# Local Indoor Positioning System - Manual P-108-061/10G/W6E

## Applications

The system can be used by the user to ascertain the location of the Low-power Indoor Client (6XD) device relative to the Low-power Indoor Accesspoint (6ID) device and the user can utilize this information for short distance survey and positioning purposes.

For industrial and robotics use.


**Figure 1: Prototype top view**

## Features

- Frequency range **6.000 GHz to 7.000 GHz**
- Distance range **0.25m to 10m**
- 10Gbps Ethernet interface (IEEE 802.3ae)
- 10Gbps Synchronization interface
- 1D positioning
- 2D positioning
- Ultra high dynamic range receiver
- AC power adapter or battery power
- Low power consumption

## Description

System includes two antennas and two high speed 10Gbps interfaces. One 10Gbps interface is configured in Ethernet mode IEEE 802.3ae. System can be powered from DC power source (10∼14V DC) or by external power adapter (90∼264V AC 47∼63Hz).

The transmission mode is SISO (Single Input Single Output), single antenna is used for transmission and reception.

The system range can be extended by connecting several units by a 10Gbps synchronization interface.

# Regulatory information

## FCC

You are cautioned that changes or modifications not expressly approved by the part responsible for compliance could void the user's authority to operate the equipment.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

**This device complies with Part 15 of the FCC Rules, operation is subject to the following two conditions:**

1. this device may not cause harmful interference and
2. this device must accept any interference received, including interference that may cause undesired operation

**FCC RF Radiation Exposure Statement:**

This Transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

This equipment complies with RF radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with a minimum distance of 20 cm between the radiator and your body.

FCC regulations restrict operation of this device to indoor use only.

The operation of this device is prohibited on oil platforms, cars, trains, boats, and aircraft, except that operation of this device is permitted in large aircraft while flying above 10,000 feet.

Operation of transmitters in the 5.925-7.125 GHz band is prohibited for control of or communications with unmanned aircraft systems.

## Canadian Notice

This device contains licence-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's licence-exempt RSS(s). Operation is subject to the following two conditions:

1. This device may not cause interference.
2. This device must accept any interference, including interference that may cause undesired operation of the device

## Avis Canadien

L'émetteur/récepteur exempt de licence contenu dans le présent appareil est conforme aux CNR d'Innovation, Sciences et Développement économique Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes :

1. L'appareil ne doit pas produire de brouillage;
2. L'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

**Caution: Exposure to Radio Frequency Radiation.**

1. To comply with the Canadian RF exposure compliance requirements, this device and its antenna must not be co-located or operating in conjunction with any other antenna or transmitter.
2. To comply with RSS 102 RF exposure compliance requirements, a separation distance of at least 20 cm must be maintained between the antenna of this device and all persons.

**Attention: exposition au rayonnement radiofréquence.**

1. Pour se conformer aux exigences de conformité RF canadienne l'exposition, cet appareil et son antenne ne doivent pas être co-localisés ou fonctionnant en conjonction avec une autre antenne ou transmetteur.
2. Pour se conformer aux exigences de conformité CNR 102 RF exposition, une distance de séparation d'au moins 20 cm doit être maintenue entre l'antenne de cet appareil et toutes les personnes.

Devices shall not be used for control of or communications with unmanned aircraft systems.

Les dispositifs ne doivent pas être utilisés pour commander des systèmes d'aéronef sans pilote ni pour communiquer avec de tels systèmes.

1. Operation shall be limited to indoor use only.
2. Operation on oil platforms, automobiles, trains, maritime vessels and aircraft shall be prohibited except for on large aircraft flying above 3,048 m (10,000 ft).

1. leur utilisation doit être limitée à l'intérieur seulement
2. leur utilisation à bord de plateformes de forage pétrolier, d'automobiles, de trains, de navires maritimes et d'aéronefs doit être interdite, sauf à bord d'un gros aéronef volant à plus de 3 048 m (10 000 pi) d'altitude.

## Quickstart

- Read the *Regulatory information* on page page 2 carefully.
- See the location of connectors and interfaces at images in the chapter *Device description* (page 5).
- Screw the device to a standard aluminum profile or to the custom mechanics. Alternatively, you can use the supplied plastic legs, which are suitable for testing the equipment. The fan must not be covered and nothing must interfere with the fan space. Keep in mind that the antennas minimum body distance is 20cm. More details in section *Installation instructions and connection to the computer* (page 7).
- Insert 10GBps SFP module into the ETH port cage, insert Fibre Optics cable to the SFP module. Detailed description is in chapter *Ethernet connection* (page 8).
- Plug the power supply into the power connector and turn on the power supply to start up the device. See the section *Power* (page 5).
- Default device IP address is *192.168.57.10*, netmask *255.255.255.0*, gateway *192.168.57.1*.
- The computer software and SW requirements are specified in section *SW requirements* (page 9). Prepare the computer as described in the *Software instructions* section (page 9).
- Set the computer's IP address to *192.168.57.1*, netmask *255.255.255.0*. Verify the connection between the computer and device by `ping 192.168.57.10` command. The device has to respond with a response time of less than 10ms.
- Start software and test the positioning as described in chapter *Positioning* (page 10)

## System description

The unit can be configured in two modes: Low-power Indoor Accesspoint (6ID) or Low-power Indoor Client (6XD).

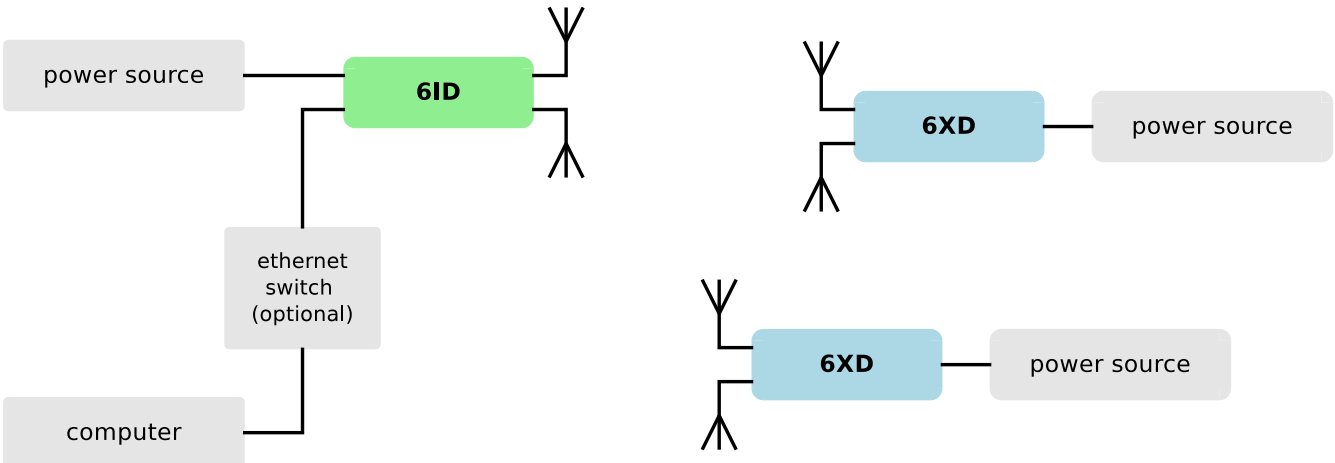


**Figure 2: System block diagram**

A unit operating in 6ID mode determines the position of a unit operating in 6XD mode relative to itself. The unit operating in 6XD mode is under the control of the unit operating in 6ID mode, and does not initiate communications or measurements on its own.

The unit operating in 6ID mode starts transmission after receiving an inquiry via the 10G Ethernet interface. The 6ID mode unit then synchronizes with a unit operating in 6XD mode to determine that unit's position.

The system uses FMCW carrier modulation with a maximum channel bandwidth of 150 MHz. The system can employ multiple channels in 6.000 GHz to 7.000 GHz range but does not transmit any signal continuously. Using a larger number of channels increases the accuracy of the position estimates, although no more than one channel is occupied simultaneously.

## Device description

The device uses two antennas for its function, see Figure 3. The antennas must not be covered and must point to the localization area. The minimum body distance is 20cm.

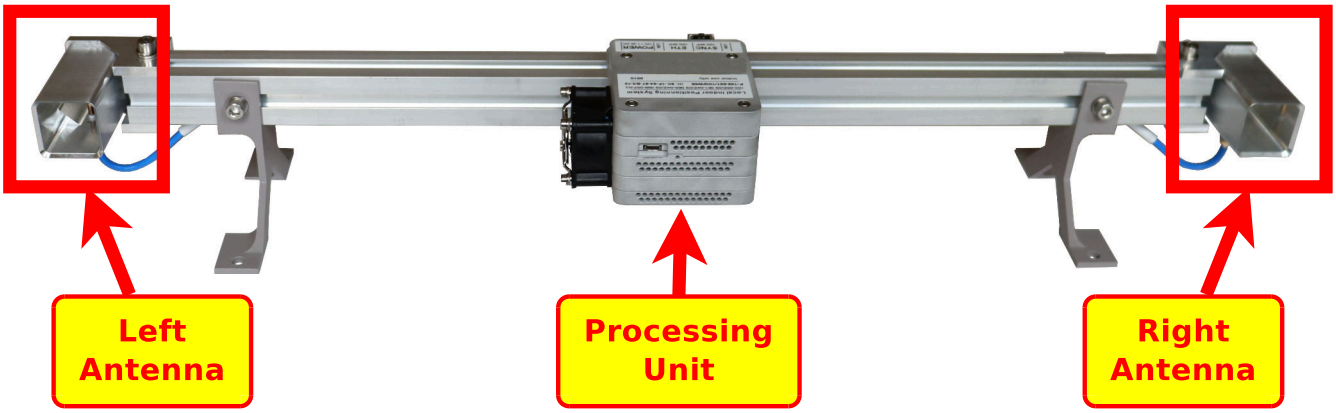


**Figure 3: Antenna positions**

The P-108-061/10G/W6E device has one power connector and two 10Gbps communication ports, see Figure 5 for the connector positions.

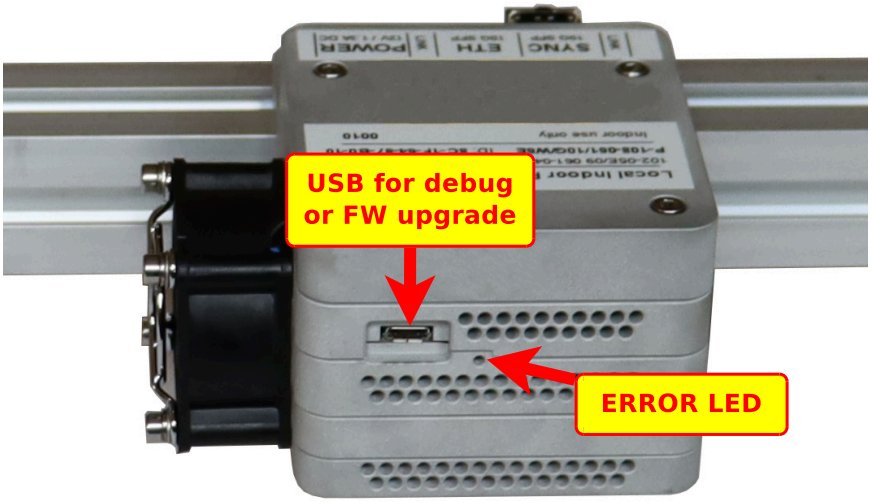


**Figure 4: Front panel description**

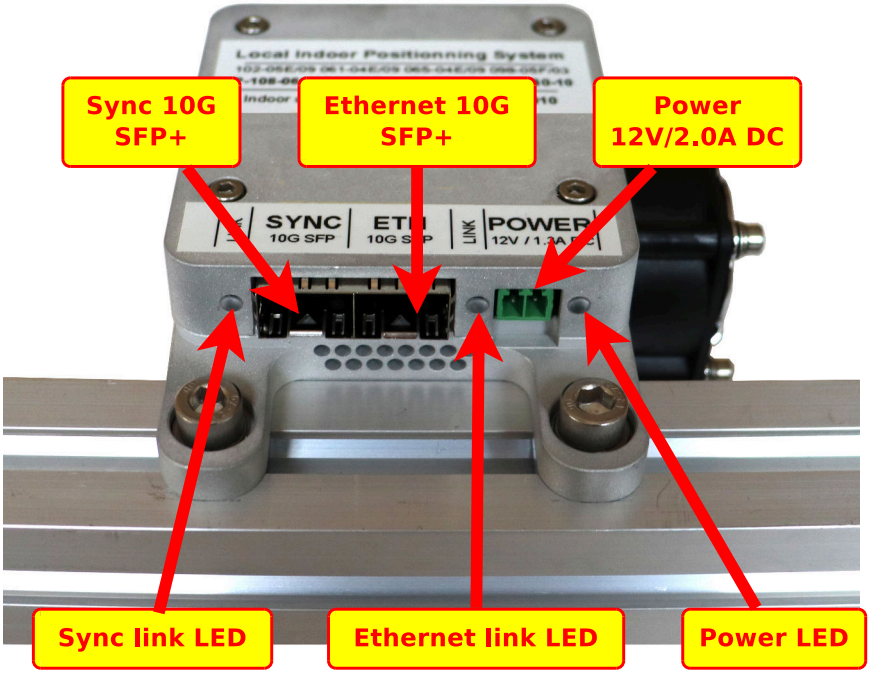


**Figure 5: Back panel description**

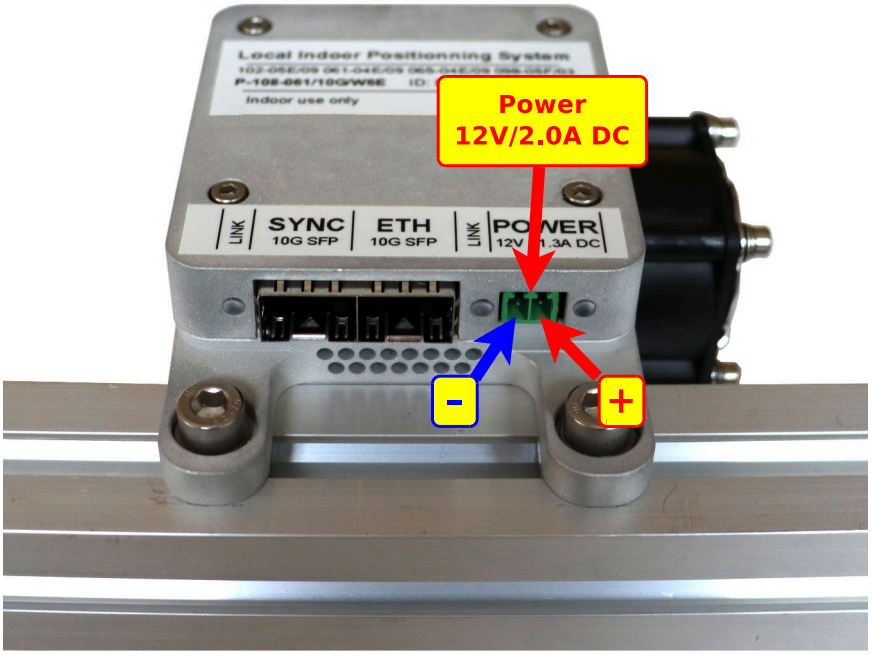


**Figure 6: Pover polarity**

# Installation instructions and connection to the computer

### Mounting

The P-108-061/10G/W6E device uses standard profiles from the aluminium modular system. Use of standardized profiles simplifies device integration. Parts for mounting to aluminium system profiles are commonly available from many different manufacturers.

An example of the installation is shown in Figure 7. The device is mounted by 2pcs screws M6 to standard alumimnum profile or to the custom mechanics. Keep in mind following istallation rules:

- The antennas must point to the localization area.
- The recommended height above floor is between 50cm and 125cm.
- The antennas must not be covered.
- The minimum body distance is 20cm.
- The fan must not be covered. Nothing must obstruct the air flow around the fan. The minimum empty space around fan is 50mm.

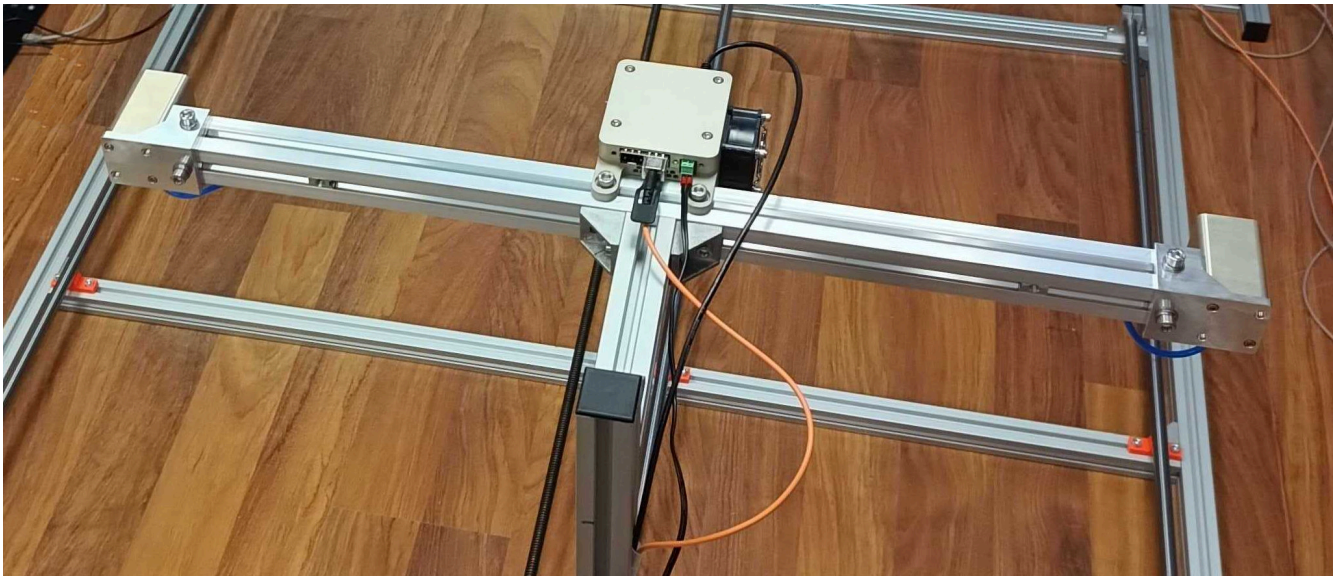

**Figure 7: P-108-061/10G/W6E device installation example**

## Power

### Operation from DC power source

The device requires a DC power supply with a nominal voltage of 12 V. The average current is about 1.5 Amps (∼17 Wats). **The recommended power suply is 12V / 2A DC**.

The device accepts the input voltage between 10V and 14V DC

To connect the power supply, use the *Wurth* connector product number *691361100002* (WR-TBL Series 3611 - 3.50 mm pitch). **Pin 1 is connected to ground (GND) and pin 2 is positive voltage (+12V DC).** The polarity of the power connector is shown in Figure 6 (page 6)

### Operation from AC power adapter

The device can be powered from AC power adapter. The nominal output voltage of the power adapter is 12V DC and the recommended current is 2.0 Amps or more. List of compatible power adapters:

- *MEAN WELL GST40A12-P1J*
- ***MEAN WELL GST60A12-P1J*** (recommended)
- *MEAN WELL GE30I12-P1J*

## Ethernet connection

The device suports 10G ethernet interface only (10GBASE-SR SFP+ modules). The block diagram in Figure 8 shows a direct connection to a computer using a 10Gbps optical network. The 10G Ethernet adapter must support the MTU size 9600 bytes.

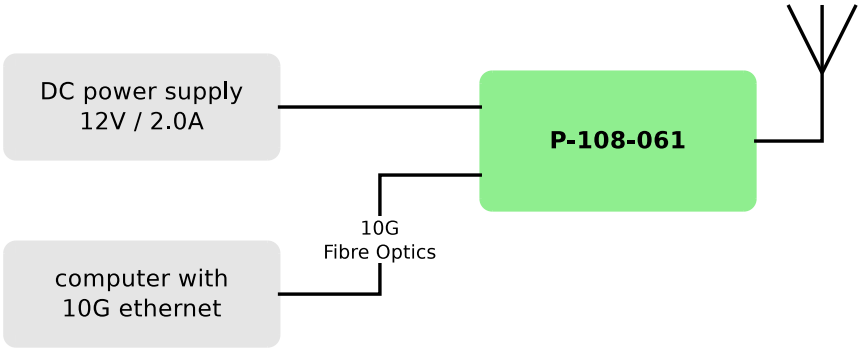


**Figure 8: Connection to the computer by 10G Ethernet interface**

The 1G or 2.5G or 5G ethernet modes are not supported by FW and SW. The 1G, 2.5G or 5G connection is possible through 10G Ethernet switch only (for example Mikrotik CRS305-1G-4S+IN or similar). The block diagram in Figure 9 shows the connection to a computer using a 1Gbps/2.5Gbps/5Gbps/10Gbps optical or copper network. The 10G Ethernet switch must support the MTU size 9600 bytes.

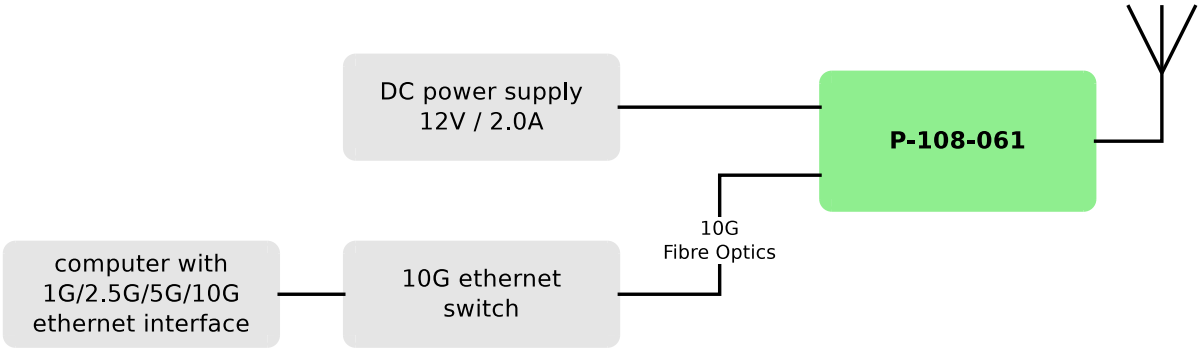


**Figure 9: Connection to the computer by 1G/2.5G/5G or 10G Ethernet interface**

### List of compatible network accessories

List of compatible SFP+ modules (10G, 850nm, LC, MMF):

- *TP-Link TL-SM5110-SR*
- ***Intel E10GSFPSR*** (recommended)
- *FS SFP-10GSR-85*

The 10G Ethernet card must support the MTU size 9600 bytes. List of compatible dual 10G Ethernet cards:

- Any Network Card with ***Intel X520-DA2 (Intel E10G42BTDA)*** chipset (recommended)
- Any Network Card with *Broadcom BCM57810S* chipset

The 10G Ethernet switch must support the MTU size 9600 bytes. List of compatible 10G switches:

- ***Mikrotik CRS305-1G-4S+IN*** (recommended)
- *Mikrotik CRS310-1G-5S-4S+IN*
- *Mikrotik CSS610-8G-2S+IN*
- *Arista DCS-7050S*

## Software instructions

### SW requirements

The processing SW uses Linux OS only. The recommended Linux distribution is **Ubuntu 22.04.3 LTS**. Following SW packages has to be installed at the computer:

- **NVIDIA CUDA** version 11.4, NVIDIA CUDA Installation Guide for Linux.
- **SW-108-061** software package
- **Python 3** software package

The P-108-061/10G/W6E device uses high datarate and Jumbo packets for communication with the computer. The following optimization of the 10G Ethernet interface must be performed on a computer:

- MTU size 9600 bytes (Jumbo packets)
- Setting the maximum RX and TX buffer sizes on the Ethernet card chipset.
- Setting large buffers for Ethernet communication in Linux operating system.

Reconfiguring buffers and MTU is done by a script during Linux OS boot. This script is part of the SW-108-061 installation package.

Hardware setup for SW tests is shown in Figure 12 and in Figure 11.

### Initial network configuration

Default device IP address is *192.168.57.10*, netmask *255.255.255.0*, gateway *192.168.57.1*.

To initially set up the device, set the computer's IP address to *192.168.57.1*, netmask *255.255.255.0*.

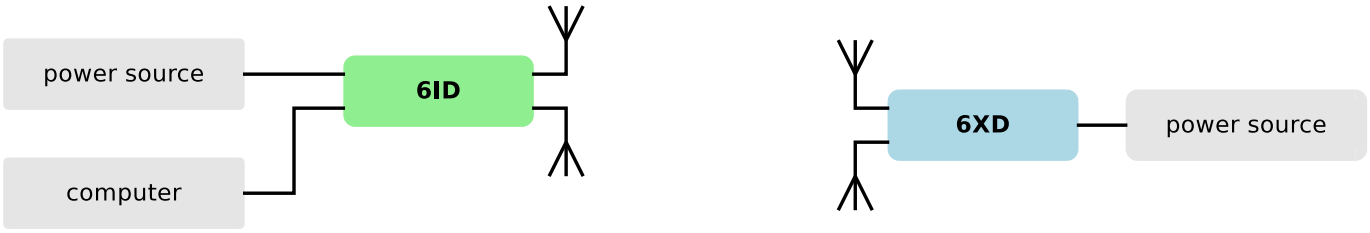


**Figure 10: Block diagram for SW tests**

### Positioning

Open a Linux terminal and change directory to the *SW-108-061* software installation directory.

```
cd /data/SW-108-061/eth_loop
```

The software is launched as follows

```
./build/sw-108-061
```

The software then starts to periodically print out the coordinates.

The program help is printed with the following command

```
./build/sw-108-061 --help
```


**Figure 11: Location of the devices for positioning tests**

### Changing the IP address, static address

Open a Linux terminal and change directory to the *SW-108-061* software installation directory.

```
cd /data/SW-108-061/
```

Connect to the device by following command

```
./terminal.py --ip-unit [current device IP address]
```

Now we are connected to the device and we can send commands to the device. The device IP address is changed by `ifconfig` command. The command structure is following:

```
ifconfig [new device IP address]/[netmask] [gateway]
```

For example, if we want to change the IP address to *192.168.58.10*, netmask *255.255.255.0*, gateway *192.168.58.1*, then we send the following command to the device:

```
ifconfig 192.168.58.10/24 192.168.58.1
```

Restart the device by following command:

```
reset
```

The Python script exits after the `reset` command is entered.

Change the IP address of the computer.

Verify the connection between computer and device by `ping` commad

```
ping [new device IP address]
```

### Changing the IP address, enable DHCP address

Open a Linux terminal and change directory to the *SW-108-061* software installation directory.

```
cd /data/SW-108-061/
```

Connect to the device by following command:

```
./terminal.py --ip-unit [current device IP address]
```

Now we are connected to the device and we can send commands to the device. Change the IP address to an address from the DHCP server:

```
ifconfig dhcp on
```

Restart the device by following command:

```
reset
```

The Python script exits after the `reset` command is entered.

The change takes effect after device reboot.

Change the IP address of the computer.

Verify the connection between computer and device by `ping` commad

```
ping [new device IP address]
```

### Changing the IP address, disable DHCP address

Open a Linux terminal and change directory to the *SW-108-061* software installation directory.

```
cd /data/SW-108-061/
```

Connect to the device by following command:

```
./terminal.py --ip-unit [current device IP address]
```

Now we are connected to the device and we can send commands to the device. To disable DHCP mode and switch back to a static IP address, use the following command in the terminal:

```
ifconfig dhcp off
```

Then restart the device by following command:

```
reset
```

The change takes effect after device reboot.

### Firmware upgrade

Connect the P-108-061/10G/W6E device by the USB interface.

Open a Linux terminal and change directory to the *FW-108-061-v[release version]* directory.

```
cd /data/FW-108-061-v[release version]/
```

Run the following batch to program the device:

```
./fw_upgrade.sh
```

After startup, the batch script backs up the unit's configuration, then programs the device with new firmware, and finally restores the unit's configuration after programming. During the programming process you will be prompted to power cycle the device (power off, wait 5 seconds, power on).

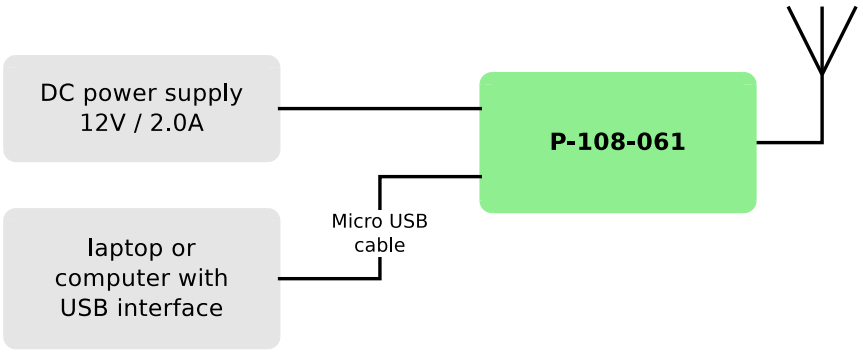


**Figure 12: FW upgrade block diagram**

# Contents