converging PPP 2: Differential GPS fix (DGNSS), SBAS, OmniSTAR VBS, Beacon, RTX in GVBS mode 3: Not applicable 4: RTK Fixed, xFill 5: RTK Float, OmniSTAR XP/HP, Location RTK, RTX 6: INS Dead reckoning 7: Manual input mode 8: Simulator mode 9: WAAS
7	Number of SVs in use, range from 00 through to 24+
8	HDOP
9	Orthometric height (MSL reference)
10	M: unit of measure for orthometric height is meters
11	Geoid separation
12	M: geoid separation measured in meters
13	Age of differential GPS data record, Type 1 or Type 9. Null field when DGPS is not used.

14	Reference station ID, range 0000 to 4095. A null field when any reference station ID is selected, and no corrections are received. See table below for a description of the field values.
15	The checksum data, always begins with *