



GATEWAY

VEGA BS

User Manual

VEGA BS gateway is designed to deploy LoRaWAN network within 863-870 MHz frequency band.

VEGA BS operates with Linux operating system and is supplied with pre-installed Packet forwarder software.

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This document applies to the following products:

| Product name | Type number |
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| VEGA BS | VEGA BS-1 |
| | VEGA BS-2 |

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| 01 | 27.04.2017 | KEV | Document creation date |
| 02 | 15.05.2017 | PKP | Minor edits |
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| 08 | 28.08.2017 | KEV | Minor edits in the « Configuration of a static IP-adress » |
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INTRODUCTION

This manual is designated for VEGA BS-1 and VEGA BS-2 gateways (hereinafter – the gateway) manufactured by LLC Vega-Absolute and provides information on powering and activation procedure, control commands and functions of the gateway.

This manual is targeted at specialists familiar with installation work fundamentals for electronic and electrical equipment.



The gateway shall be installed and adjusted by qualified specialists in order to ensure proper operation of the device.

1 DESCRIPTION AND OPERATION PRINCIPLES

VEGA BS gateway is designed to deploy LoRaWAN network within 863-870 MHz frequency band.

The gateway operates with Linux operating system and is supplied with pre-installed Packet forwarder software.



Fig. 1.1 Appearance of VEGA BS gateway

The gateway is powered and communicates with the server via the Ethernet channel.

The device is configured through Ethernet via SSH protocol with any terminal program (e.g. PuTTY).

VEGA BS-2 has an additional 3G-module for communication channel and GPS/GLONASS-module for gateway positioning, and internal clock synchronizing with navigation-satellites signals.

2 SPECIFICATION

| | BS-1 | BS-2 |
|---|--------------------------------|------------------|
| Main | | |
| GPS/GLONASS module | no | yes |
| 3G modem | no | yes |
| Server communication link | Ethernet | Ethernet, GSM 3G |
| Operating system | Linux | |
| USB-port | yes | |
| Operating temperatures | -40...+85 °C | |
| LoRaWAN | | |
| Number of LoRa channels | 8 | |
| Frequency band | 863-870 MHz | |
| Power output | up to 500 mW | |
| Antenna connector | SMA | |
| Radio coverage in restrained urban conditions | up to 5 km | |
| Radio coverage within line of sight | up to 15 km | |
| Power | | |
| Power consumption | 3 W | 4 W |
| Power supply | Passive POE 4,5(+) 7,8(-) 15 W | |
| Case | | |
| Housing dimensions | 165 x 110 x 40 mm | |
| Ingress protection rating | IP65 | |
| Mounting | mast supports | |

3 OPERATION

The gateway terminal board has control and indication instruments, input and output interfaces. Detailed information see below.

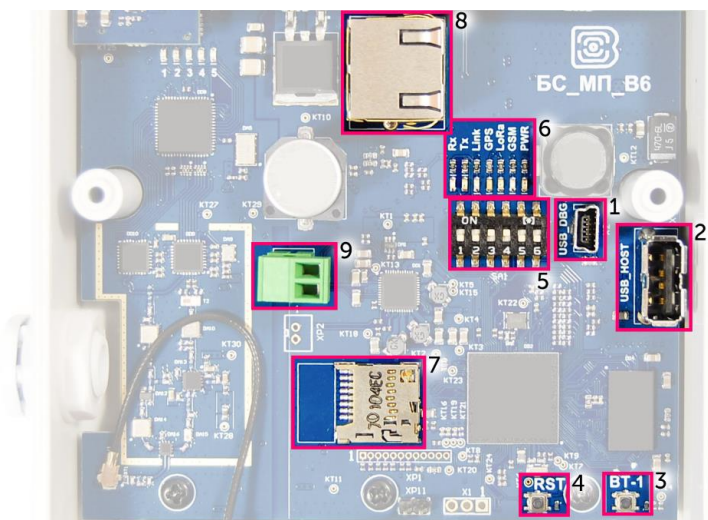


Fig. 3.1. Control and indication instruments, input and output interfaces.

- 1 – mini USB-port for connection to a computer
- 2 – USB-host for connection of external devices
- 3 – */Spare/*
- 4 – gateway reset button
- 5 – service DIP-switches
- 6 – performance indicators of various systems
- 7 – micro SD-card connector
- 8 – Ethernet-cable connector
- 9 – additional power connector (optional)

CONTACTS

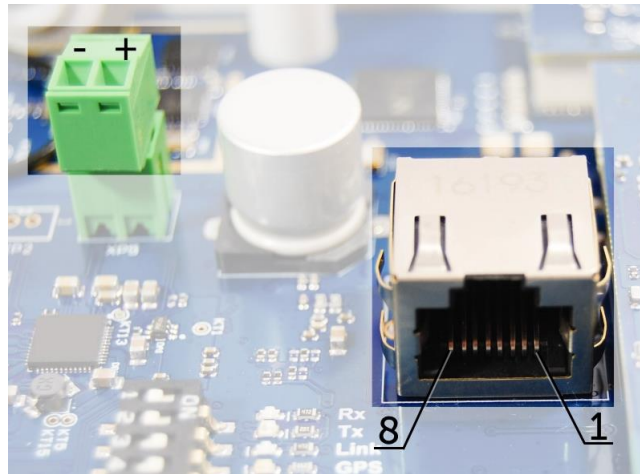


Fig. 3.2. Contacts in the connectors.

The gateway is connected to the network with 8-core network cable (twisted pair) through connector on the terminal board (fig. 3.1 (8)). Cable shall be crimped in compliance with T568A and T568B standards. Contacts shall be numerated 1-8 right-to-left.

Colors are shown for cable T568B:

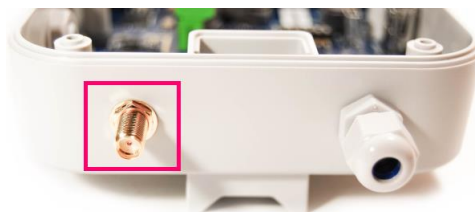
| Contact no. | Color | Designation |
|-------------|------------------|-------------|
| 1 | Orange-and-white | TD+ signal |
| 2 | Orange | TD- signal |
| 3 | Green-and-white | RD+ signal |
| 4 | Blue | Power |
| 5 | Blue-and-white | Power |
| 6 | Green | RD- signal |
| 7 | Brown-and-white | Ground |
| 8 | Brown | Ground |

There is an additional power connector on the board (fig. 3.1 (9)). It can be connected only when power contacts 4, 5 and 7, 8 in the network cable are disabled. Permissible power voltage is 12-48 V. Minimum power is 20 W.

INPUT AND OUTPUT INTERFACES

The gateway has a mini-USB-port for connecting to a computer and working via the SSH protocol (Fig. 3.1 (1)), and a USB-host for connecting of external devices via a USB cable (Fig. 3.1 (2)). There is a slot on the board for a SD card (fig. 3.1 (7)).

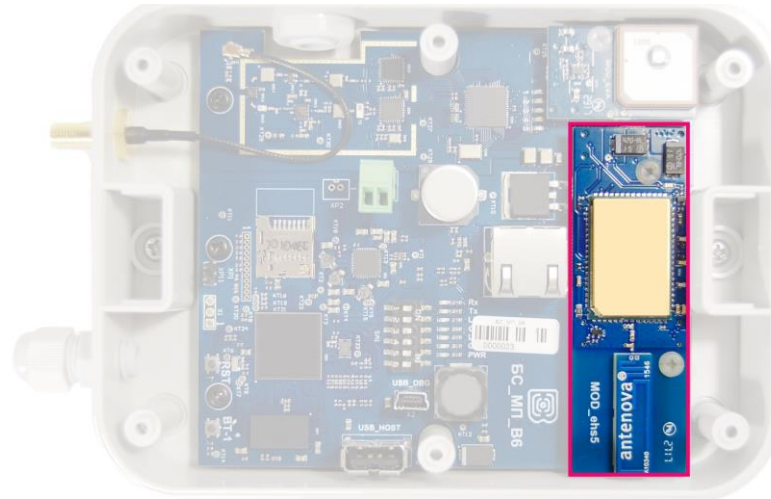
In addition, there is a SMA socket on the gateway housing for connecting of the antenna supplied with the device.



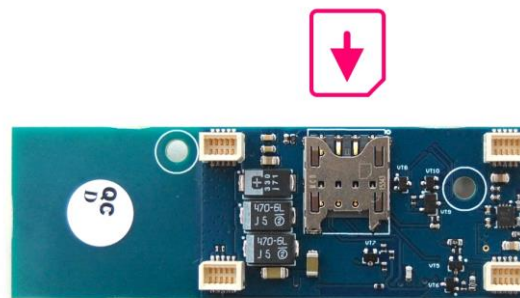
For high-quality signal reception, it is important to properly place the gateway antenna. For antenna installing recommendations, see the [Appendix](#).

SIM CARD INSTALLATION AT THE BS-2

The Vega BS-2 gateway includes a GSM module, which is installed on the main board.



The SIM slot is located on the back of the module. To install the SIM card, you must disconnect the GSM module from the main board and turn it over.



The SIM card of the micro-SIM format is inserted into the slot, after which the GSM module is replaced.

CONTROL INSTRUMENTS – PUSHBUTTONS AND SWITCHES

There are two buttons on the gateway board. One button is spare for further developments (Fig. 3.1 (3)). Push the other button (Fig. 3.1 (4)) for the gateway instantaneous rebooting.

In addition, there are DIP switches (Fig. 3.1 (5)) on the board used to select the download option of the firmware image: from internal memory, from the SD card or via mini-USB from the computer. The switches are used only in service conditions. In operating mode, only switches 3 and 4 shall be enabled, see fig. 3.3.

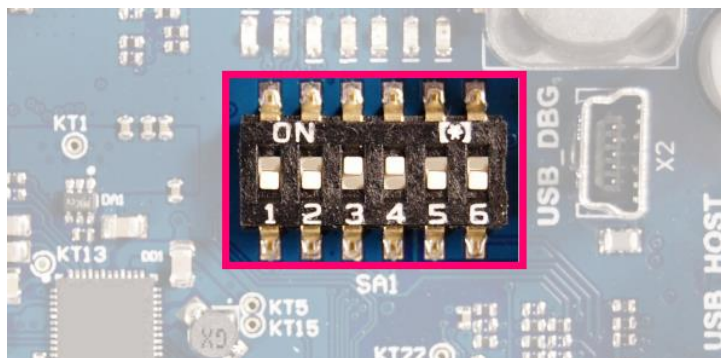


Fig. 3.3. Operating position of DIP-switches

INDICATION

There are several LEDs (fig. 3.1 (6)) on the terminal board, which signals are shown in the table below. They indicate operation of particular systems: power (on / off), visibility of GPS satellites, GSM modem (on / off), operation of the LoRa signal processing program (Packet forwarder on/off), Ethernet activity, the data exchange via mini USB port.

| LED | Color | Indication |
|------------------|--------|--|
| Rx | Green | <i>Flashes</i> – data exchange via USB_DBG port |
| Tx | Red | |
| Link | Green | <i>Flashes</i> – activity via Ethernet |
| GPS ¹ | Blue | <i>Doesn't light</i> – no data from GPS-receiver |
| | | <i>Flashes</i> – there data exist, but are not valid for use by Packet forwarder |
| | | <i>Lights</i> – location identified |
| LoRa | Yellow | <i>Lights</i> – Packet forwarder is started |
| | | <i>Doesn't light</i> – Packet forwarder is stopped |
| GSM | Green | <i>Lights</i> – GSM-modem is enabled |
| | | <i>Doesn't light</i> – GSM-modem is disabled |
| PWR | Red | <i>Lights</i> – gateway is powered |
| | | <i>Doesn't light</i> – gateway is not powered |

¹ GPS LED indicates GPS system functioning only when Packet forwarder is started (LoRa LED lights).

4 GATEWAY CONFIGURATION

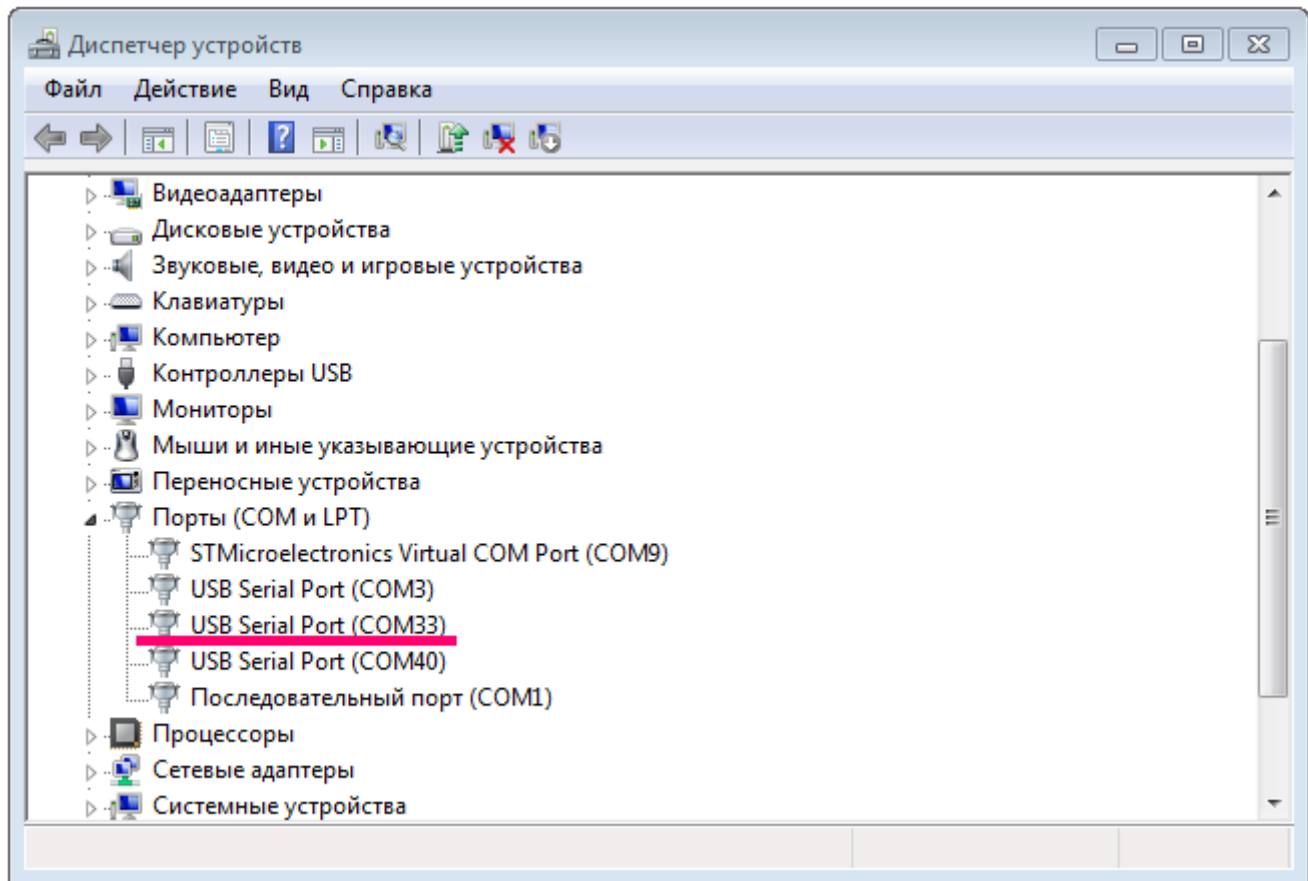
CONNECTION TO THE COMPUTER – START OF WORK

The gateway is configured when connected to a computer using a terminal program. Connection is possible, for example, with a mass-market PuTTY program. There are two ways of connection to the gateway – via a serial port or SSH.

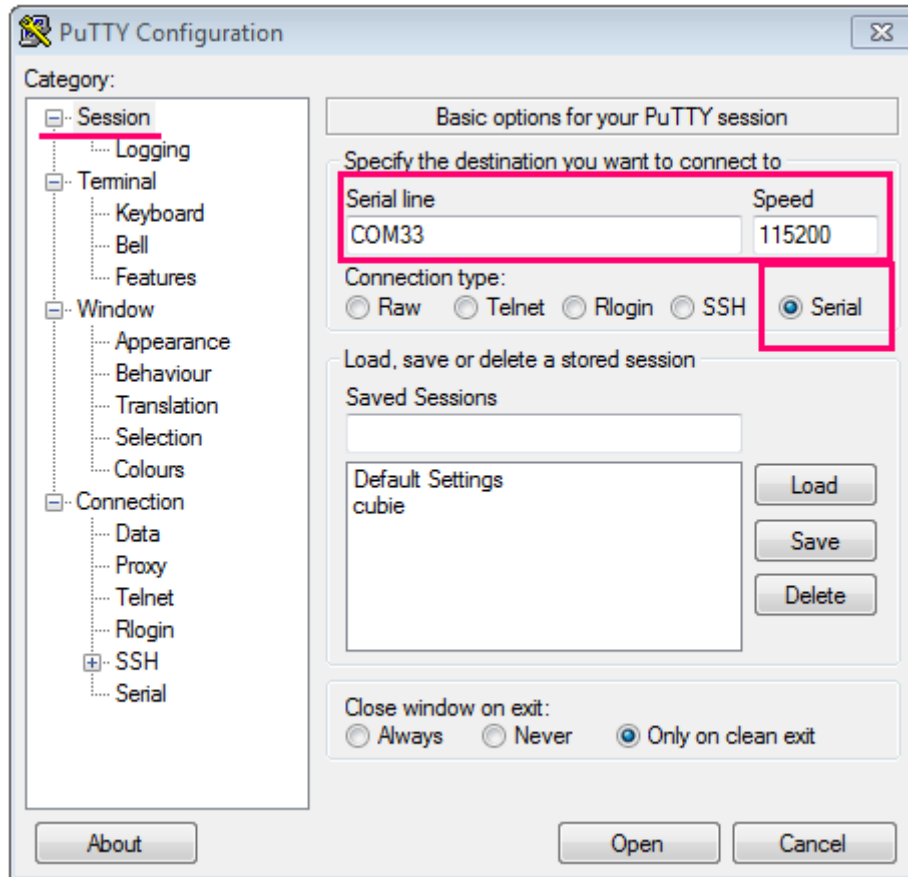
1. Connection via a serial port

In case of a serial port, connect the gateway to a personal computer with a mini-USB connector by a cable. On the board, the required port is designated as USB_DBG (Fig. 3.1 (1)). Next, connect to a virtual COM port by installing the driver for MCP2200. **"Ports (COM and LPT)"** menu appears at the device manager.

Search **"USB Serial Port"** in the **"Ports"** menu and see its number.



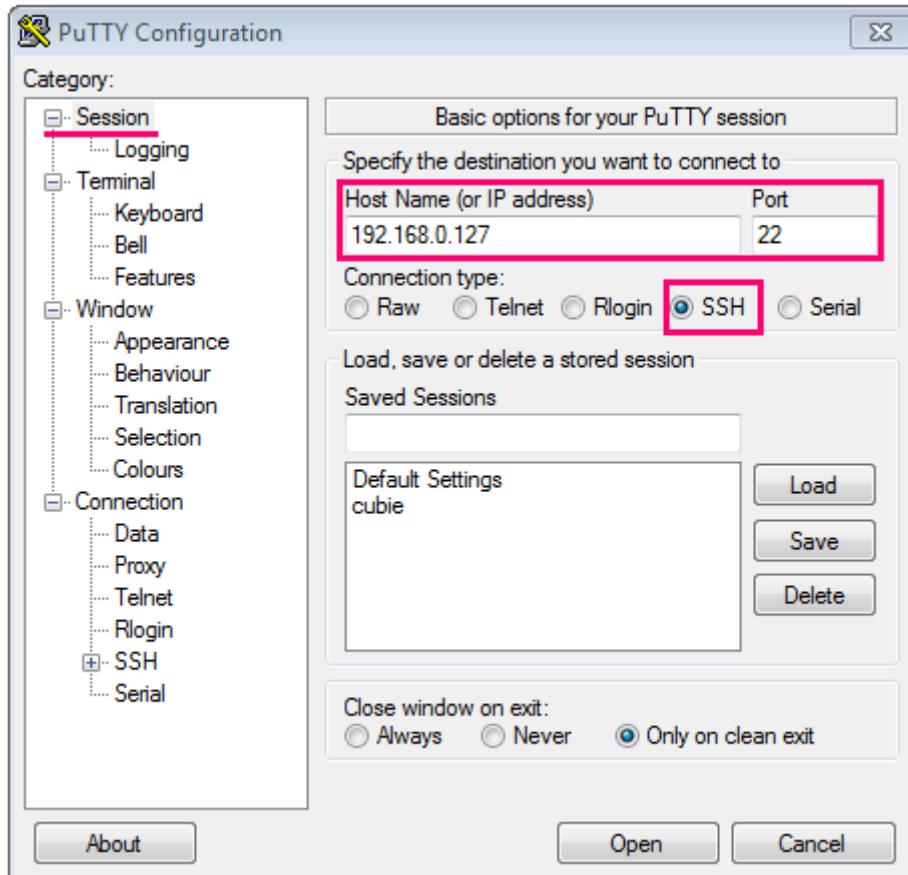
Open PuTTY, select **Serial**, enter number of the gateway virtual COM-port and speed (115200) in the corresponding fields.



Push **“Open”** button.

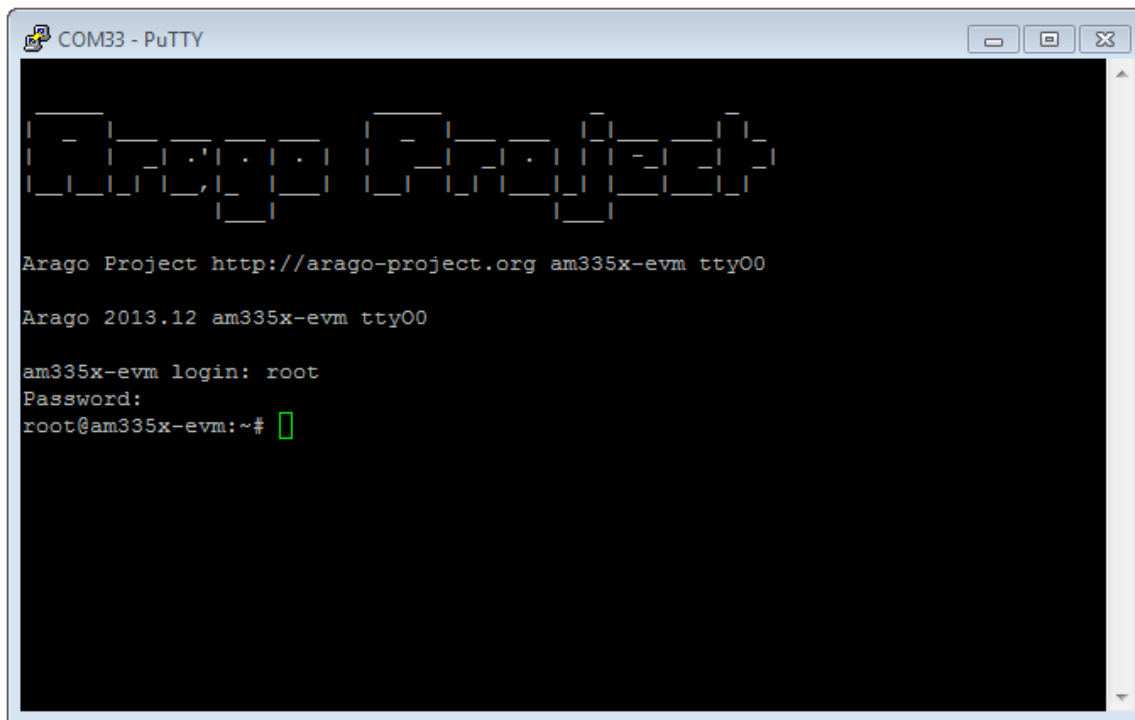
2. Connection via SSH

In case of SSH, select SSH connection in the PuTTY dialog box, enter the device's IP-address and port 22. By default, the device obtains an IP-address via DHCP when connected via Ethernet.



Push “Open” button.

After connecting to the gateway by one of the methods, PuTTY terminal window appears, where login and password shall be entered. By default, login **root** and password **temppwd** are used for connection to the gateway. At the first connection, it is recommended to change the password for individual access.



```
COM33 - PuTTY

Arago Project http://arago-project.org am335x-evm tty00

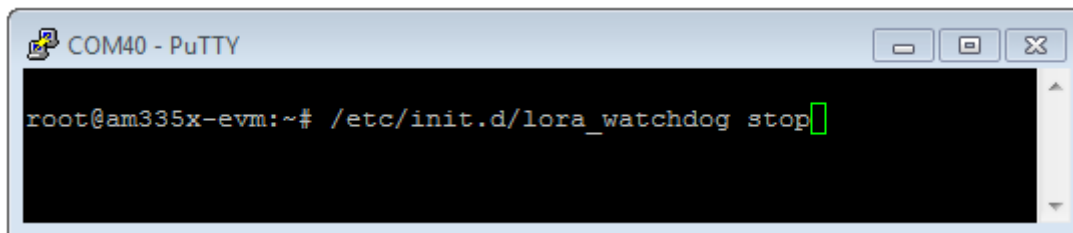
Arago 2013.12 am335x-evm tty00

am335x-evm login: root
Password:
root@am335x-evm:~#
```

Now the configuration can be carried out.

Packet forwarder starts automatically when the system starts. Before the gateway configuring, stop Packet forwarder by entering command:

```
/etc/init.d/lora_watchdog stop
```



```
COM40 - PuTTY

root@am335x-evm:~# /etc/init.d/lora_watchdog stop
```

Configuration files are in the directory **LoRa/packet_forwarder/lora_pkt_fwd** – it may contain frequency band, the gateway ID, IP-address and server ports settings.

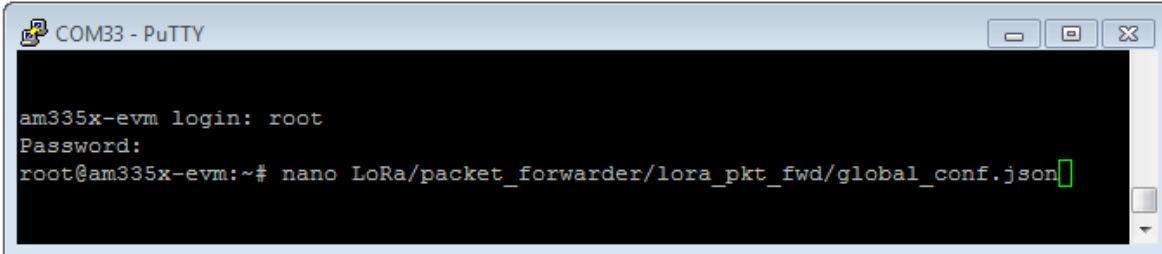
global_conf.json – global configuration file;

local_conf.json – local configuration file.



Settings contained in local_conf.json file take priority over global_conf.json

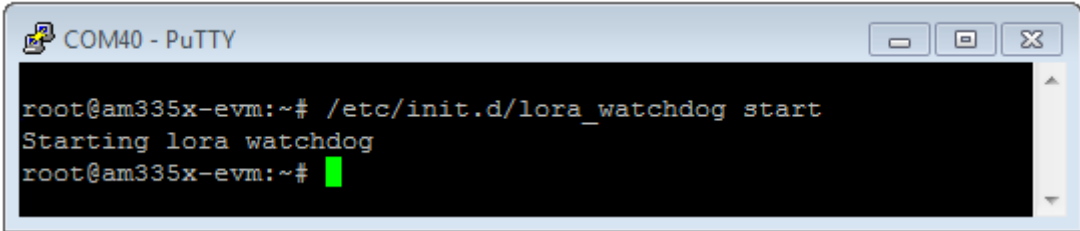
Enter the command, containing the required configuration file in order to change the settings, for example:



```
COM33 - PuTTY
am335x-evm login: root
Password:
root@am335x-evm:~# nano LoRa/packet_forwarder/lora_pkt_fwd/global_conf.json
```

After all changes completed enter the command:

/etc/init.d/lora_watchdog start



```
COM40 - PuTTY
root@am335x-evm:~# /etc/init.d/lora_watchdog start
Starting lora watchdog
root@am335x-evm:~#
```

Packet forwarder will automatically start with new settings.

PACKET FORWARDER UPDATING TO 4.0.1 VERSION

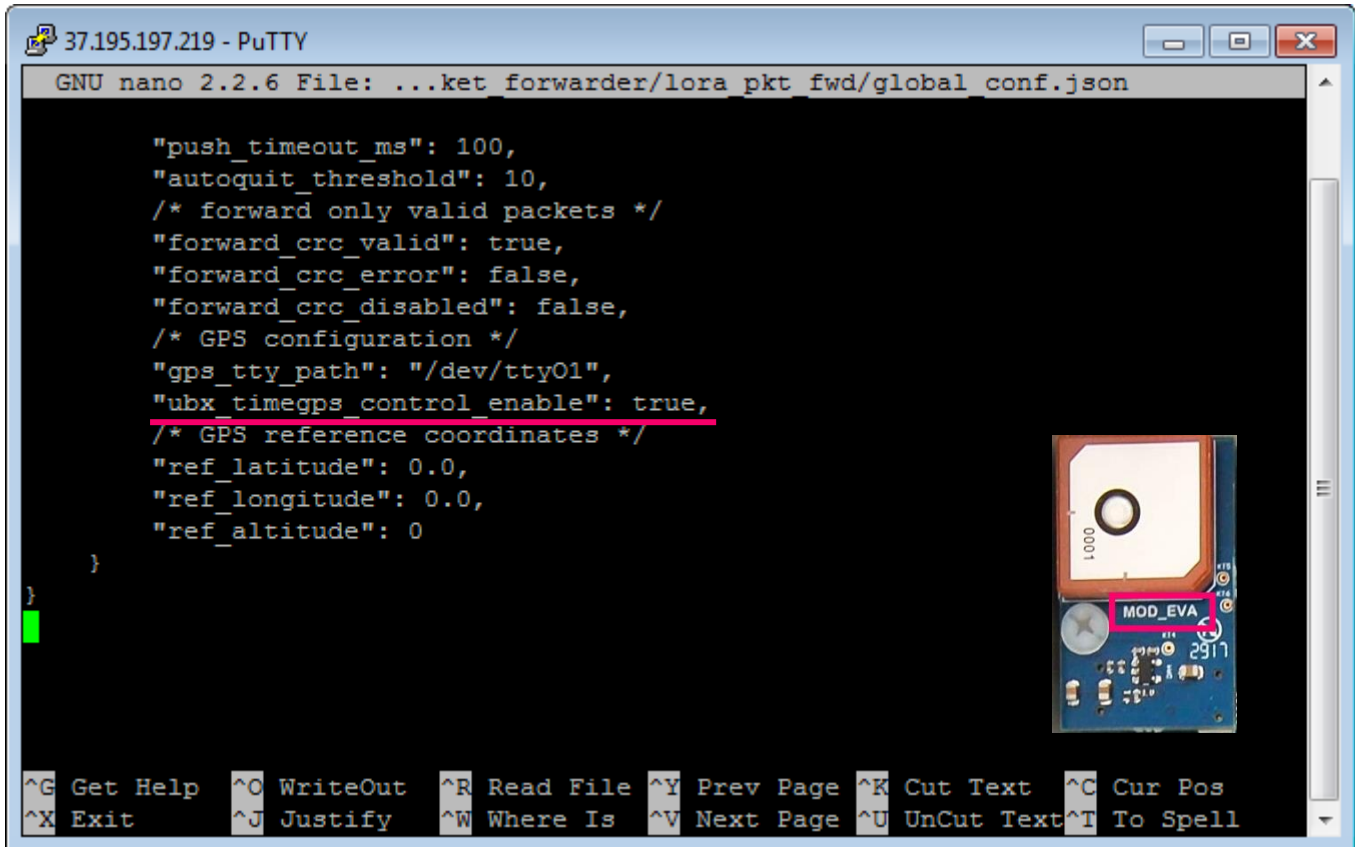
Packet forwarder updating is carried out when connected to a computer using the terminal program as follows:

1. After connecting to the gateway enter login and password in the PuTTY terminal window.
2. Enter a command `/etc/init.d/lora_watchdog stop` – command to turn off the internal timer.
3. Go to the root directory with the command `cd ~/`



Before upgrading Packet forwarder, save the settings from the files `local_conf.json` and `global_conf.json` located in `~/LoRa/packet_forwarder/lora_pkt_fwd/` for later restoration of the settings after the update

4. Delete files of the previous version of Packet forwarder by sequential introduction of commands:
`rm -r LoRa`
`rm LoRa.tar.gz`
5. Download files of the new version of the Packet forwarder by typing at the command line:
`wget ftp://89.189.183.233:14104/3.12.10-ti2013.12.01/LoRa_v4.0.1.tar.gz`
6. Unzip the downloaded files with the command `tar xf LoRa_v4.0.1.tar.gz -C ~/`
7. Move downloaded files to the working directory `mv ~/LoRa_v4.0.1 ~/LoRa`
8. Restore settings in files `local_conf.json` и `global_conf.json`
9. If the GPS module "MOD_EVA" is used in BS-2, then in the file `global_conf.json` the option "ubx_timegps_control_enable" should be enabled, i.e. "Ubx_timegps_control_enable": true. In other cases, when the GPS-module is called otherwise, this option should be turned off, i.e. "Ubx_timegps_control_enable": false.



```

GNU nano 2.2.6 File: ...ket forwarder/lora pkt fwd/global.conf.json

    "push_timeout_ms": 100,
    "autoquit_threshold": 10,
    /* forward only valid packets */
    "forward_crc_valid": true,
    "forward_crc_error": false,
    "forward_crc_disabled": false,
    /* GPS configuration */
    "gps_tty_path": "/dev/ttyO1",
    "ubx_timegps_control_enable": true,
    /* GPS reference coordinates */
    "ref_latitude": 0.0,
    "ref_longitude": 0.0,
    "ref_altitude": 0
  }
}
  
```

^G Get Help ^O WriteOut ^R Read File ^Y Prev Page ^K Cut Text ^C Cur Pos
 ^X Exit ^J Justify ^W Where Is ^V Next Page ^U UnCut Text ^T To Spell

10. Restart the Packet forwarder process with the command
/etc/init.d/lora_watchdog start

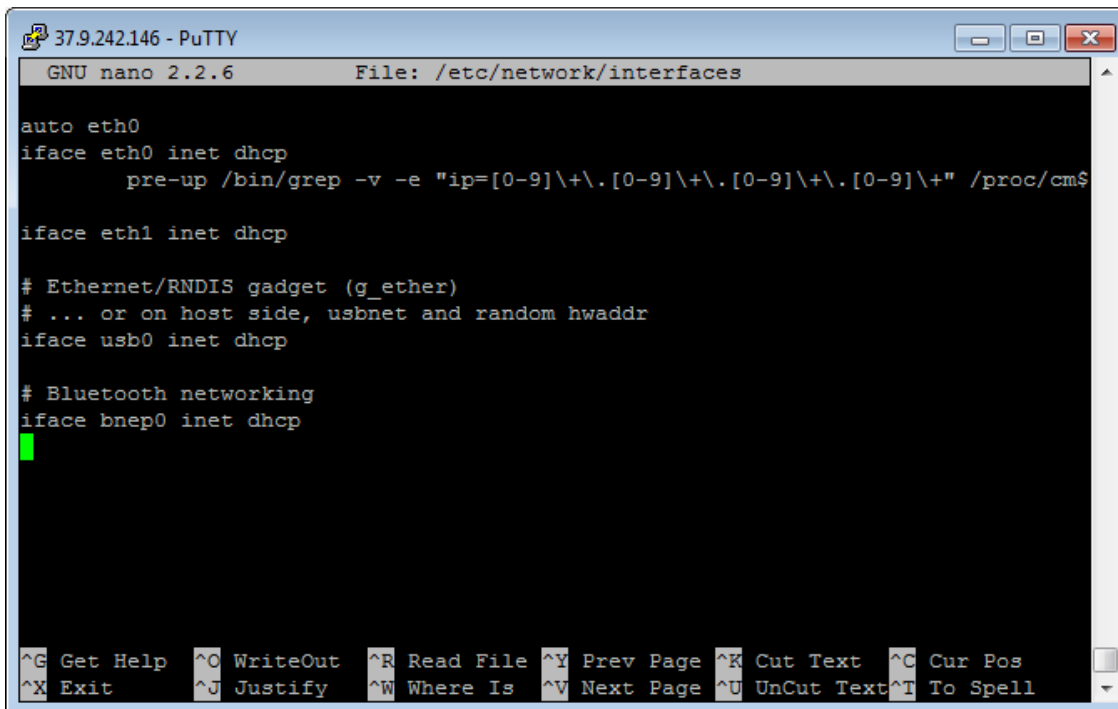
Update complete.

CONFIGURATION OF A STATIC IP-ADRESS FOR THE GATEWAY

Configuration of a static IP shall be carried out with the terminal program:

1. After connecting to the gateway enter login and password in the PuTTY terminal window.

- Open file `/etc/network/interfaces`. Search authorization settings in this file:



```

37.9.242.146 - PuTTY
GNU nano 2.2.6      File: /etc/network/interfaces

auto eth0
iface eth0 inet dhcp
    pre-up /bin/grep -v -e "ip=[0-9]\+\.[0-9]\+\.[0-9]\+\.[0-9]\+" /proc/cmd$

iface eth1 inet dhcp

# Ethernet/RNDIS gadget (g_ether)
# ... or on host side, usbnet and random hwaddr
iface usb0 inet dhcp

# Bluetooth networking
iface bnep0 inet dhcp

```

- Enter changes highlighted in red (example: static IP address 192.168.240.252 and gateway 192.168.240.1):

```

auto eth0
iface eth0 inet static
pre-up /bin/grep -v -e "ip=[0-9]\+\.[0-9]\+\.[0-9]\+\.[0-9]\+" /proc/cmdline > /dev/null
address 192.168.240.252
netmask 255.255.255.0
gateway 192.168.240.1

```

- Open file `~/link_detect.sh`, then search string
`if ["$LINK_STATE" == "UP"] ; then`

Check, that after this string the following string is entered

```
if [ -n "$(cat /etc/network/interfaces | grep "iface $INTERFACE inet dhcp")" ]; then
```

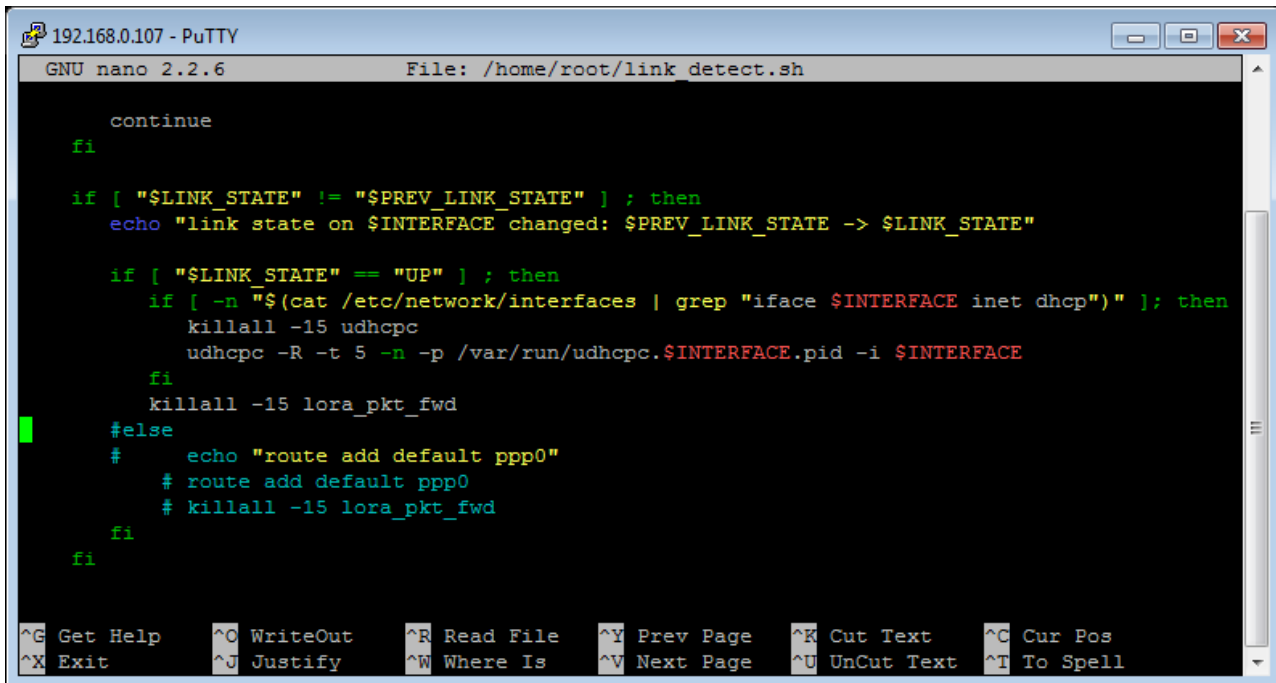
Check, that before string

```
killall -15 lora_pkt_fwd
```

the following string is entered

```
fi
```

(see figure below)



```

192.168.0.107 - PuTTY
GNU nano 2.2.6 File: /home/root/link_detect.sh

    continue
fi

if [ "$LINK_STATE" != "$PREV_LINK_STATE" ] ; then
    echo "link state on $INTERFACE changed: $PREV_LINK_STATE -> $LINK_STATE"

    if [ "$LINK_STATE" == "UP" ] ; then
        if [ -n "$(cat /etc/network/interfaces | grep "iface $INTERFACE inet dhcp")" ]; then
            killall -15 udhcpc
            udhcpc -R -t 5 -n -p /var/run/udhcpc.$INTERFACE.pid -i $INTERFACE
        fi
        killall -15 lora_pkt_fwd
    #else
    #     echo "route add default ppp0"
    #     route add default ppp0
    #     killall -15 lora_pkt_fwd
    fi
fi

```

5. If the strings correspond to the figure above, do not change anything. If these strings are absent, enter them – changes are highlighted in red:

```

if [ "$LINK_STATE" == "UP" ] ; then
if [ -n "$(cat /etc/network/interfaces | grep "iface $INTERFACE inet dhcp")" ]; then
killall -15 udhcpc

```

```
udhcpc -R -t 5 -n -p /var/run/udhcpc.$INTERFACE.pid -i $INTERFACE
fi
killall -15 lora_pkt_fwd
```

6. Enter **reboot** at the command line to reboot the gateway with new settings.

GATEWAY SETTING UP FOR 3G OPERATION

Gateway setting up for 3G operation using the terminal program is carried out in the following order:

1. After connecting to the gateway enter login and password in the PuTTY terminal window.
2. Check, that in file `/etc/ppp/peers/wvdial` entered strings highlighted in red:

```
noauth
name wvdial
usepeerdns
defaultroute
replacedefaultroute
```

If these strings are not present, then they should be added.

3. Check, that in file `/etc/wvdial.conf` entered strings highlighted in red:

```
; Init1 = ATZ
; Init2=ATQO V1 E1 &C1 &D2 +FCLASS=0
Init1 = AT+CPIN?
Init2 = AT+CGDCONT=1,"IP","internet.beeline.ru"
Modem Type = USB Modem
Baud = 460800
New PPPD = yes
Auto Reconnect = off
Modem = /dev/ttyACM0
```

```
ISDN = 0  
Phone = *99#  
Password = beeline  
Username = beeline
```

where "internet.beeline.ru" is APN cellular operator.

If the strings correspond to the figure above, you do not need to change anything. If these strings are not present, then they should be added. At that, strings

```
Init1 = AT+CPIN?  
Init2 = AT+CGDCONT=1,"IP","internet.beeline.ru"
```

entered instead string

```
Init = AT+CGDCONT=1,"IP","internet.beeline.ru"
```

The last three strings of the file specify the required dial-up phone, user name and password (different for each cellular operator):

```
Phone = *99#  
Password = beeline  
Username = beeline
```

4. Create a script to update the DNS data received from the operator

```
nano /etc/ppp/ip-up.d/resolv_conf_update
```

```
#!/bin/sh -e  
cat /etc/ppp/resolv.conf > /etc/resolv.conf  
exit 0
```

Give him the right to run by typing at the command line:

```
chmod +x /etc/ppp/ip-up.d/resolv_conf_update
```


5. Add parameters to startup by typing at the command line:

update-rc.d gsm_init defaults

6. Type **reboot** at the command line to reboot the gateway with new settings.

To stop using the 3G modem for communicate with server, type at the command line **update-rc.d -f gsm_init remove** and restart the gateway to apply new settings.

To start using the 3G modem to communicate with the server again, type **update-rc.d gsm_init defaults** at the command line and restart the gateway to apply new settings.

For recommendations for gateways using white IP, see [Appendix](#).

5 STORAGE AND TRANSPORTATION REQUIREMENTS

VEGA BS gateways shall be stored in the original packaging in heated room at temperatures +5°C to +40°C and relative humidity less than 85%.

The gateway shall be transported in covered freight compartments of all types at any distance at temperatures -40°C to +85°C.

6 CONTENT OF THE PACKAGE

The gateway is delivered complete with:

VEGA BS gateway – 1 pce.

Antenna 864-870 MHz– 1 pce.

POE-adapter– 1 pce.

Data sheet – 1 pce.

7 WARRANTY

The manufacturer guarantees normal operation of the gateway and its elements within 36 months from the date of sale.

The manufacturer undertakes to repair or replace the failed device within 36 months from the date of sale.

The consumer undertakes to comply with the terms and conditions of transportation, storage and operation, specified in this manual.

Warranty does not apply to:

- the device with mechanical, electrical and / or other damages and defects caused by violation of the transportation, storage and operation requirements;
- the device lacking any part of the kit;
- the device with traces of repair performed not by the manufacturer's service center;
- the device with traces of oxidation or other signs of liquids leaking inside the device.

In the event of a warranty claim, contact the service center:

113/1, Kirova Str., Novosibirsk, 630008, Russia.

Tel.: +7 (383) 206-41-35.

APPENDIX – RECOMMENDATIONS FOR WORKING WITH GATEWAY

ANTENNA MOUNTING RECOMMENDATIONS

The Antenna included in the scope of supply has fasteners for installation on a mast support. To ensure maximum communication range, follow the installation guidelines for the antenna:

1. Install the antenna outside, preferably on the roof of the building (the higher - the better, depending on the surrounding buildings). Installing the antenna in the room significantly weakens the sensitivity of the antenna.

2. The installation site shall be as far as possible from the cellular antennas. Antenna tuning requires the maximum distance from other antennas. After tuning and testing, antenna can be brought back closer to the cellular antennas, if the quality of the communication is satisfactory.

3. The antenna shall not stand in the close proximity to obstacles (about 2 meters from railing, walls, etc.). The sensitivity towards the obstacle weakens.

4. The gateway shall be installed in the close proximity to the antenna – at the length of the antenna coaxial conductor. Increase of the cable length between the antenna and the gateway will result in a loss of antenna sensitivity.



For example, 25 meters of RG-58 cable attenuate the signal by 14 dBm, i.e. if transmission power is 14 dBm (25mW), the power on the antenna will be 1mW

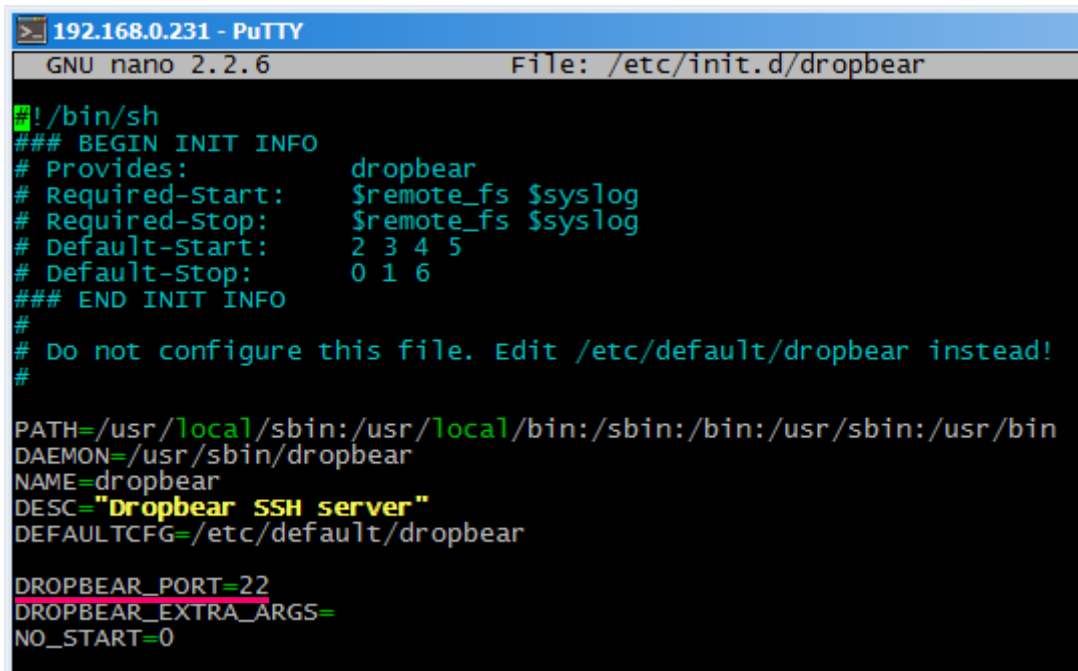
5. The antenna directional pattern shall be taken into account. In the horizontal plane, the antenna has a circular direction, but no vertical direction. Therefore, the quality of communication directly under the antenna will be worse than at some distance from the antenna.

RECOMMENDATIONS FOR GATEWAY USING IN WHITE IP NET

In case the BS is used in network with white IP, it is recommended to change the standard port numbers of ssh and telnet to others. This should be taken into account while port forwarding. The steps sequence for changing BS dropbear and telnetd ports is described below.

To change ssh port:

1. Enter at the command line of the terminal program `/etc/init.d/dropbear stop`
2. Open file `nano /etc/init.d/dropbear`



```
192.168.0.231 - PuTTY
GNU nano 2.2.6 File: /etc/init.d/dropbear
#!/bin/sh
### BEGIN INIT INFO
# Provides: dropbear
# Required-start: $remote_fs $syslog
# Required-stop: $remote_fs $syslog
# Default-start: 2 3 4 5
# Default-stop: 0 1 6
### END INIT INFO
#
# Do not configure this file. Edit /etc/default/dropbear instead!
#
PATH=/usr/local/sbin:/usr/local/bin:/sbin:/bin:/usr/sbin:/usr/bin
DAEMON=/usr/sbin/dropbear
NAME=dropbear
DESC="Dropbear SSH server"
DEFAULTTCFG=/etc/default/dropbear
DROPBEAR_PORT=22
DROPBEAR_EXTRA_ARGS=
NO_START=0
```

3. Find string `DROPBEAR_PORT=22` and change standard port «22» to another, then save the file.
4. Enter at the command line of the terminal program `/etc/init.d/dropbear start`

To change telnet port:

1. Enter at the command line of the terminal program `/etc/init.d/telnetd stop`
2. Enter at the command line `killall -15 telnetd`
3. Open file `nano /etc/init.d/telnetd` - and find strings:

```

192.168.0.231 - PuTTY
GNU nano 2.2.6 File: /etc/init.d/telnetd

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#THE SOFTWARE.

telnetd=/usr/sbin/telnetd
test -x "$telnetd" || exit 0

case "$1" in
start)
  echo -n "Starting telnet daemon"
  start-stop-daemon --start --quiet --exec $telnetd
  echo " : "
  ;;
stop)
  echo -n "Stopping telnet daemon"
  start-stop-daemon --stop --quiet --pidfile /var/run/telnetd.pid
  echo " : "

```

4. Enter strings highlighted in red (instead of "2224" enter the desired port number):

```

telnetd=/usr/sbin/telnetd
port="-p 2224"
...
start-stop-daemon --start --quiet --exec $telnetd -- $port

```

5. Save file and enter at the command line `/etc/init.d/telnetd start`



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