Maxon + EPOS4 + ROS1 + CSP

Jeong Gowoon

2025.11.30.

Department of Mechanical Engineering
Chonnam National University

Overview

➢ 참고 자료

- https://github.com/Roboprotos/maxon_epos4_ros1
- maxon_EPOS4_ROS1_ros_canopen_Documentation_2022-02.pdf

➢ 수정된 코드 및 github 링크

- https://github.com/Gowoon12/maxon_epos4_ros1_csp.git
- /ShareFolder/04_Lab_Equipment_Related/maxon_epos4_ros1_csp

➢ 테스트 환경

- Ubuntu 20.04 LTS
- ROS Noetic

Catkin workspace 및 패키지 설치

- **기존에 사용하던 catkin_ws의 의존성 문제를 피하기 위해 새로운 catkin workspace를 만드는 것이 좋음**
- mkdir –p ~/maxon_ws/src
- cd ~/maxon_ws
- catkin_make
- source ~/maxon_ws/devel/setup.bash
- **기존에 사용하던 catkin_ws의 의존성 문제를 피하기 위해 새로운 catkin workspace를 만드는 것이 좋음**
- **maxon_epos4_ros1 패키지 설치 (catkin_make를 사용하면 오류날 수 있어서 maxon_epos4_ros_canopen 만 빌드해야함.**
- cd ~/maxon_ws/src
- git clone https://github.com/Roboprotos/maxon_epos4_ros1.git
- cd ..
- catkin_make --pkg maxon_epos4_ros_canopen
- source ~/maxon_ws/devel/setup.bash

Hardware setup

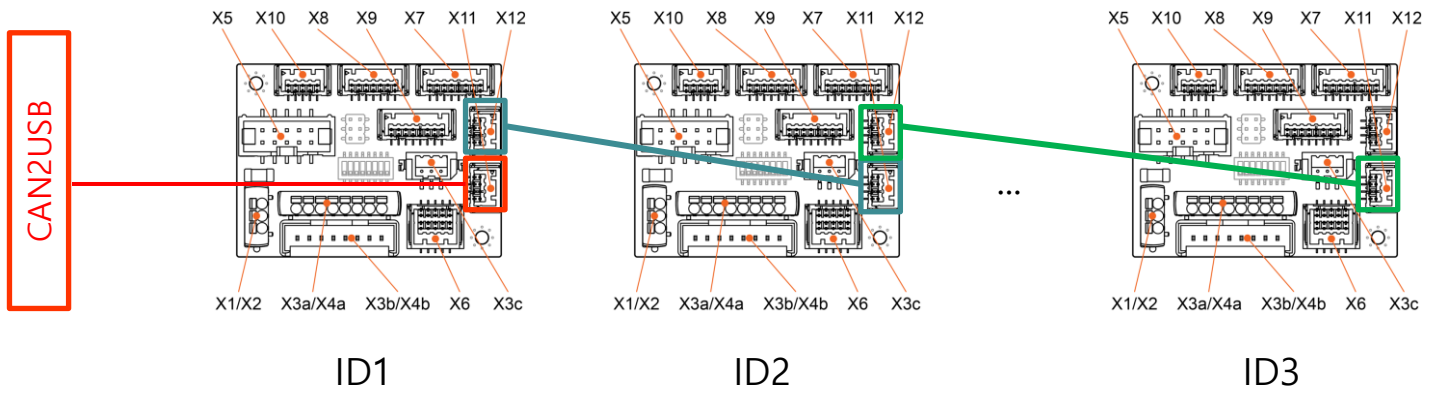
➢ CAN cable (CAN-USB)

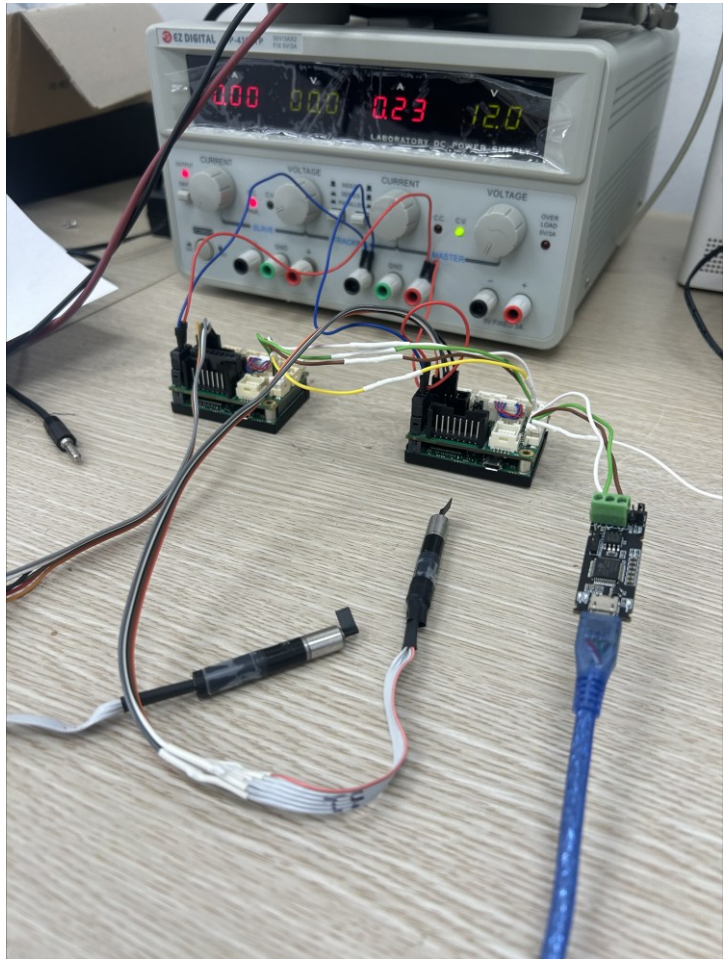
3.3.5.10 CAN 1 (X11) & CAN 2 (X12)

Figure 3-24 CAN 1 connector X11/CAN 2 connector X12

X11/X12 Head A Pin	Prefab Cable Color	520857 Head B Pin	520858 Head B Pin	Signal	Description
1	white	7	1	CAN high	CAN high bus line
2	brown	2	2	CAN low	CAN low bus line
3	green	3	3	GND	Ground
4	Shield	5	4	Shield	Cable shield

Table 3-35 CAN 1 connector X11/CAN 2 connector X12 – Pin assignment

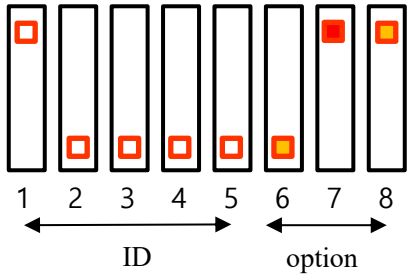




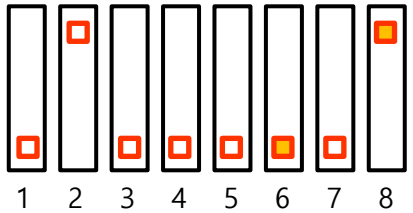
Hardware setup

➢ DIP switch

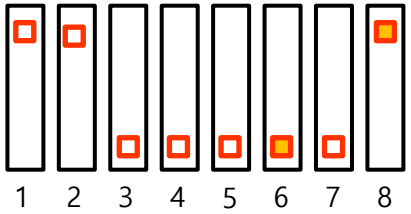
ID = 1



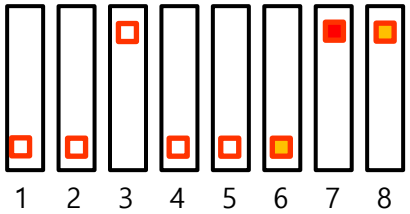
ID = 2



ID = 3



ID = 4



3.3.7.2 CAN automatic Bit Rate Detection (Compact CAN)

Controller	Switch	OFF	ON
Compact CAN	6	1 8 ON OFF Automatic bit rate detection deactivated	1 8 ON OFF Automatic bit rate detection activated (factory setting)

Table 3-46 DIP switch SW1 – CAN automatic bit rate detection

3.3.7.3 CAN Bus Termination (Compact CAN)

Controller	Switch	OFF 나머지	ON 처음과 마지막
Compact CAN	7	1 8 ON OFF Without bus termination (factory setting)	1 8 ON OFF Bus termination with 120 Ω

Table 3-47 DIP switch SW1 – CAN bus termination

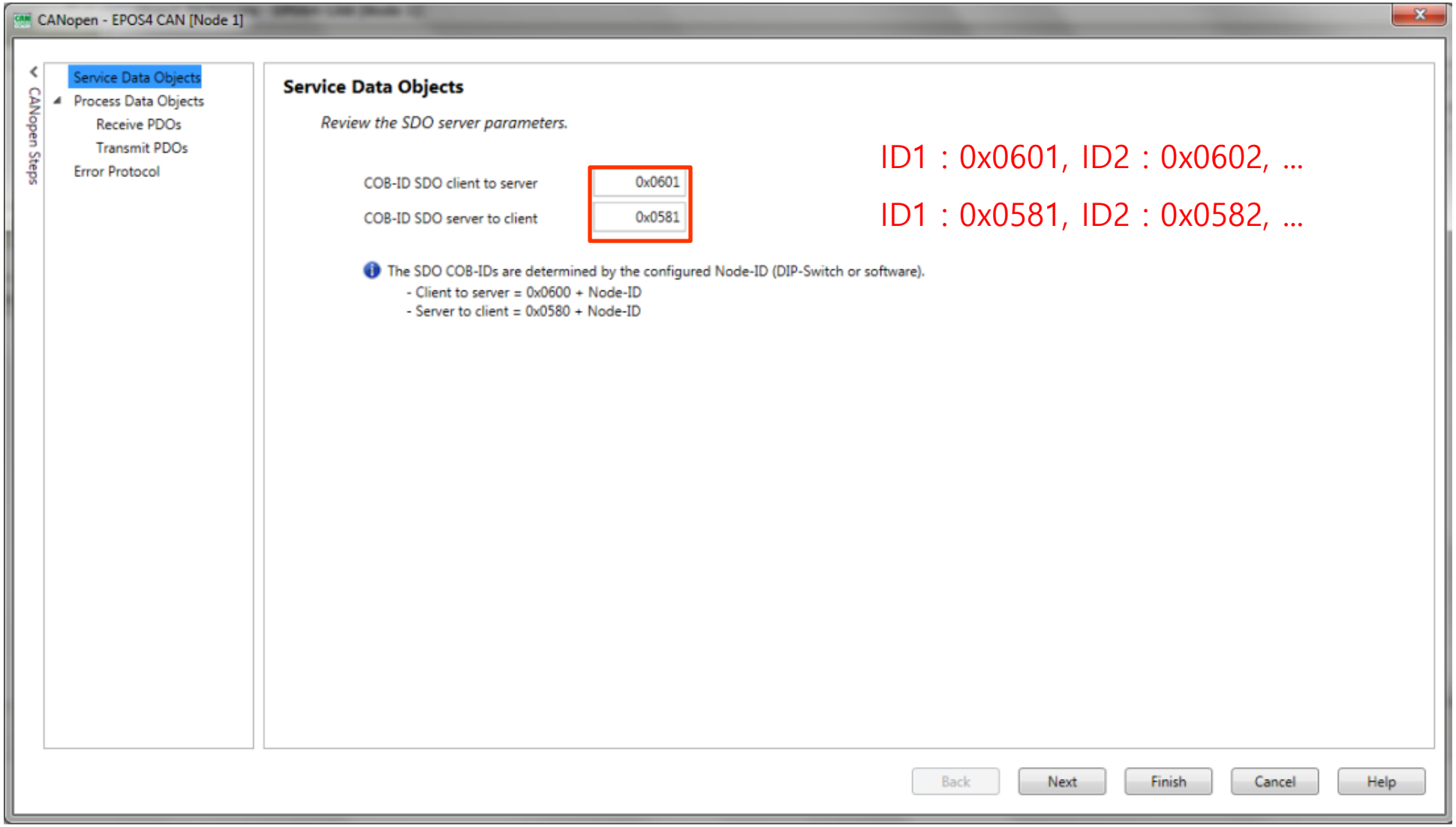
3.3.7.4 Digital Input Level

For details ➔chapter "3.4.7 Digital I/Os" on page 3-68.

Controller	Switch	OFF	ON
Compact CAN	8	1 8 ON OFF Logic level (factory setting)	1 8 ON OFF PLC level
Compact EtherCAT	6	1 6 ON OFF Logic level (factory setting)	1 6 ON OFF PLC level

Table 3-48 DIP switch SW1 – Digital input level

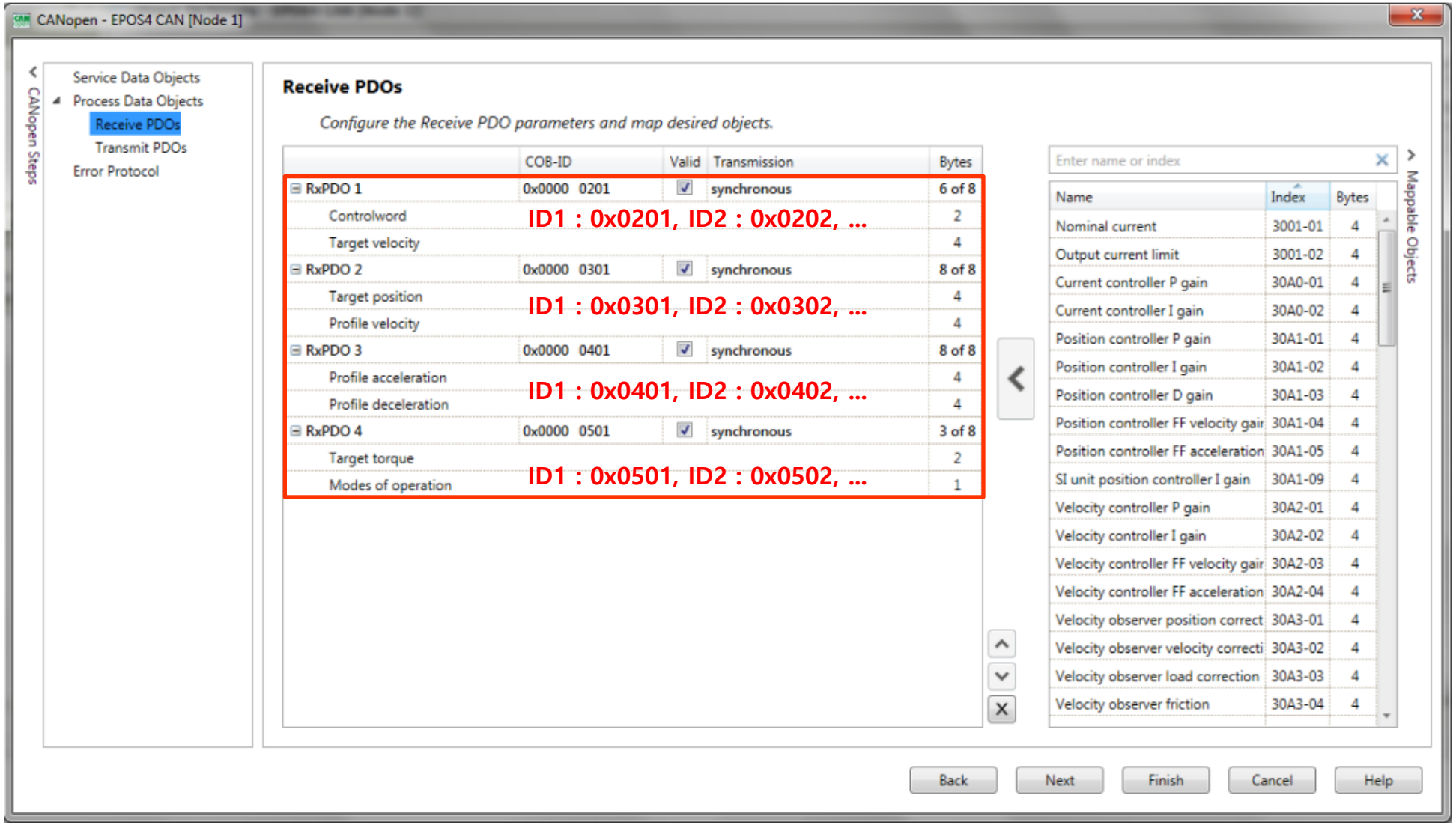
CANopen setting (EPOS studio)



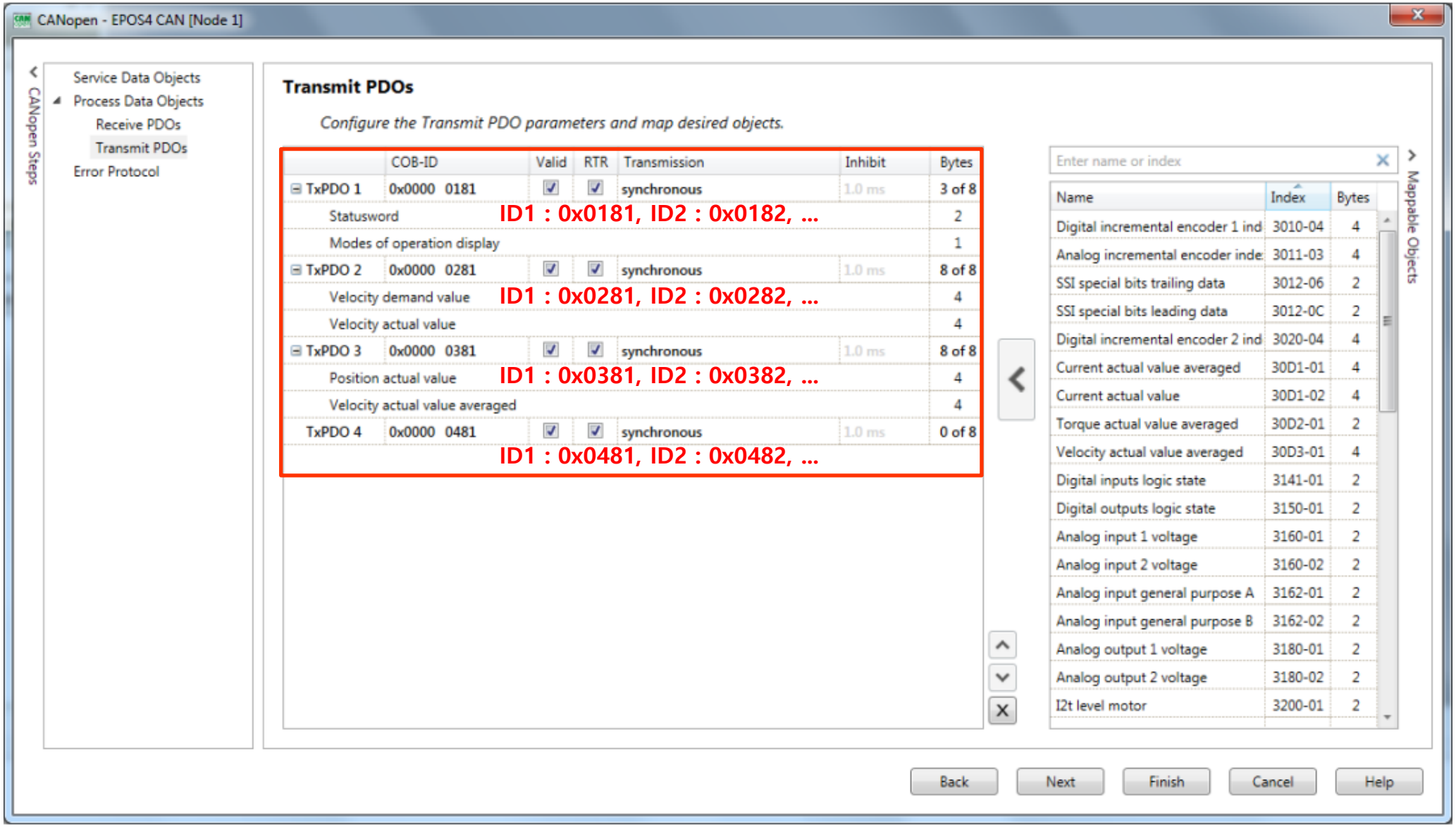
ID1 : 0x0601, ID2 : 0x0602, ...

ID1 : 0x0581, ID2 : 0x0582, ...

CANopen setting (EPOS studio)



CANopen setting (EPOS studio)



Object Dictionary (EPOS studio)

- Interpolation time period value : 10ms
- can bit rate : 1kbs (1000000)

- Wizards -> Parameter Import/Export -> Export Parameters to File
- dcf 파일을 저장하여 코드에서 불러와야 함

- Linux → dcf 수정 필요

dcf 파일 수정

```
[2200]
~~SubNumber=3~~
SubNumber=2
ParameterName=Power supply
ObjectType=0x9

[2200sub0]
ParameterName=Highest sub-index supported
ObjectType=0x7
DataType=0x5
AccessType=ro
DefaultValue=2
PDOMapping=0
ObjFlags=1
~~ParameterValue=2~~
ParameterValue=1

[2200sub1]
ParameterName=Power supply voltage
ObjectType=0x7
DataType=0x6
AccessType=ro
PDOMapping=0
ObjFlags=3

~~[2200sub2]~~
~~ParameterName=Internal valid logic supply~~
~~ObjectType=0x7~~
~~DataType=0x1~~
~~AccessType=ro~~
~~PDOMapping=0~~
~~ObjFlags=1~~
```

```
[6098]
ParameterName=Homing method
ObjectType=0x7
DataType=0x2
AccessType=rww
~~DefaultValue=7~~
DefaultValue=0
PDOMapping=0
ObjFlags=0
~~ParameterValue=7~~
ParameterValue=0
```

- homming 사용 O : 7
- homming 사용 X : 0

패키지 구성

```
maxon_epos4_ros_canopen
├── CMakeLists.txt
├── config
│   ├── canopen_bus_layer.yaml
│   ├── controller_1dof_ppm.yaml
│   ├── controller_2dof_csp.yaml
│   ├── controller_2dof_pvm.yaml
│   ├── epos4_50_15_can_ec90flat_gp52c_mile800_node1.dcf
│   ├── epos4_50_15_can_ec90flat_gp52c_mile800_node1_hm.dcf
│   ├── epos4_50_15_can_ec90flat_gp52c_mile800_node2.dcf
│   ├── node_layer_1dof_ppm_hm.yaml
│   ├── node_layer_1dof_ppm.yaml
│   ├── node_layer_2dof_csp.yaml
│   ├── node_layer_2dof_pvm.yaml
│   └── ros_layer.yaml
├── launch
│   ├── maxon_epos4_canopen_motor_1dof_ppm_hm.launch
│   ├── maxon_epos4_canopen_motor_1dof_ppm.launch
│   ├── maxon_epos4_canopen_motor_2dof_csp.launch
│   └── maxon_epos4_canopen_motor_2dof_pvm.launch
├── LICENSE
├── package.xml
├── scripts
│   └── python_example_1dof_ppm.py
├── src
│   └── cpp_example_1dof_ppm.cpp
└── urdf
    ├── maxon_epos4_1dof_ppm.xacro
    ├── maxon_epos4_2dof_csp.xacro
    └── maxon_epos4_2dof_pvm.xacro
```

- 통신 및 ros
- 1dof ppm mode
- 2dof csp mode
- 실제 dcf 파일로 교체 필요

코드 수정 필요

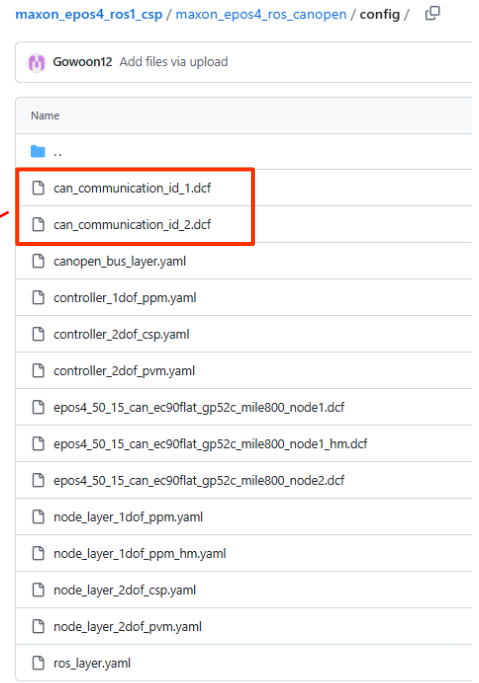
➢ controller_2dof_csp.yaml

```yaml
joint_names: [base_link1_joint, link1_link2_joint]

joint_state_controller:
    type: joint_state_controller/JointStateController
    publish_rate: 50

# Settings of the controller and assossiated drive modes
# drive mode : see http://wiki.ros.org/canopen_402

# position controllers
# example using Cyclic Synchronous Position (8) drive mode

joint_trajectory_controller:
  type: position_controllers/JointTrajectoryController
  joints:
    - base_link1_joint
    - link1_link2_joint
  required_drive_mode: 8
  constraints:
    stopped_velocity_tolerance: 20
    base_link1_joint: {trajectory: 50, goal: 50}
    link1_link2_joint: {trajectory: 50, goal: 50}
```

Here are the 3 modes defined in this documentation:

- Profile Position Mode: `required_drive_mode: 1`
- Profile Velocity Mode: `required_drive_mode: 3`
- Cyclic Synchronous Position Mode: `required_drive_mode: 8`

➢ node_layer_2dof_csp.yaml




```yaml
# struct syntax
nodes:
  node1:
    id: 1
    name: base_link1_joint
    eds_pkg: maxon_epos4_ros_canopen # optionals package  name for relative path
    eds_file: "config/can_communication_id_1.dcf" # path to EDS/DCF file
  node2:
    id: 2
    name: link1_link2_joint
    eds_pkg: maxon_epos4_ros_canopen # optionals package  name for relative path
    eds_file: "config/can_communication_id_2.dcf" # path to EDS/DCF file

defaults: # optional, all defaults can be overwritten per node
#  eds_pkg: my_config_package # optional package  name for relative path
#  eds_file: "my_config.dcf" # path to EDS/DCF file
  dcf_overlay: # "ObjectID": "ParameterValue" (both as strings)
    "60C2sub1": "10" # Interpolation time period value, to be set as the sync/interval_ms value present in canopen_bus_layer.yaml file, 10ms is recommended
    "607Dsub1": "-2147483648"     # disable software min limit
    "607Dsub2": "2147483647"     # disable software max limit

#    "6084": "10000" # Profile deceleration
#    "6085": "10000" # Quick-stop deceleration
#    "6098": "0" # No homing operation required
#    "1016sub1" : "0x7F0064" # heartbeat timeout of 100 ms for master at 127
#    "1017": "100" # heartbeat producer

# canopen_chain_node settings ..
  motor_allocator: canopen::Motor402::Allocator # select allocator for motor layer
#   motor_layer: settings passed to motor layer (plugin-specific)
  switching_state: 2 # (Operation_Enable), state for mode switching. Drive mode of operation from canopen_402 wiki
  pos_to_device: "rint(rad2deg(pos)*400*16/360)" # rad -> inc, for a MILE 800 CPT encoder and a 26:1 gearbox, 3200 = 4*800 --> 4 * 100
  pos_from_device: "deg2rad(obj6064*360/400/16)" # actual position [inc] -> rad
  vel_to_device: "vel" # rad/s -> mdeg/s
  vel_from_device: "obj606C" # actual velocity [mdeg/s] -> rad/s
  eff_to_device: "rint(eff)" # just round to integer
  eff_from_device: "0" # unset
```

CAN open setup

- CAN-USB 꽂은 후, *lsusb* 로 연결 확인
- sudo ip link set can0 type can bitrate 1000000
- sudo ip link set can0 up
- candump can0

```
gowoon@gowoon-15ZD990-VX50K:~$ lsusb
Bus 004 Device 001: ID 1d6b:0003 Linux Foundation 3.0 root hub
Bus 003 Device 001: ID 1d6b:0002 Linux Foundation 2.0 root hub
Bus 002 Device 001: ID 1d6b:0003 Linux Foundation 3.0 root hub
Bus 001 Device 030: ID 1d50:606f OpenMoko, Inc. canable gs_usb
Bus 001 Device 003: ID 04f2:b678 Chicony Electronics Co., Ltd LG Camera
Bus 001 Device 005: ID 8087:0aaa Intel Corp.
Bus 001 Device 002: ID 062a:4101 MosArt Semiconductor Corp. Wireless Keyboard/Mouse
Bus 001 Device 001: ID 1d6b:0002 Linux Foundation 2.0 root hub
gowoon@gowoon-15ZD990-VX50K:~$ sudo ip link set can0 type can bitrate 1000000
[sudo] password for gowoon:
gowoon@gowoon-15ZD990-VX50K:~$ sudo ip link set can0 up
gowoon@gowoon-15ZD990-VX50K:~$ candump can0
  can0  701   [1]  00
  can0  702   [1]  00
```

1dof ppm (예제)

- (모든 terminal : source ~/maxon_ws/devel/setup.bash)
- roscore
- roslaunch maxon_epos4_ros_canopen maxon_epos4_canopen_motor_1dof_ppm.launch
- rosservice call /maxon/driver/init

➢ publish 테스트

- rostopic pub /maxon/canopen_motor/base_link1_joint_position_controller/command std_msgs/Float64 – 10

➢ python 예제

- rosrun maxon_epos4_ros_canopen python_example_1dof_ppm.py

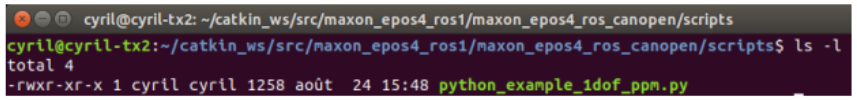
➢ cpp 예제

- rosrun maxon_epos4_ros_canopen ccp_example_1dof_ppm.ccp
- rostopic list
- rostopic echo /maxon/joint/

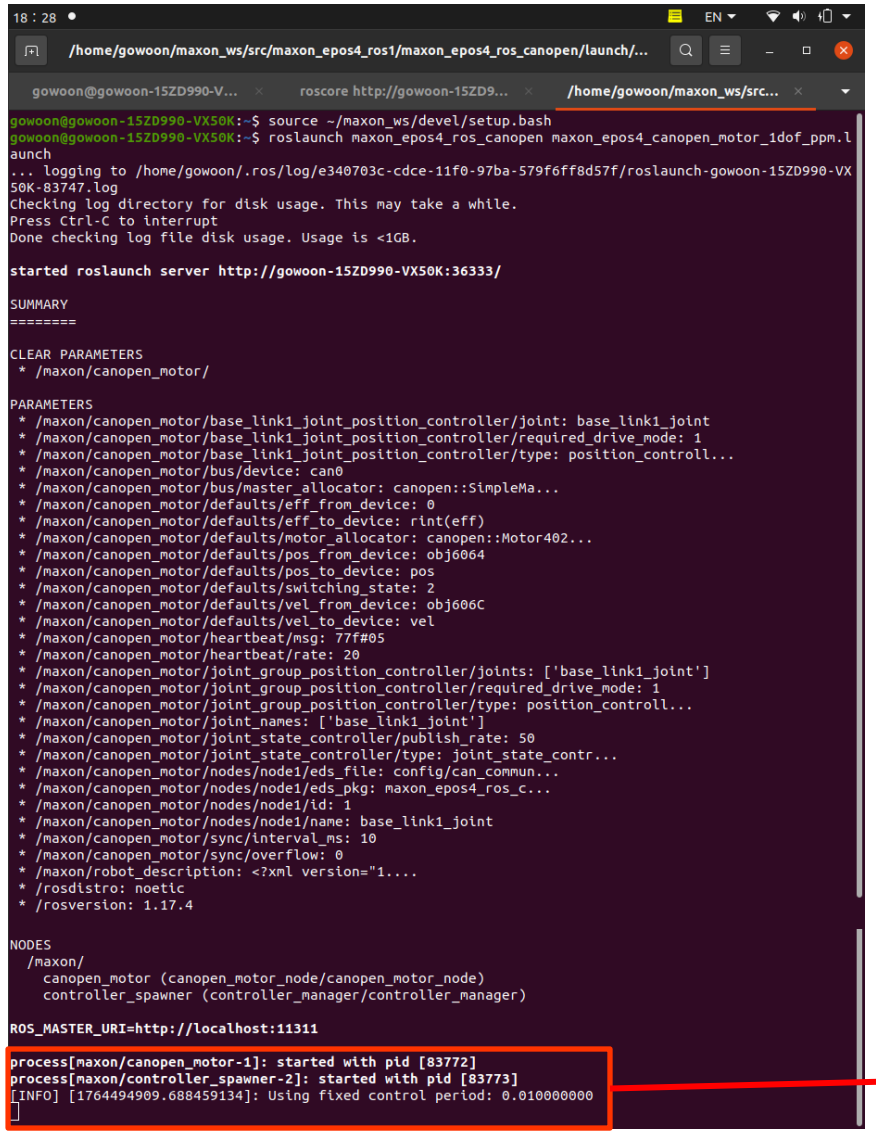
```
$ cd
~/catkin_ws/src/maxon_epos4_ros1/maxon_epos4_ros_canopen/scripts

$ chmod +x python_example_1dof_ppm.py
```

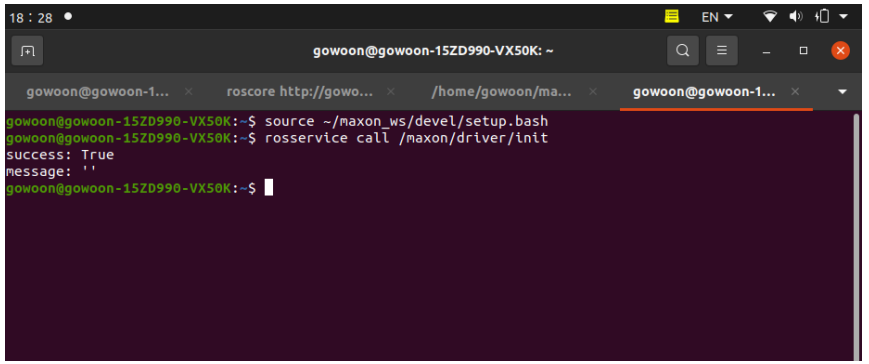
You can check that it worked by looking whether the following command displays “x” in the user permissions:

```
$ ls -l
```

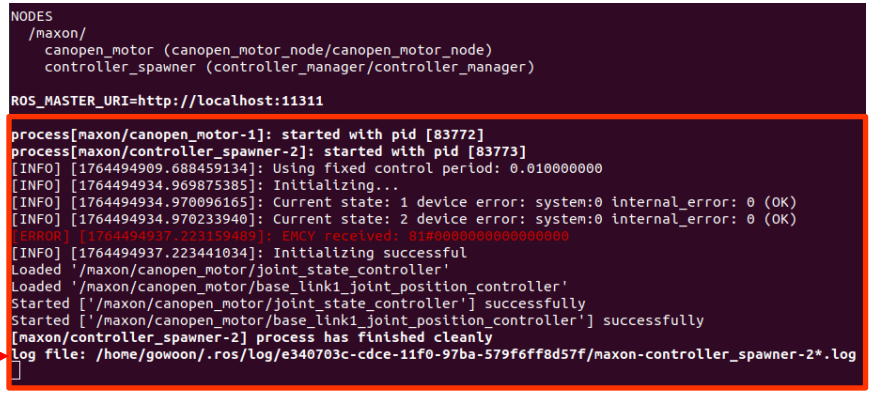


1dof ppm (예제)



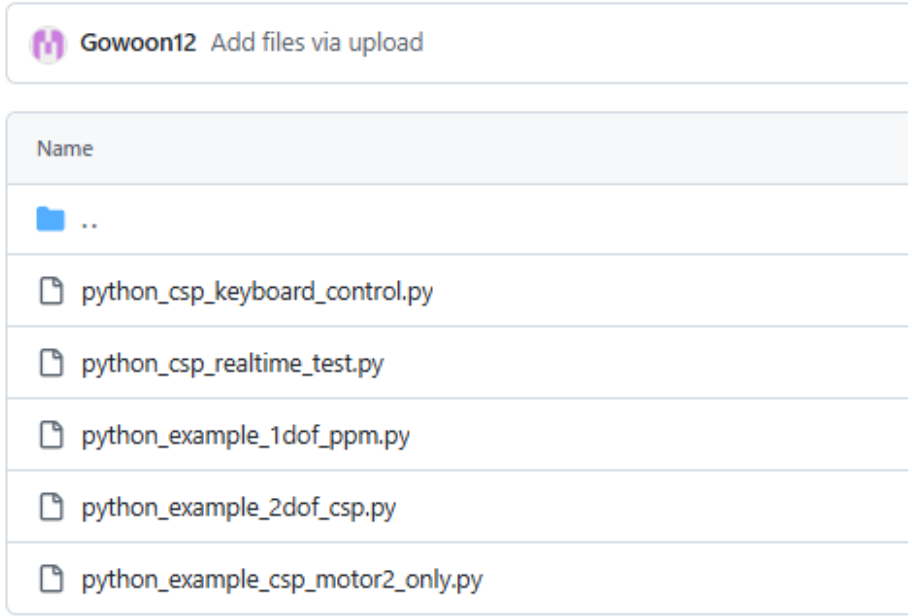


- ➢ **새로운 창에서 초기화 필요**
- rosservice call /maxon/driver/init → 이것만 하면 됨
- rosservice call /maxon/driver/halt
- rosservice call /maxon/driver/recover
- rosservice call /maxon/driver/shutdown



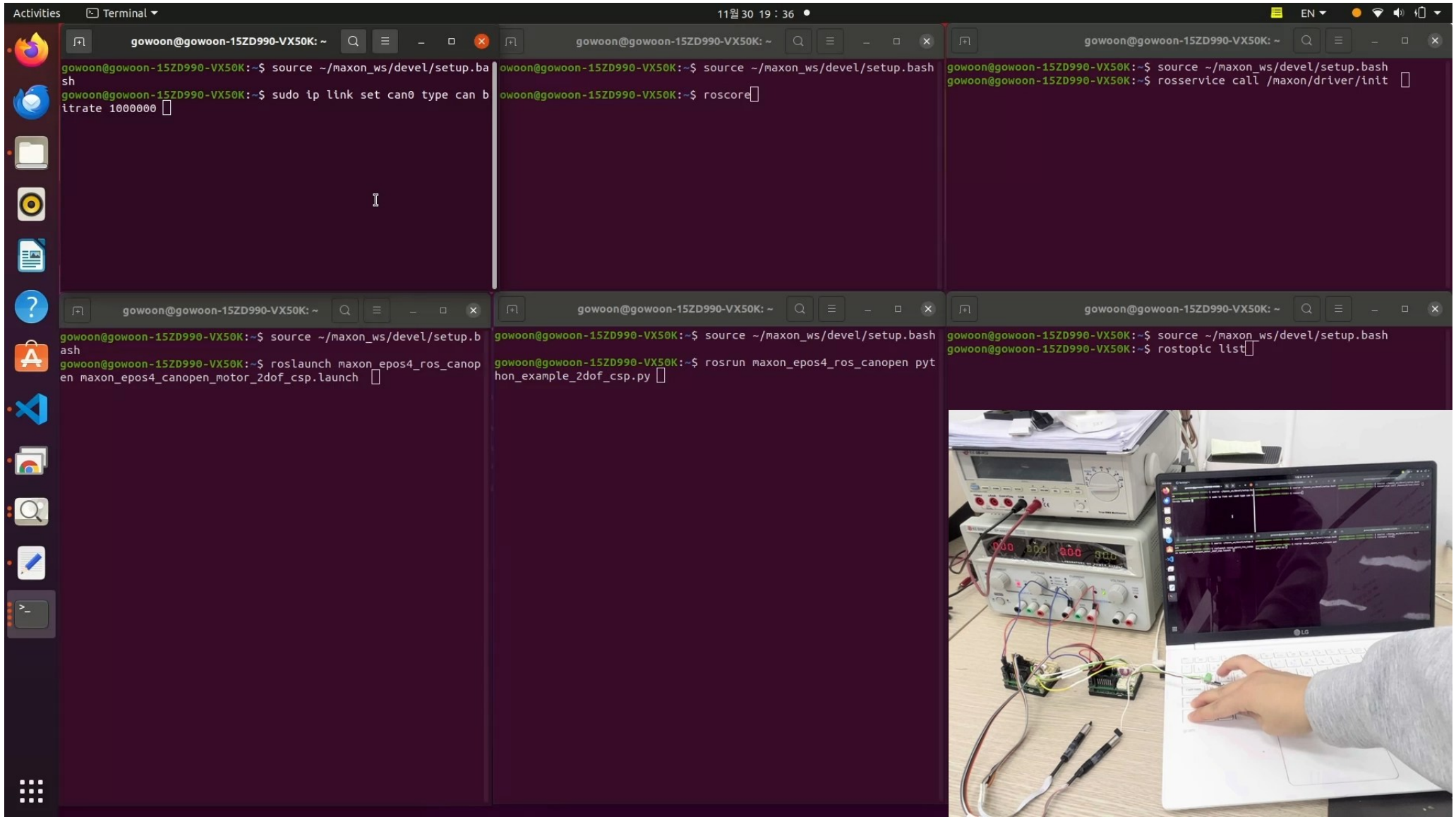
2dof csp mode

- (모든 terminal : source ~/maxon_ws/devel/setup.bash)
- roscore
- roslaunch maxon_epos4_ros_canopen maxon_epos4_canopen_motor_2dof_csp.launch
- rosservice call /maxon/driver/init
- ➢ **python 예제 (새로 작성함)** → maxon_epos4_ros1_csp / maxon_epos4_ros_canopen / scripts /
- rosrun maxon_epos4_ros_canopen python_example_2dof_csp.py



- rostopic list
- rostopic echo /maxon/joint/

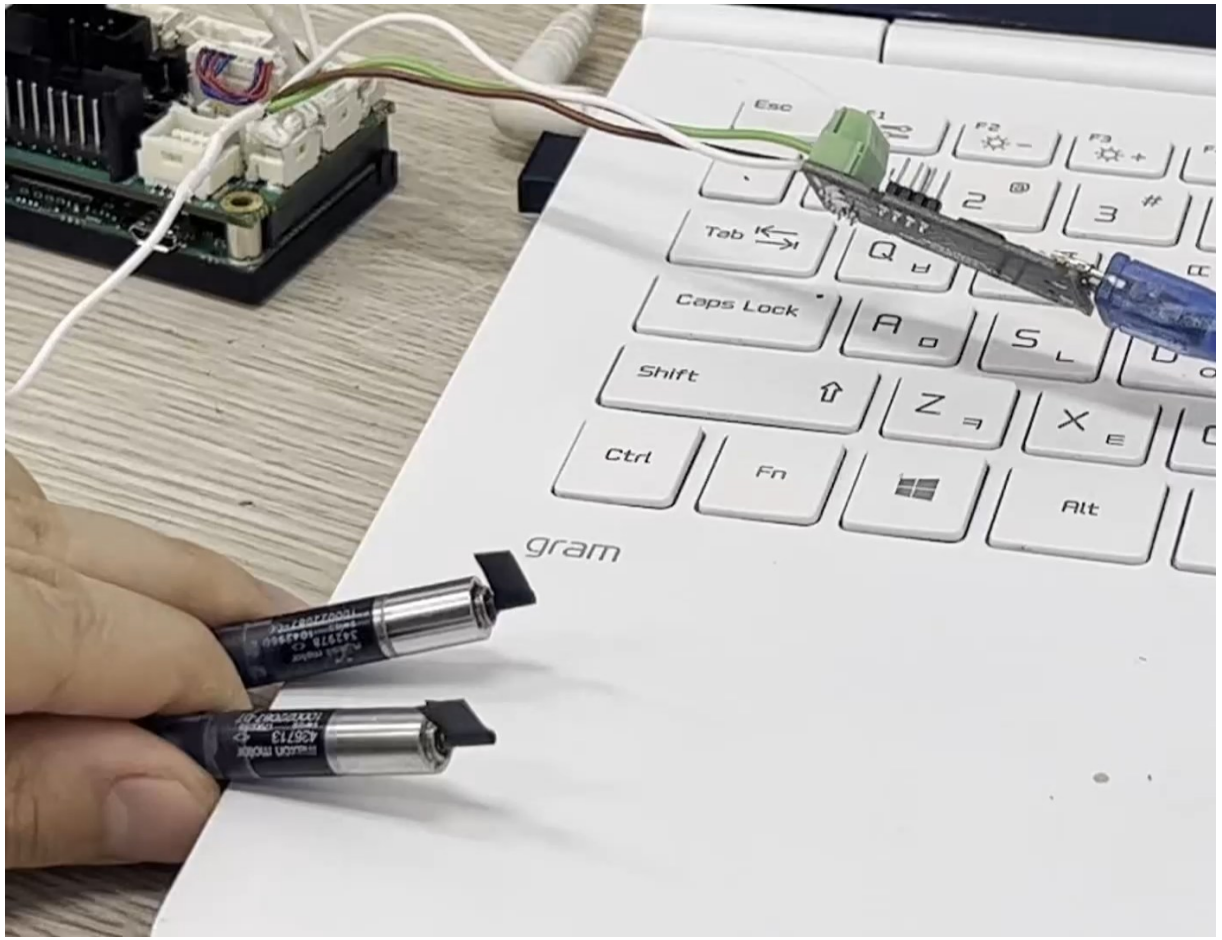
2dof csp mode



2dof csp mode

- 약 100hz

```
gowoon@gowoon-15ZD990-VX50K: ~
[INFO] [1764499188.483207]: Δt = 0.009882 sec   (101.2 Hz)
[INFO] [1764499188.493193]: Δt = 0.009985 sec   (100.2 Hz)
[INFO] [1764499188.503330]: Δt = 0.010072 sec   (99.3 Hz)
[INFO] [1764499188.513115]: Δt = 0.009896 sec   (101.1 Hz)
[INFO] [1764499188.523200]: Δt = 0.010001 sec   (100.0 Hz)
[INFO] [1764499188.533436]: Δt = 0.010184 sec   (98.2 Hz)
[INFO] [1764499188.543104]: Δt = 0.009776 sec   (102.3 Hz)
[INFO] [1764499188.553404]: Δt = 0.010200 sec   (98.0 Hz)
[INFO] [1764499188.563376]: Δt = 0.010011 sec   (99.9 Hz)
[INFO] [1764499188.573198]: Δt = 0.009875 sec   (101.3 Hz)
[INFO] [1764499188.583206]: Δt = 0.009995 sec   (100.0 Hz)
[INFO] [1764499188.593165]: Δt = 0.009976 sec   (100.2 Hz)
[INFO] [1764499188.603390]: Δt = 0.010202 sec   (98.0 Hz)
[INFO] [1764499188.613207]: Δt = 0.009798 sec   (102.1 Hz)
[INFO] [1764499188.623198]: Δt = 0.010015 sec   (99.8 Hz)
[INFO] [1764499188.633383]: Δt = 0.010126 sec   (98.8 Hz)
[INFO] [1764499188.643177]: Δt = 0.009864 sec   (101.4 Hz)
[INFO] [1764499188.653137]: Δt = 0.009978 sec   (100.2 Hz)
[INFO] [1764499188.663300]: Δt = 0.010082 sec   (99.2 Hz)
[INFO] [1764499188.673177]: Δt = 0.009949 sec   (100.5 Hz)
[INFO] [1764499188.683221]: Δt = 0.010027 sec   (99.7 Hz)
[INFO] [1764499188.693213]: Δt = 0.010013 sec   (99.9 Hz)
[INFO] [1764499188.703401]: Δt = 0.010170 sec   (98.3 Hz)
[INFO] [1764499188.713174]: Δt = 0.009764 sec   (102.4 Hz)
[INFO] [1764499188.723251]: Δt = 0.010019 sec   (99.8 Hz)
[INFO] [1764499188.733214]: Δt = 0.010014 sec   (99.9 Hz)
[INFO] [1764499188.743281]: Δt = 0.010022 sec   (99.8 Hz)
[INFO] [1764499188.753122]: Δt = 0.009916 sec   (100.8 Hz)
[INFO] [1764499188.763321]: Δt = 0.010126 sec   (98.8 Hz)
[INFO] [1764499188.773350]: Δt = 0.010021 sec   (99.8 Hz)
[INFO] [1764499188.783104]: Δt = 0.009841 sec   (101.6 Hz)
[INFO] [1764499188.792931]: Δt = 0.009928 sec   (100.7 Hz)
[INFO] [1764499188.803219]: Δt = 0.010168 sec   (98.3 Hz)
[INFO] [1764499188.813042]: Δt = 0.009917 sec   (100.8 Hz)
```



Thank you