INS401 EVK Manual

1. INS401 EVK Introduction

The INS401 Evaluation Kit (EVK) is designed to evaluate the INS401 module with Aceinna tool-AceNav.exe. A full set of INS401 EVK is shown below after you unpack the product box. Our target is quick running in your side with PC.

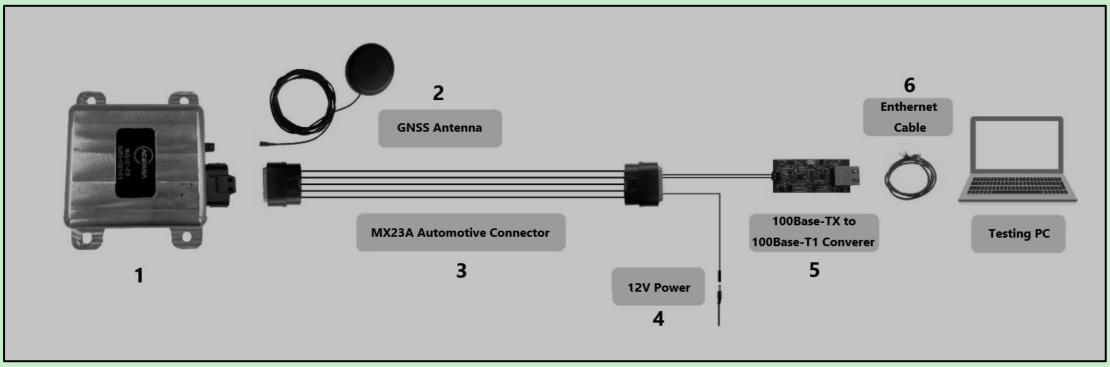


Figure 1 Typical INS401 Connection System

Include:
1: Unit of INS401
2: Multi-Constellation and Multi-frequency GNSS antenna, supports
3: Wire harness connector
4: 12 V DC Adapter with 5.5 mm x 2.1 mm Jack
5: 100Base-TX to 100Base-T1 Converter (3-ETH_TRX_N-, 4-ETH_TRX_P+)
6: Ethernet cable
If no EVK in your side, below parts need to be prepared by your-self:

- Mating harness connector
  Part number MX23A18SF1 from JAE Electronics
- 100base-T1/TX converter board
  Part number EV02N47A - EVB-LAN8770_MC from MICROCHIP

2. Prerequisites

2.1. HW

A typical configuration of the INS401 is shown in Figure 1. The circular RF connector connects with an active GNSS antenna, and the main MX23A connector contains the connection with the external power, the ethernet data cable and the other communication port cable if needed. The primary data port is the automotive grade ethernet port to connect to a vehicle ECU directly or to a testing computer via a converter.

Figure 1 shows a test setup only with a testing PC, which requires a key unit and the 100Base-TX (with RJ-45 connector) to 100Base-T1 converter (3-ETH_TRX_N-, 4-ETH_TRX_P+), to connect an automotive-grade ethernet device with an industrial ethernet device typically seen on a computer.

Pls note: **FW version of INS401 is equal or larger than 28.02**, pls refer to the information (FW/Bootloader version) about INS401

2.2. SW

OS: take Windown10 as example.

“AceNav” is open sourced on Aceinna/acenav-(github.com) and executables download link: https://github.com/Aceinna/acenav-cli/releases

Npcap download link (need to be installed):
https://navview.blob.core.windows.net/forum/upload/npcap-1.55.exe-kv7fw14u.zip

User manual for your reference:
https://www.aceinna.com/inertial-systems/INS401

2.3. Configurations used

Default parameters as below, no need to update it if only for simple function testing

Parameter ID	Name	Unit	Description	Current value used
1	gnssLeverArmBx	m	IMU to GNSS antenna phase center lever arm	1.19
2	gnssLeverArmBy	m		-0.24
3	gnssLeverArmBz	m		-0.9
4	vrpLeverArmBx	m	IMU to vehicle reference point lever arm	0
5	vrpLeverArmBy	m		0
6	vrpLeverArmBz	m		0
7	userLeverArmBx	m	The offset between IMU to the user point of interest (which position is output in INS packets of INS401)	1.19
8	userLeverArmBy	m		-0.24
9	userLeverArmBz	m		-0.9
10	rotationRbvx	deg	Rotation angles to align IMU body	0

11	rotationRbvy	deg	frame to vehicle frame, in order Z->Y->X	0
12	rotationRbvz	deg		0

*** INS401(see user manual) is origin point under vehicle coordinate system. And** X/Y/Z of INS401 Axis pls refer 3.1 Orientation.

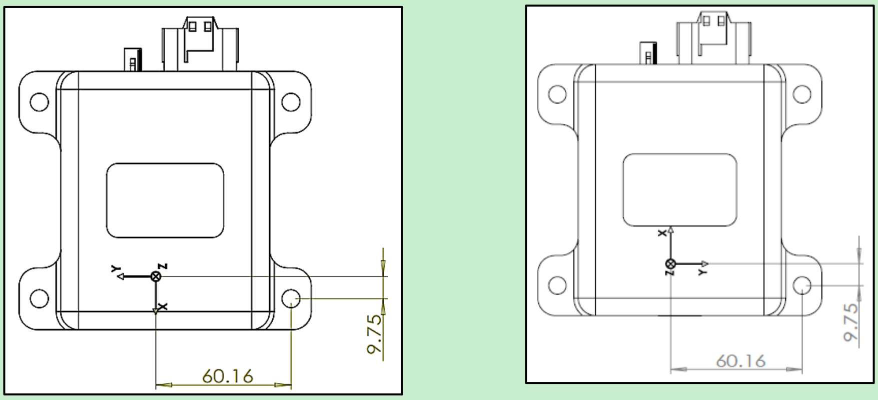
Odometer is not used now, and pls refer to Configuration of odometer when using it.

3. Usage steps

3.1. Setup

3.1.1. Mount the INS401 on a flat rigid panel in the vehicle, align the x-axis with the forward driving direction of the vehicle

The recommended coordinate system is that X is facing forward, Y is right and Z is down when mounting, let’s use the orientation for quick star. Pls refer to Configuration of orientation if new orientation is used.



Firmware (≥28.02)

Firmware (<28.02)

Figure 2 IMU Axis Definition and Navigation Center Location

3.1.2. Mount the antenna to a secure, stable structure with a clear view of the sky

3.1.3. Connect the antenna to the FAKRA RF terminal

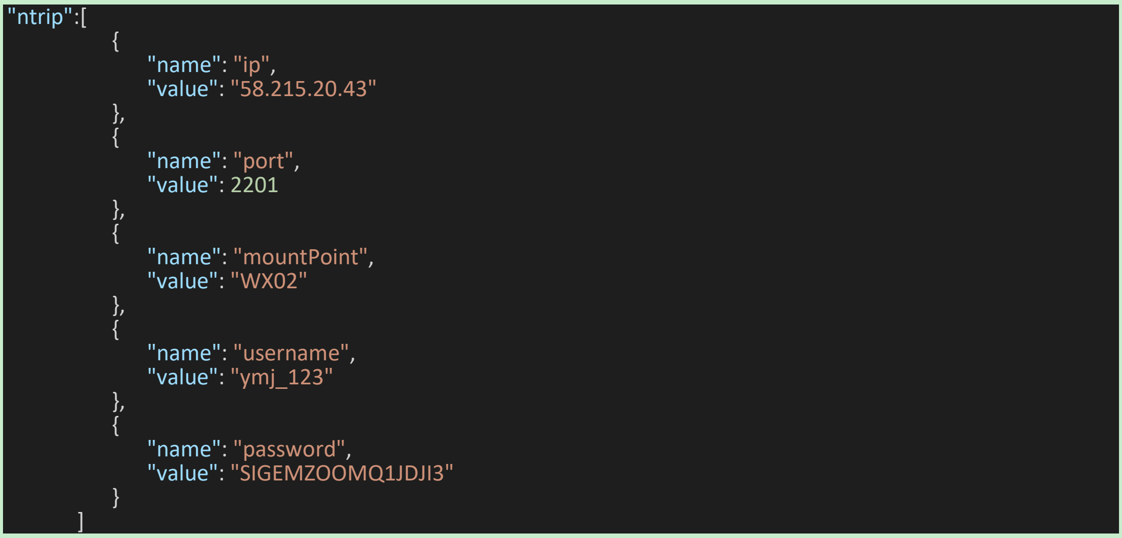
3.1.4. Connect the wire harness connector to the main connector of the INS401

3.1.5. Use the ethernet cable to connect the ethernet converter to the ethernet port on the PC

3.1.6. Connect the jack from the wire harness to the 12 V power adapter and connect the power adapter to a power supply

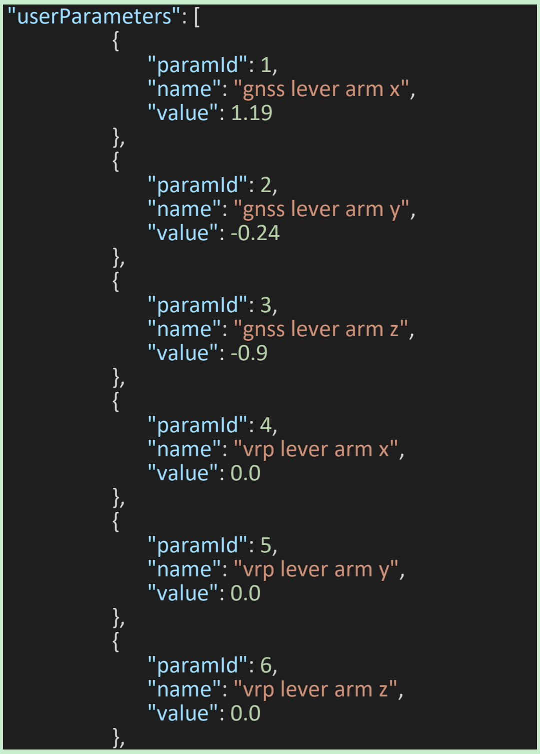
3.2. Running Steps and Data Logging

1. In “AceNav” folder, modify the “ins401.json” JSON file inside the “settings/INS401” subfolder, input the correct NTRIP account information as shown below:

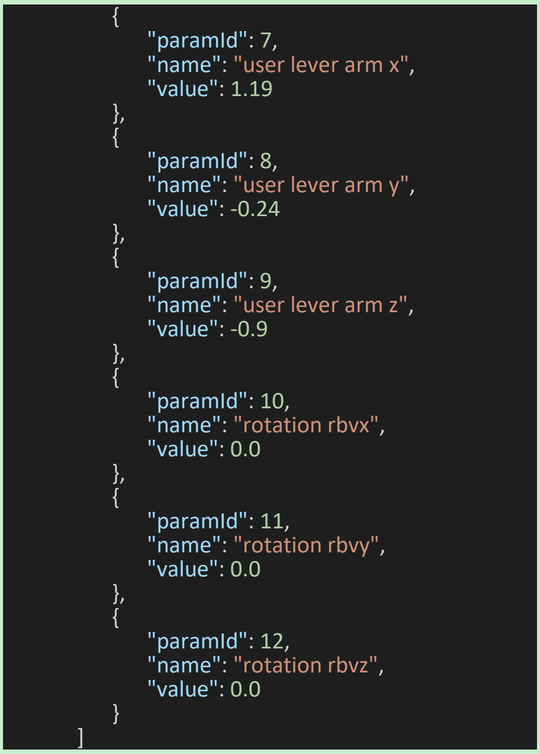


```
"ntrip":[
            {
                "name": "ip",
                "value": "58.215.20.43"
            },
            {
                "name": "port",
                "value": 2201
            },
            {
                "name": "mountPoint",
                "value": "WX02"
            },
            {
                "name": "username",
                "value": "ymj_123"
            },
            {
                "name": "password",
                "value": "SIGEMZOOMQ1JDJI3"
            }
        ]
```

2. Update values for ID (1-12) based on Configurations used.



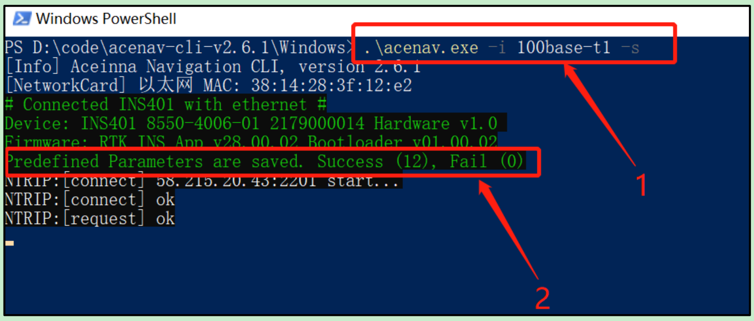
```
"userParameters": [
        {
            "paramId": 1,
            "name": "gnss lever arm x",
            "value": 1.19
        },
        {
            "paramId": 2,
            "name": "gnss lever arm y",
            "value": -0.24
        },
        {
            "paramId": 3,
            "name": "gnss lever arm z",
            "value": -0.9
        },
        {
            "paramId": 4,
            "name": "vrp lever arm x",
            "value": 0.0
        },
        {
            "paramId": 5,
            "name": "vrp lever arm y",
            "value": 0.0
        },
        {
            "paramId": 6,
            "name": "vrp lever arm z",
            "value": 0.0
        },
```



```
        {
            "paramId": 7,
            "name": "user lever arm x",
            "value": 1.19
        },
        {
            "paramId": 8,
            "name": "user lever arm y",
            "value": -0.24
        },
        {
            "paramId": 9,
            "name": "user lever arm z",
            "value": -0.9
        },
        {
            "paramId": 10,
            "name": "rotation rbvx",
            "value": 0.0
        },
        {
            "paramId": 11,
            "name": "rotation rbvy",
            "value": 0.0
        },
        {
            "paramId": 12,
            "name": "rotation rbvz",
            "value": 0.0
        }
    ]
```

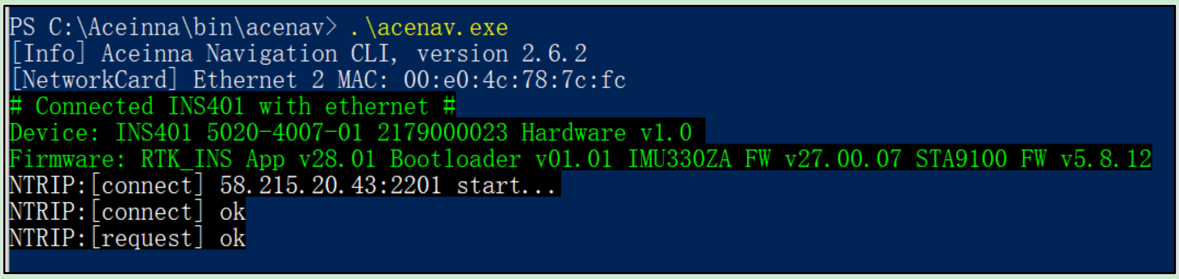
3. After “ins401.json” file is updated, to make it effective, run AceNav.exe with “-s” option as below, and successed when “Success (12)” is displayed on console.

.\acenav.exe -i 100base-t1 -s



```
PS D:\code\acenav-cli-v2.6.1\Windows> .\acenav.exe -i 100base-t1 -s
[Info] Aceinna Navigation CLI, version 2.6.1
[NetworkCard] 以太网 MAC: 38:14:28:3f:12:e2
# Connected INS401 with ethernet #
Device: INS401 8550-4006-01 2179000014 Hardware v1.0
Firmware: RTK_INS App v28.00.02 Bootloader v01.00.02
Predefined Parameters are saved. Success (12), Fail (0)
NTRIP:[connect] 58.215.20.43:2201 start...
NTRIP:[connect] ok
NTRIP:[request] ok
```

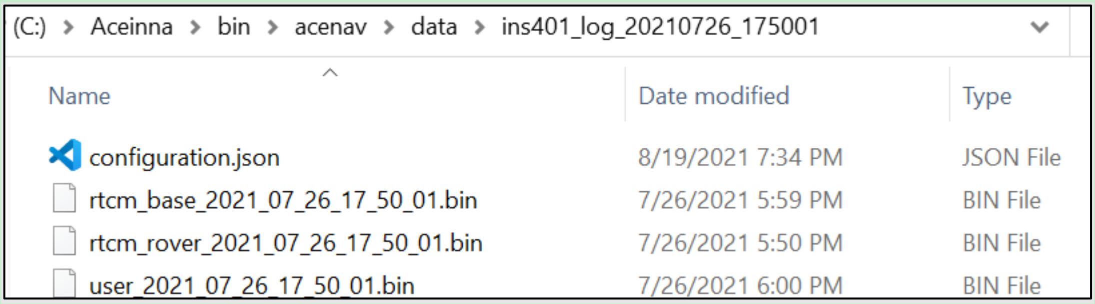
4. Power reset INS401 and running AceNav.exe, the information (FW/Bootloader version) about INS401, the PC connection, and the NTRIP connection status will be displayed on the console. The NTRIP status shows “ok” of both [connect] and [request], then the system has connected to a valid NTRIP server for the GNSS RTK operation



```
PS C:\Aceinna\bin\acenav> .\acenav.exe
[Info] Aceinna Navigation CLI, version 2.6.2
[NetworkCard] Ethernet 2 MAC: 00:e0:4c:78:7c:fc
# Connected INS401 with ethernet #
Device: INS401 5020-4007-01 2179000023 Hardware v1.0
Firmware: RTK_INS App v28.01 Bootloader v01.01 IMU330ZA FW v27.00.07 STA9100 FW v5.8.12
NTRIP:[connect] 58.215.20.43:2201 start...
NTRIP:[connect] ok
NTRIP:[request] ok
```

5. Check the output bin files. Every session the “AceNav” has started, a data log subfolder with the time tag in the folder name is created under “acenav/data”. The data log subfolder for each data logging session contains four files:

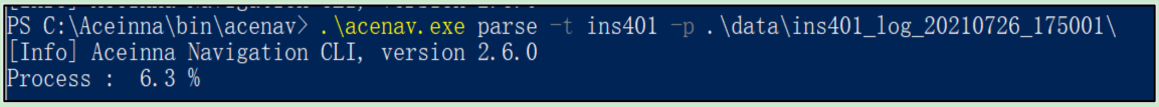
- configuration.json: INS401 configuration file read from the device flash
- rtcm_base_<time_tag>.bin: GNSS RTK correction data in RTCM format
- rtcm_rover_<time_tag>.bin: INS401 GNSS raw data in RTCM format
- user_<time_tag>.bin: positioning solution, raw IMU and other related variance/status information shown in #6
- ins_save_<time_tag>.bin: save last status of INS401 when power was off



(C:) › Aceinna › bin › acenav › data › ins401_log_20210726_175001

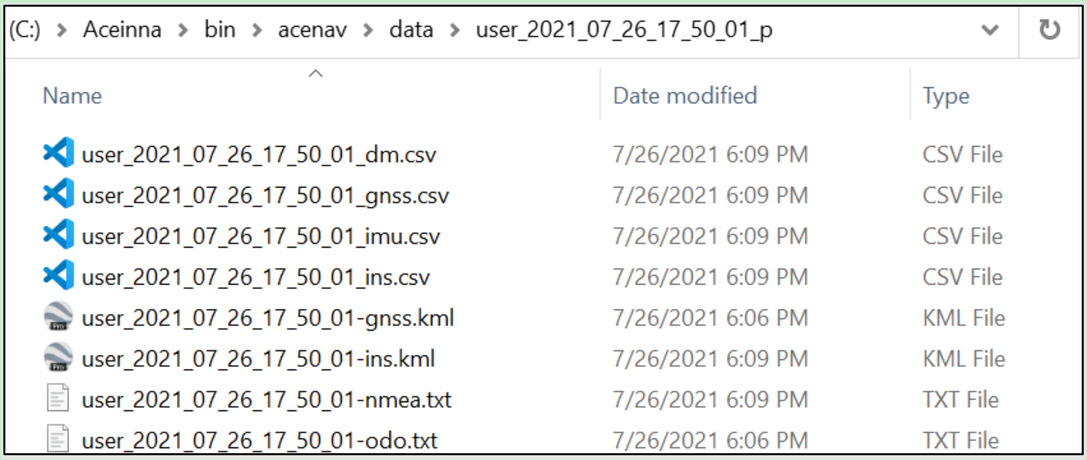
Name	Date modified	Type
configuration.json	8/19/2021 7:34 PM	JSON File
rtcm_base_2021_07_26_17_50_01.bin	7/26/2021 5:59 PM	BIN File
rtcm_rover_2021_07_26_17_50_01.bin	7/26/2021 5:50 PM	BIN File
user_2021_07_26_17_50_01.bin	7/26/2021 6:00 PM	BIN File

6. Run the data parsing command to get engineering data from the “user_bin” file



```
PS C:\Aceinna\bin\acenav> .\acenav.exe parse -t ins401 -p .\data\ins401_log_20210726_175001\
[Info] Aceinna Navigation CLI, version 2.6.0
Process :  6.3 %
```

7. Check the decoded files for results representation and analysis
   - user_<time_tag>_dm.csv: INS401 system diagnostic messages
   - user_<time_tag>_gnss.csv: GNSS solution at 1 Hz
   - user_<time_tag>_imu.csv: raw IMU data at 100 Hz
   - user_<time_tag>_ins.csv: INS solution at 100 Hz
   - user_<time_tag>_gnss.kml: GNSS solution trajectory in kml format
   - user_<time_tag>_ins.kml: INS solution trajectory in kml format
   - user_<time_tag>_nmea.txt: GNSS solution in NMEA 0183 ASCII
   - user_<time_tag>_odo.txt: vehicle odometer speed data received by INS401



(C:) › Aceinna › bin › acenav › data › user_2021_07_26_17_50_01_p

Name	Date modified	Type
user_2021_07_26_17_50_01_dm.csv	7/26/2021 6:09 PM	CSV File
user_2021_07_26_17_50_01_gnss.csv	7/26/2021 6:09 PM	CSV File
user_2021_07_26_17_50_01_imu.csv	7/26/2021 6:09 PM	CSV File
user_2021_07_26_17_50_01_ins.csv	7/26/2021 6:09 PM	CSV File
user_2021_07_26_17_50_01-gnss.kml	7/26/2021 6:06 PM	KML File
user_2021_07_26_17_50_01-ins.kml	7/26/2021 6:09 PM	KML File
user_2021_07_26_17_50_01-nmea.txt	7/26/2021 6:09 PM	TXT File
user_2021_07_26_17_50_01-odo.txt	7/26/2021 6:06 PM	TXT File

4. Backup

4.1. Configuration of orientation

No need to update orientation, if we mounting INS401 same as recommended direction.
Pls update below rotation parameters to re-align with forward/right/down, if your mounting is different.

Sequence ID	Type	Name	Unit	Description
10	float	rotationRbvx	deg	Rotation angles to align IMU body frame to vehicle frame, in order Z->Y->X when rotated
11	float	rotationRbvy	deg	
12	float	rotationRbvz	deg	

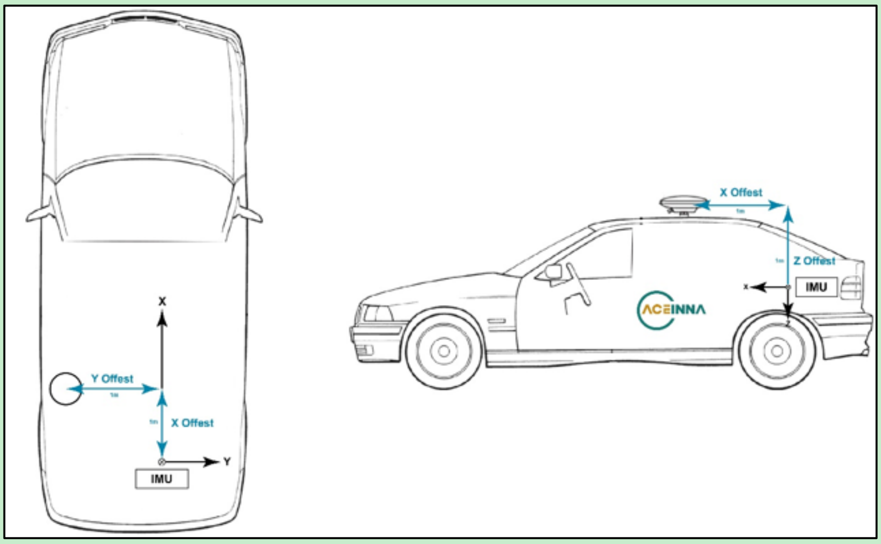
X/Y/Z of INS401 Axis pls refer 3.1 Orientation.
Below table for your reference:

INS401 Axis	**X**	**Y**	**Z**	**Rotation X/Y/Z**
1- Recommended	Forward	Right	Down	0, 0, 0
2	Forward	Left	Up	180, 0, 0
3	Forward	Down	Left	-90.0, 0, 0
4	Forward	Up	Right	90.0, 0, 0
5	Backward	Left	Down	0, 0, 180.0
6	Backward	Right	Up	0, 180.0, 0
7	Backward	Up	Left	-90.0, 0, 180.0
8	Backward	Down	Right	90.0, 0, 180
9	Right	Backward	Down	0, 0, -90.0
10	Right	Forward	Up	180, 0, -90.0
11	Right	Up	Backward	90.0, 90.0, 0
12	Right	Down	Forward	0, -90.0, -90.0
13	Left	Forward	Down	0, 0, 90.0
14	Left	Backward	Up	180.0, 0, -90.0
15	Left	Up	Forward	0, -90.0, 90.0
16	Left	Down	Backward	-90.0, 90.0, 0
17	Up	Forward	Left	-90.0, 0, 90
18	Up	Backward	Right	90.0, 0, -90.0
19	Up	Right	Forward	0, -90.0, 0
20	Up	Left	Backward	0, 90.0, 180.0
21	Down	Forward	Right	90.0, 0, 90.0
22	Down	Backward	Left	-90.0, 0, -90.0
23	Down	Left	Forward	0, -90.0, 180.0
24	Down	Right	Backward	0, 90.0, 0

4.2. Configuration of antenna lever arm

After the INS401 is mounted to the vehicle, measure the IMU to the GNSS antenna lever arm (translational offset) from the IMU navigation center to the GNSS antenna phase center. The GNSS antenna is typically installed on top of the vehicle roof. For optimal performance, it is required to have the lever arm accuracy of less than 2 cm.

For instance, a lever arm measurement is shown in figure below. The translation offset is measured as 1 m in each direction of x, y, z. The IMU to the GNSS antenna lever arm is [x, y, z] = [1.0, -1.0, -1.0] m. The "Set User Configuration" command should be used to configure the INS401 with the correct lever arm.



4.3. Configuration of interesting point lever arm

The interesting point is the position which will be output in INS packet, so we need to configure the target position corresponding to origin point of INS401.

Generally, the interesting point are antenna or odometer reference point.

4.4. Configuration of odometer reference point

1. Confirm Odometer enabled
   Pls refer to "Get User Configuration" command in user manual, and check status of ID-13. It is enabled by default, pls ignore this step if no change before.
2. Measure distances from INS401 to odometer reference point
3. Update the input value Configurations used
4. Send speed value to INS401 with 100base-T1 protocol:
   Example:

Speed values	**Packets**

39.5km/h	**01 02 03 04 05 06** 06 05 04 03 02 01 00 0e 55 55 01 0b 04 00 00 00 00 00 1e 42 a8 90 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
-11.5km/h	**01 02 03 04 05 06** 06 05 04 03 02 01 00 0e 55 55 01 0b 04 00 00 00 00 00 38 c1 a5 3b 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00

*DST_MAC = '**01:02:03:04:05:06**'

SRC_MAC = '06:05:04:03:02:01'

5. Confirm odometer is used in INS401, there 2 ways to verify
   - In step_9 from 3.2, check whether *user_<time_tag>_odo.txt* is existed in decoded files
   - Check 0x0a04 msg in 100base-T1 net or not, tools recommended: Wireshark.exe