GTR30/GTR40

Industrial 3G/4G Router Series

User Guide

Revision 2.6, March 22, 2021

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The present user guide contains information about the purpose, design, technical parameters and operating principles of the GTR series 3G and 4G industrial routers. Information on the router installation, connection and initial setting is presented.

Advanced Digital Technologies s.r.o. reserves the right, without any prior notice, to make changes to the User Guide related to the improvements in hardware and software, as well as to eliminating misprints and inaccuracies.

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Content

Chapter 1. GTR Router Overview

1.1. Product Description

GTR30/GTR40 is a series of 3G and 4G routers for commercial and industrial facilities that provide high-speed wireless access to the Internet over the UMTS (3G) and LTE (4G) cellular networks (Fig. 1).

OpenWrt Linux-based opensource operating system allows to implement practically all known methods of data transmission and ensures safe and reliable connection over the secure channel, which makes the device a universal means solving a wide range of industrial automation and telemetry tasks.

Fig. 1. GTR Series Router.

The series is represented by two models:

- **GTR30** – 3G router (HSPA+ transmission speed – up to 7.2 Mbps).
- **GTR40** – 4G router (LTE transmission speed – up to 100 Mbps).

Key Features

The router combines a variety of devices into the network and possesses a large number of hardware and software capabilities. GTR series key feature is represented by its modular structure allowing to choose additional options and create the optimal device configuration in accordance with the user requirements.

Major functionalities:

- Network connection using the two 10/100Base-TX Ethernet interfaces.
- Embedded cellular 3G (or 4G) modem provides a secure Internet connection in any place, where the coverage by a mobile communication network operator is registered. In order to improve the operating quality, external 3G/4G antenna is used in the device.
- Two SIM card slots provide the communication channel reservation. SIM priority setting is included. In case communication failure occurs with the main SIM card, automatic switching to a backup card is executed. Capability to automatically switch between Ethernet and cellular networks.
- Interfaces: USB Host/Device (A type), RS-232 serial port, RS-485 serial port.
- Four universal I/O lines envisaging several operation modes.
- MicroSD memory card slot.
- OpenWrt Linux-based open source operating system allows to program the device for any user tasks by embedding the user software.
- Network services: OpenVPN, PPTP, GRE, IPSec, NAT, Firewall, IPv6, DHCP (Server/Client), TinyProxy, NTP, FTP, SIM manager, etc.
- Conversion between the Modbus-TCP and Modbus RTU/ASCII protocols

- Various administration techniques: via the LuCI Web interface; remote management from the command line using the SSH and Telnet protocols; via the console (COM port).
- Wide range of power supply voltages: 10-50 VDC.
- Built-in real-time clock (RTC) unit allowing to ensure the clock functioning, if the router external power supply is disabled.
- High-precision real-time clock circuit with thermal compensation generator ensuring the current time counting with maximum accuracy (±1 sec/day)
- Hardware Watchdog timer designed to reboot the router in case of software failures.

Additional options:

Additional options can be selected depending on the user tasks and requirements:

- GPS module designed to ensure precise location determination and high accuracy time synchronization (up to 1 msec) using the GPS/GLONASS satellite systems
- Supercapacitor based back-up power supply unit ensuring the 2 minutes autonomous router operation in case external power supply is disabled

The entire list of the parameters required for optimal modification selection is presented in Application 1. GTR Router Series

Application areas:

- Internet access outside the city, in private sector and at facilities remote from the city infrastructure.
- Access points on stationary and mobile objects: gas stations, cafes, retail outlets, automobiles, intercity buses, trains, river transportation.
- Secure connection to the Internet network of small office organizations and complex corporate networks.
- IP video surveillance, data transfer from remote sites in the on-line mode.
- Financial sector: POS terminals, ATMs, vending.
- Security systems (alarm, security and surveillance).

1.2. Specifications

A list of possible additional options see in Application 1. GTR Router Series .

Table. 1 GTR30/GTR40 technical specifications.

	3G router GTR30	4G router GTR40
POWER SUPPLY		
Power supply voltage (DC)	10-50 V	
Power consumption	Max. 8 W	
Consumption current (Uvolt = 24V)	Max. 400 mA	
GSM PARAMETERS		
Frequency range	UMTS 900/2100, GSM 900/1800	FDD-LTE B1/B3/B5/B7/B8/B20, UMTS/HSPA+, B1/B5/B8, GSM/GPRS/EDGE B3/B8
Output power	3.1W (900MHz), 1.5W (1800MHz), 0,3W (2100MHz)	2W (900MHz), 1W (1800 MHz), 0,25W (2100 MHz), 0,25W (2600 MHz)
Data transmission rate[1]		
LTE (DL/UL)	—	up to 150 Mbps / up to 50 Mbps
HSPA, HSPA+ (DL/UL)	7.2Mbps/ 5.76 Mbps	up to 42Mbps / up to 5.76 Mbps
WCDMA (DL/UL)	up to 384 Kbps (DL/UL)	
EDGE class 12 (DL/UL)	up to 236,8 Kbps (DL/UL)	
GPRS class 12 (DL/UL)	up to 85,6 Kbps (DL/UL)	
HARDWARE PLATFORM		
Processor	**FreeScale i.MX287 454 MHz**	
RAM	128 Mb	
Flash memory capacity	256 Mb	
CONNECTIONS AND INTERFACES		
Ethernet	**x2**, 10/100 Mbps, RJ-45	
USB Host	**x1**, USB 2.0, A type	
SIM	**x2**, mini-SIM (25×15×0,76 mm)	
RS-232	**x1**, DB-9M connector, Baud rate: 1200-115200 bps. Data format: 8N1	
RS-485	**x1**, Screw terminal block connector Baud rate: 1200-115200 bps Communication range: up to 1000 m at 9600 bps Load capability: 32 unit loads Terminal resistor: connected, 120 Ohm	
Universal I/O lines	**x4**, Operation modes: voltage measurement, load control. Screw terminal block connector Max. input voltage: 50V (max. measurable input voltage: 18V). Max. current (per channel): 60mA ADC measurements accuracy: ±5%	

[1] Data transmission rate depends on the operator's network coverage and device location.

	3G router GTR30	4G router GTR40
Antenna GSM	**x1**, SMA(f) (for 3G antenna)	**x2**, SMA(f) (for 4G antennas)
Antenna GPS[2]	**x1**, SMA(f)	
Power supply input	**x1**, MicroFit 4-Pin	
OPERATING SYSTEM PARAMETERS		
Operating system	**OpenWrt Chaos Calmer 15.05**	
Core	Linux 3.18.23	
FUNCTIONS AND NETWORK SERVICES		
Protocols conversion	Modbus RTU/ASCII ↔ Modbus TCP	
Network functions	see Application 2. GTR Routers Network Options and Services	
Administration	LuCI web interface, SSH, Telnet, console port (RS-232)	
Security	VPN, NAT, Firewall, IP/MAC address filtering	
GENERAL SPECIFICATIONS		
Overall dimensions	97 x 78 x 36 mm	
Weight	250 gr	
Enclosure material	Aluminum	
Enclosure protection class	IP30	
Average term of service	10 years	
Warranty	2 years	
OPERATION CONDITIONS		
Ambient temperature	-40...+70°C (-20...+55°C – for routers with supercapacitor)	
Relative ambient air humidity	Up to 90% at 20°C temperature	

[2] For routers supporting GPS only.

1.3. Appearance

Structurally, the modem is manufactured in a durable metal enclosure having the IP30 protection class. Description of buttons and connectors on the enclosure is presented below.

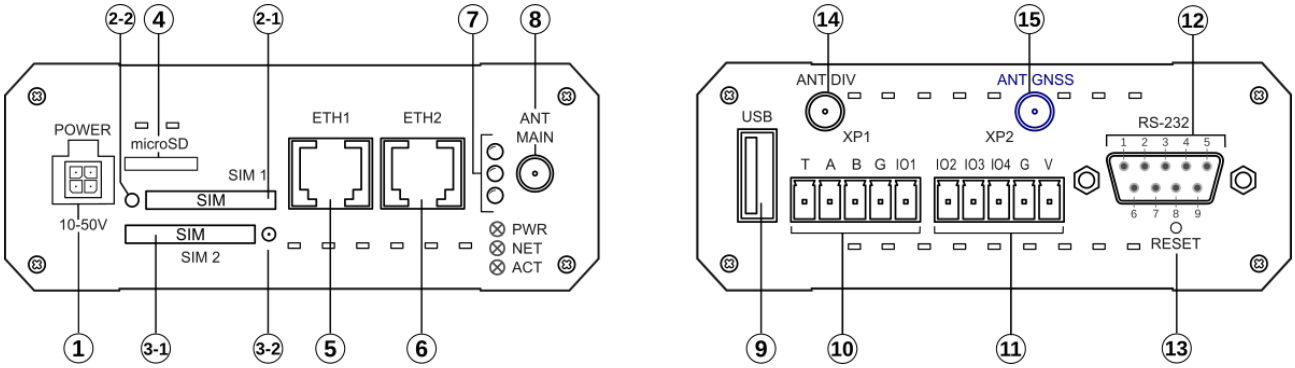


Fig. 2. GTR30/GTR40. Device external appearance.

Table. 2 GTR30/GTR40 routers. Contacts and connections description.

Designation			Description
External appearance front view			
1	**POWER**		10–50V DC Power supply MicroFit 4-Pin connector
2-1	**SIM1**		SIM card 1 slot
2-2			SIM card 1 extraction button SIM card 1 slot
3-1	**SIM2**		SIM card 2 slot
3-2			SIM card 2 extraction button SIM card 1 slot
4	**microSD**		MicroSD card slot
5	**ETH1**		Ethernet1 port (LAN/WAN 10/100 Mbps), RJ-45 connector
6	**ETH2**		Ethernet2 (LAN/WAN 10/100 Mbps), RJ-45 connector
7			LED indicators (from top to bottom: **PWR, NET, ACT**)
8	**ANT MAIN**		SMA(f) connector for 3G antenna or main 4G antenna
External appearance back view			
9	**USB**		USB 2.0 connector, A type
10 Terminal block connector	**XP1**	T	Built-in terminal resistor output [3]
		A	A+ signal, RS-485 line
		B	B- signal, RS-485 line
		G	Signal ground (connected, if necessary)
		IO1	Universal Input/Output line 1
11 Terminal block connector	**XP2**	IO2	Universal Input/Output line 2
		IO3	Universal Input/Output line 3
		IO4	Universal Input/Output line 4
		G	Ground
		V	External power supply positive input
12	**RS-232**		RS-232 interface DB-9M 9-pin connector
13	**RESET**		Reboot/reset to factory default settings button

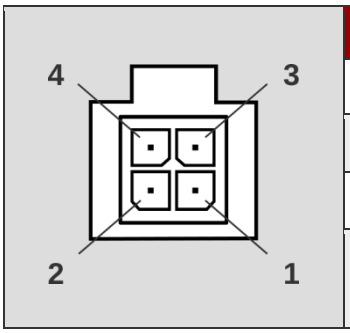
[3] In order to commute terminator, T-output should be connected to the B-output (B- signal, RS-485).

Designation		Description
14	ANT DIV	SMA(f) connector for diversity 4G antenna (only for 4G router)
15	ANT GNSS [4]	SMA(f) connector for GPS antenna

1.4. 4-Pin MicroFit Power Connector

A 4-pin MicroFit connector is used to connect power to the router. The connector view and pinout are given in the table below.

Table. 3 MicroFit power connector pinout.

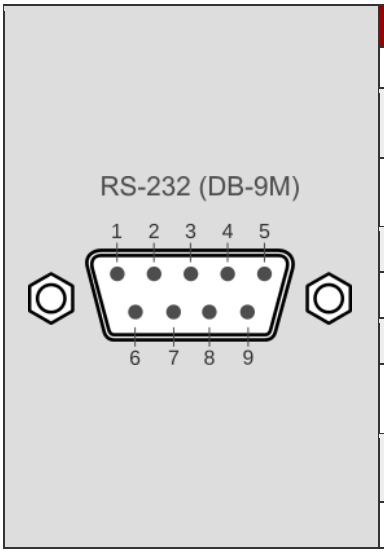


Contact	Signal	Description
1	NC	Not connected
2	NC	Not connected
3	–	Power supply ground input
4	+	External power supply positive input. Protection from overvoltage and polarity reversal

1.5. RS-232 DB9 Male Connector (Console Port)

In order to commute via the RS-232 interface the router is using the 9-pin DB-9M connector (COM port). The connector pinout is shown in Table 4.

Table. 4 RS-232 connector pinout.



Contact	Signal	I/O	Parameters
1	-	O	-5V Output
2	RxD	I	Log.0 > +2.4V Log.1 < 0.8V
3	TxD	O	Log.0 > +5V Log.1 < -5V
4	DTR	-	Closed with pin 6 (DSR)
5	GND	Ground	
6	DSR	-	Closed with pin 4 (DTR)
7	RTS	O	Log.0 > +5V Log.1 < -5V
8	CTS	I	Log.0 > +2.4V Log.1 < 0.8V
9	-	O	+5V Output

By default, the RS-232 port is equipped with the OpenWrt operating system and U-boot loader console output, three-wire UART (rate - 115200 bit/sec, 8N1). The port is designed to ensure the router configuration and to restore access to the device under the following situations:

- Password loss.
- Software restoration needed.

[4]Only for devices supporting GPS.

- Obtaining access to the router using the IP address is impossible.

Router connection via the console is described in 2.4. Connection via RS-232 Console Port section. **A password shall not be required to access the console**.

When using the RS-232 port to communicate with other equipment (for example, connecting and polling the measuring instruments), the console output to the port should be disabled. (See How to disable the console mode on serial port **in OpenW**rt)

1.6. USB Interface Parameters

The USB2.0 interface is provided with a standard USB-A connector and is able to operate in two modes:

1. **HOST mode (default)** to receive Internet traffic from other USB devices (e.g, from 4G modems).
2. **DEVICE mode** to send Internet traffic via USB to other devices.

The mode can be changed via the console by editing the file

```
/etc/init.d/initscripts
```

To enable the device mode change the following line:

```
/etc/initscripts/usbhost &
```

to

```
/etc/initscripts/usbdevice &
```

1.7. Universal Input/Output Lines

The GTR30/GTR40 routers are provided with four universal input/output (I/O) lines **IO1–IO4** (Fig. 2). The ports are independent, could be programmatically configured in Linux (see Application 3. GTR Routers Port Map) and envisage the following operation modes:

1. **Voltage measurement mode** (*default mode*), the functional diagram is shown in Fig. 3. In this mode you can measure the voltage level from the devices connected to the I/O lines (batteries, accumulators and other power sources).

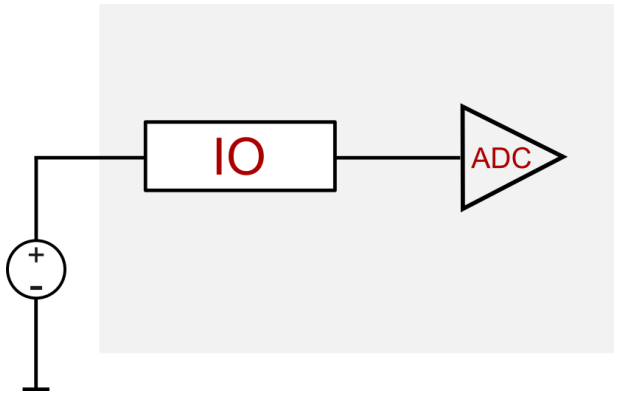


Fig. 3. Voltage measurement.

In this mode you can measure voltage from sensors with current loop output (4-20mA) as well. The connection scheme is shown in Fig. 4.

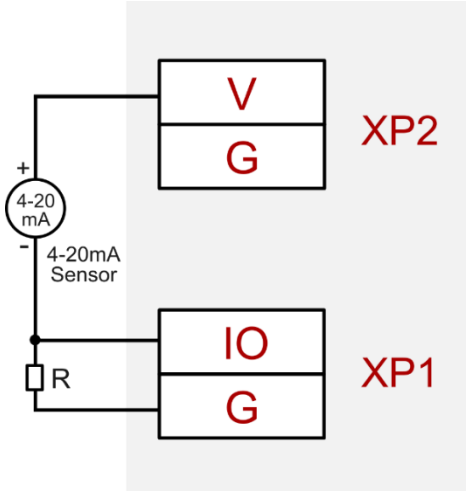


Fig. 4. Connection of current-output sensors.

2. **Load control mode.** In this mode, the GPIO pins work as outputs and the load can be switched through them. The maximum current at each output - 60 mA.

   The pins can be combined to increase the load capacity of the output.

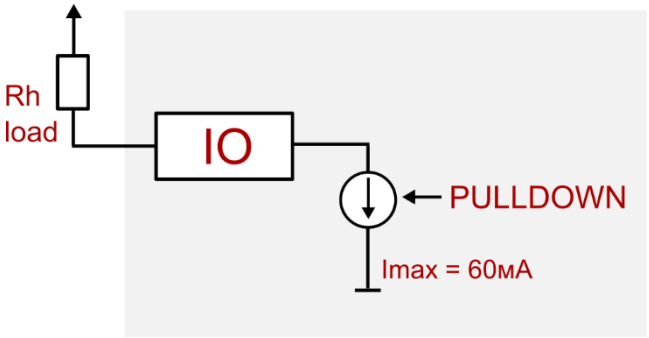


Fig. 5. Load control mode.

You can set up the operation mode of every I/O port and read the value at every port via Web interface as well as using a command line (see Chapter 5. Configuring I/O Lines).

1.8. LED Indicators

GTR routers are provided with three LED indicators on the front side of the case: **PWR**, **NET** and **ACT**. By default, the indicators are set to the following values:

- **PWR** — power supply indicator.
- **NET** —3G or 4G cellular connection indicator.
- **ACT** — data receive/transmit over 3G/4G indicator.

The indicators operation modes by default are presented in Tab. 5

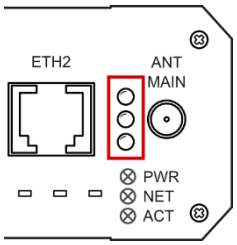


Fig. 6. GTR indicators.

Table. 5 LED Operation Modes.

Indicator	Function	State	Description
PWR	Power supply	Continuously ON	Power supply is on
		Continuously OFF	Power supply is off
NET	GSM connection	Continuously ON	3G/4G Internet connection is established
		Continuously OFF	No registration in 3G or 4G network
ACT	GSM data receive/transmit	Blinking	The device is receiving/sending data over 3G (4G) network

NOTES!

- The indicators could be configured via the Web interface: **System** -> **LED configuration**.
- It is not recommended to reconfigure the values of **PWR** and **NET** indicators without necessity.

1.9. Converting Modbus RTU/ASCII to Modbus TCP

All GTR routers support bidirectional Modbus RTU/ASCII to Modbus TCP protocol conversion, i.e., act as a gateway, providing transparent data transmission between devices. The function successfully solves tasks of connecting equipment with different protocols and interfaces.

Modbus TCP protocol is designed to allow Modbus protocol to be carried over Ethernet network. Modbus serial line may use serial interfaces (RS-232, RS-485 and RS-422) and includes two transmission modes: RTU and ASCII. When the router receives the Modbus TCP request, it converts the package to Modbus RTU frame and sends it to serial devices. When a Modbus RTU response is received, the router wraps the data into a TCP packet and sends the packet across the Ethernet network.

Modbus interaction uses a master/slave relationship in which one device in pair operates a Modbus master and the other one acts as a slave. A conversation is always started by a master. A Modbus master sends a request message and a slave can only respond to it.

Router can work in both server and client modes. Possible connection schemes are given below:

1. **Example 1**. In this case router (with attached device) usually functions in Server mode (though, can operate as a Client), meanwhile, a distant PC connects to it as a Client. Computer (Modbus Master) sends a Modbus TCP request to the router. The router converts the package into the Modbus RTU and readdresses the request to the metering device (Modbus Slave). Router converts the response into the Modbus TCP package and sends it to the PC via Ethernet.

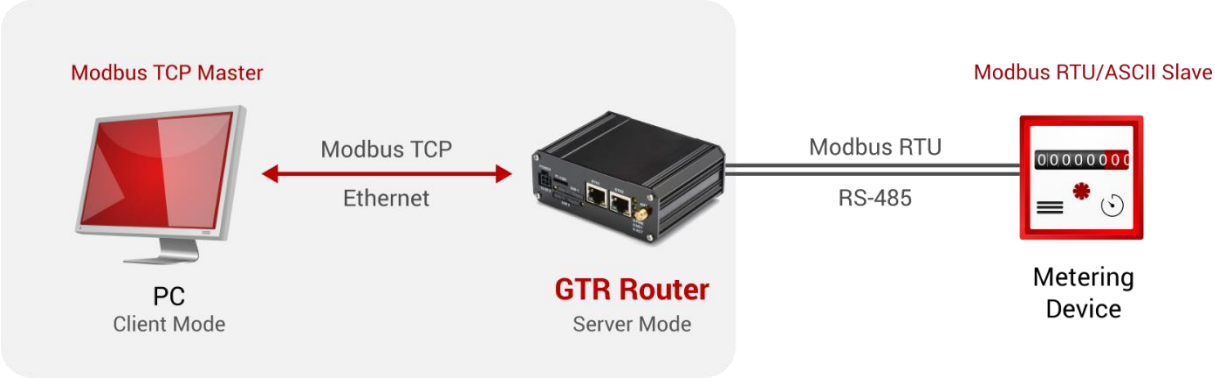


Fig. 7. GTR Router in Server Mode.

2. **Example 2**. In this scheme router, attached to the controller (PLC), functions in Client mode and connects to the meter (Server). PLC (Modbus Master) sends request Modbus RTU to the router. Router converts this request to the Modbus TCP package and sends it to the metering device (Modbus Slave) via Ethernet. Router converts the response, received via TCP, into the Modbus RTU package and sends it to the PLC.

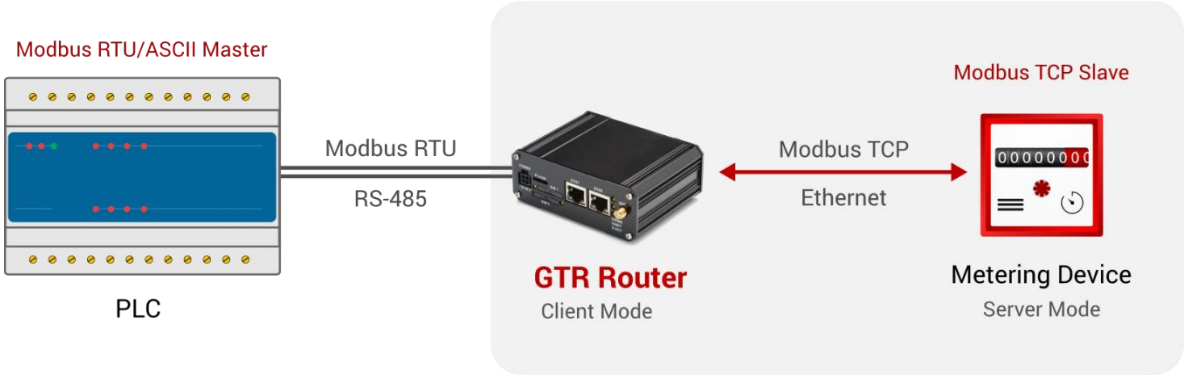


Fig. 8. GTR Router in Client Mode.

Chapter 2. Getting Started

2.1. Connection Procedure

1. Insert the **SIM card (-s)** into the router previously disabling the PIN code entry (the function is disabled by default and can be enabled via the web interface). In order to extract the SIM card tray, press the yellow SIM card tray ejection button. Place the SIM cards in the trays with the contact pad facing outwards. Insert the trays into the connectors until they click: the tray with the SIM 1 in the SIM1 connector with the contact pad downwards and the tray with SIM 2 in the SIM2 connector with the contact pad upwards.
2. Commute antennas:

   GTR30 (3G router): connect 3G antenna to the **ANT MAIN** connector.

   GTR40 (4G router): connect 4G antennas to the **ANT MAIN** and **ANT DIV** connectors.

   In order to obtain the maximum rate and stability of connection, make sure that your antenna corresponds to the required frequency range.
3. Connect an ethernet cable to the **ETH1** or **ETH2** port.
4. Connect the power supply unit to the **POWER** connector and to the power outlet. **PWR**, **NET** and **ACT** indicators will light up simultaneously on the front panel of the router. After the bottom indicator (ACT) goes out or starts flashing, the router is ready to work.

2.2. Default Settings

GTR30/GTR40 routers are delivered with the default configuration. Default settings could be changed by the manufacturer without prior notification of the user.

Table. 6 GTR Routers Default Settings.

Interface	Parameter	State	
		GTR30	**GTR40**
Default network configuration	ETH1+ETH2	LAN (eth0/eth1) Interfaces are merged to bridge 192.168.88.1/255.255.255.0	
	3G/4G	WAN	
LAN (ETH1/ETH2)	IP address	192.168.88.1	
	Subnet Mask	255.255.255.0	
	Login	root	
	Password	root	
	DHCP server	Switched on (pool of addresses: 192.168.88.100 - 192.168.88.255)	
WAN	Connection name	INTERNET	wwan0
	Protocol	UMTS/GPRS	QMI
	Modem	/dev/ttyUSB3	/dev/cdc-wdm0
	Service type	UMTS/GPRS	All
	APN	internet	internet
	Dialup number	*99***1#	—
RS-232	Console (to access the operating system and U-boot loader, as well as to update the firmware). Parameters: 8N1,115200 bit/sec. Password is not required.		
USB2.0	By default, the HOST mode is configured to connect the USB devices.		

2.3. Enable Ethernet Connection (for OS Windows)

1. Connect the network cable (patch cord) to **ETH1** or **ETH2** port. ETH1 and ETH2 interfaces are merged to bridge, so the cable could be commuted to any of the connectors. Connect the other end of the cable to the computer or LAN hub.

2. In the **Control Panel** menu (**Start -> Control Panel**) open the **Networks and sharing center**. In the window that appears, click the **Change adapter options**.

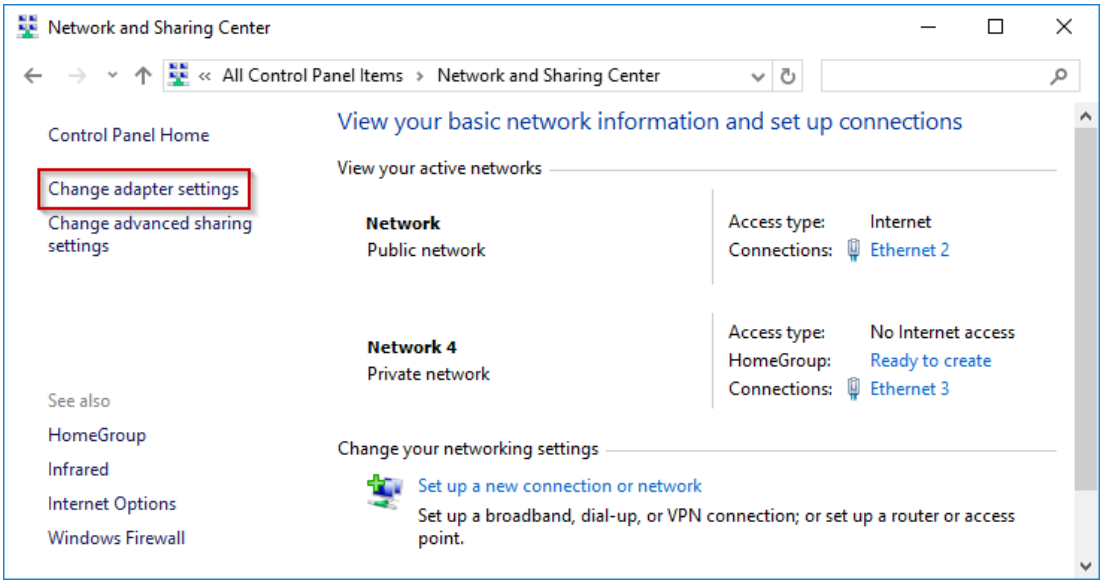


Fig. 9. Connecting GTR router to PC. Changing adapter parameters.

3. In the opened window right-click the relevant **Ethernet** (or **Local area connection**) menu and select the **Properties** line in the menu displayed.

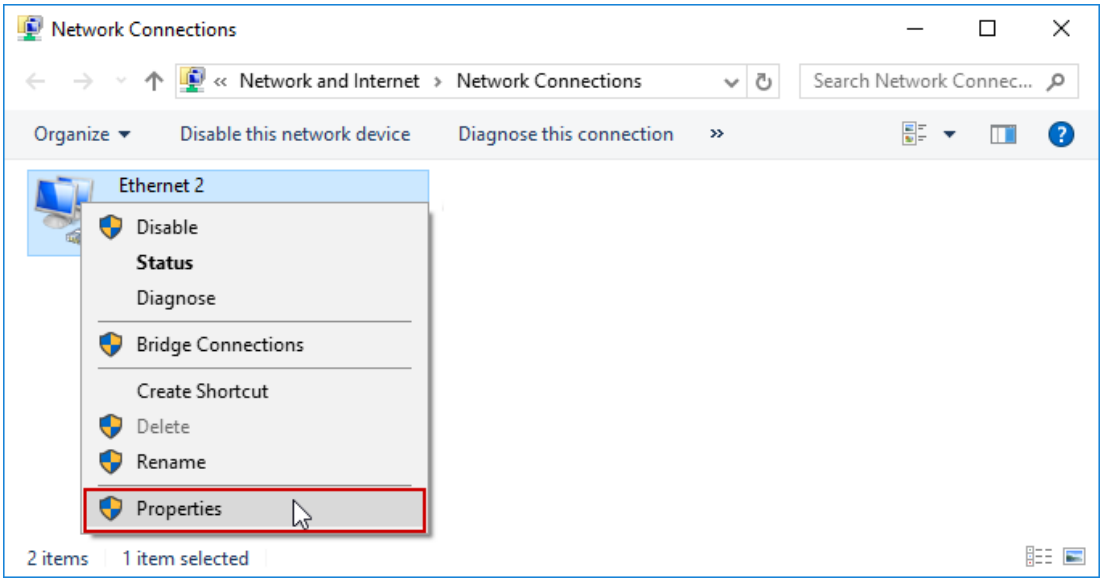


Fig. 10. Connecting GTR router to PC. Connection properties via local network.

4. In the **Ethernet Properties** window select **Internet Protocol Version 4 (TCP/IPv4)** and click the **Properties**.

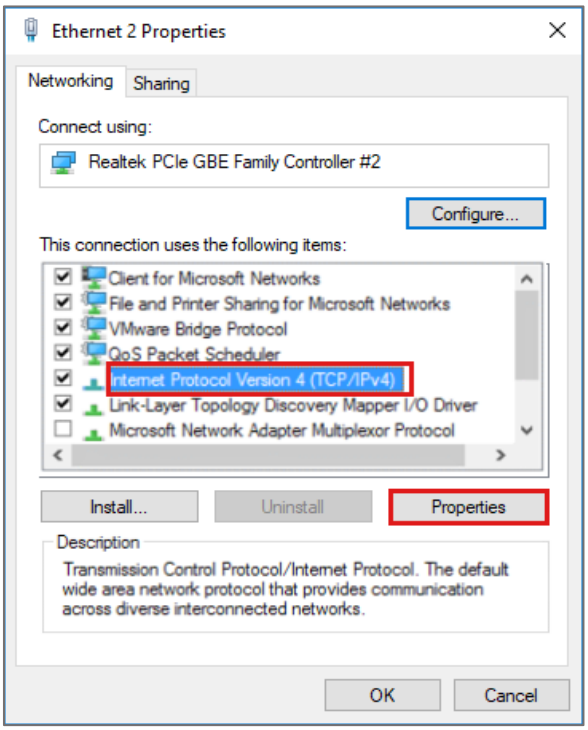


Fig. 11. TCP/IPv4 Internet protocol.

5. Configure **TCP/IP parameters**. There are two ways to configure:
   - **Automatically**. By default, the DHCP server in the router is switched on; and this server automatically assigns IP addresses to clients, so within the TCP/IP protocol properties you could simply select **Obtain an IP address automatically.**
   - **Manually**. If it is required to manually configure the TCP/IP parameters, in the protocol properties select **Use the following IP address** and configure the following parameters:

✓ **IP address:** 192.168.88.* (* - any number from 2 to 254). Default IP address: 192.168.88.1. Computer IP address for the local connection should belong to router subnet, that is, to correspond to the router address except for the last digits.
For example, 192.168.88.100.

✓ **Subnet mask**: 255.255.255.0

If the PC needs an Internet access, specify the additional gateway and DNS server address (corresponds to the router address):

✓ **Gateway:** 192.168.88.1

✓ **Preferred DNS server:** 192.168.88.1

The alternative DNS server field could be left blank, or a public Google, Yandex or any other DNS server could be specified (for example, Google DNS server: 8.8.8.8)

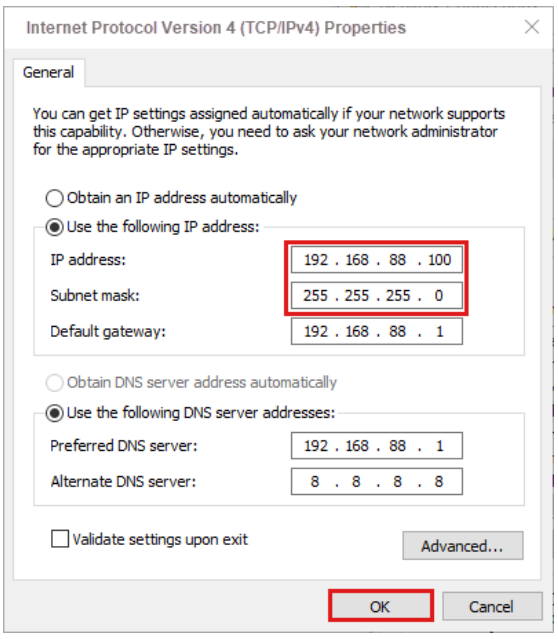


Fig. 12. TCP/IPv4 parameters configuration.

6. Click **OK**. If the connection is successful, you could proceed to the device configuration.

2.4. Connection via RS-232 Console Port

Connecting router via RS-232 console interface is executed to ensure the access to the operating system or loader, as well as to update the device firmware or get back to the factory default settings.

1. Connect the console port of the router to the computer COM port using the terminal cable. If there is no COM port on the PC, use the COM-USB converter.
2. To enter the console, use any terminal program (for example, Putty, HyperTerminal for the Windows OS and Picocom or Socat for the Linux OS). In the program, select the **Serial connection** type (serial port), enter the COM port number and specify the rate of 115200 bps. **Attention! Password to access the system console is not required**!

How to disable the console mode on serial port in OpenWrt

When using the RS-232 port to communicate with other equipment (for example, connecting and polling the measuring instruments), the console output to the port should be disabled. There are two ways to disable the console:

Via web interface:

Services menu **-> Poll My Device -> RS232 -> Disable console** button

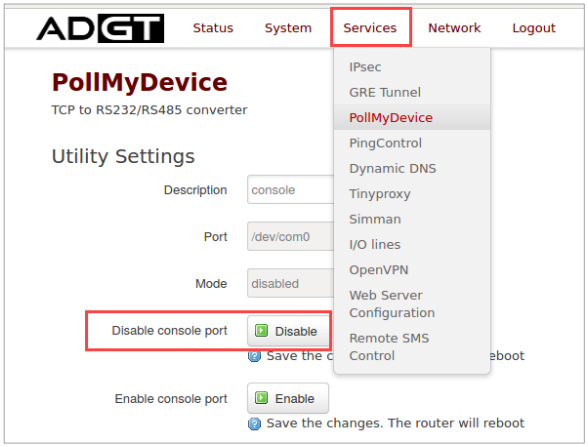


Fig. 13

Via command line:

To switch RS-232 interface from console mode to data transfer mode you need to edit two files:

```
/etc/sysctl.conf
/etc/inittab
```

1. At the beginning of the file **/etc/sysctl.conf** add a new line:

   `kernel.printk=0 4 1 7` (*and save the file*)

2. Edit the file **/etc/inittab.** Comment the next line (add the hash symbol #):

   `ttyAPP4::askfirst:/bin/ash --login`

   The result:

   `#ttyAPP4::askfirst:/bin/ash --login` (*and save the file*)

3. Reboot your device:

   `reboot`

4. Check the operation of console:

If you did everything correctly, at about 20-25 seconds of its loading, the router will stop issuing the bootloader information to the console and will enable the transfer operation mode.

To check the correct RS-232 operation, without disconnecting from the console, connect to the router via SSH (standard IP address – 192.168.88.1) and open the console on the side of the router via any terminal program (e.g. Picocom on Linux):

```
picocom /dev/ttyAPP4 -b 115200
```

(*don't forget you're connected to the console at a rate of 115200bps*)

Try to press the keys on the keyboard, you must see these symbols on the other side of connection.

2.5. U-Boot Loader

The **U-Boot 2014/10** is employed in GTR routers as the loader. Access to the loader is organized through the RS-232 interface using any terminal program. To access the loader:

1. Connect the console port of the router to COM port of the computer using the terminal cable. If there is no COM port on the PC, use the COM-USB converter.

2. Enter the console using any terminal program (for example, Putty for Windows OS and Picocom or Socat for Linux OS). In the program, select the **Serial** connection type, enter the COM port number and specify the rate of ***115200*** bps. **Attention! Password to access the system console is not required**!

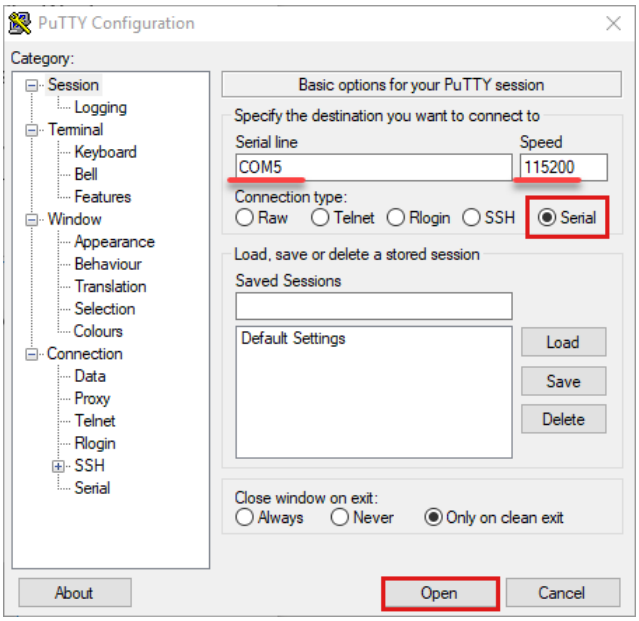


Fig. 14. Entering the router console using PuTTY.

3. Enter the **reboot** command in the console window. The system will restart; and the welcome page will appear, where you will be asked to enter the password to access the menu within three seconds.

   The default password is **root**.
   To exit the loader, enter the **reset** command in the console.

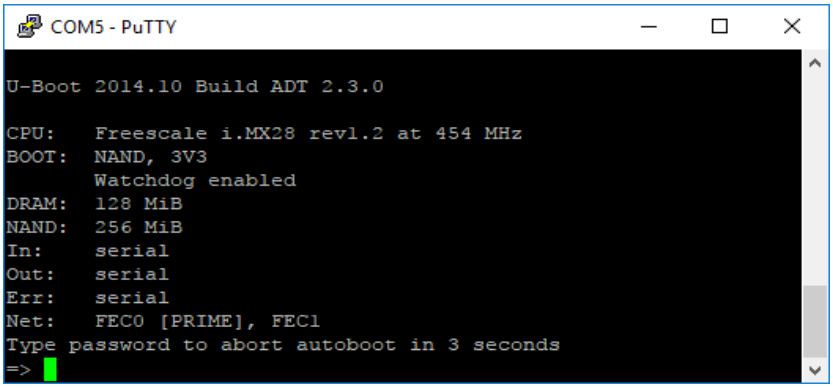


Fig. 15. Entering the loader menu.

NOTES:

- Password and time period for entering the password are stored in the following variables: *bootstopkey2* and *bootdelay*. After changing the variables, enter the *saveenv* command to save the changes
- Password and time to enter it could also be changed in the OpenWrt command line: *fw_printenv/fw_setenv*.
- The loader version could be found in the command line using the following command: *fw_printenv ver*.

2.6. Configuring GTR Router via Web Interface

GTR router has a graphical **web interface LuCI** for configuring the device through a web browser.

1. In order to access the router control via web interface, open the browser and enter the default router address in the address bar: **192.168.88.1**. The authorization page will appear in the window.

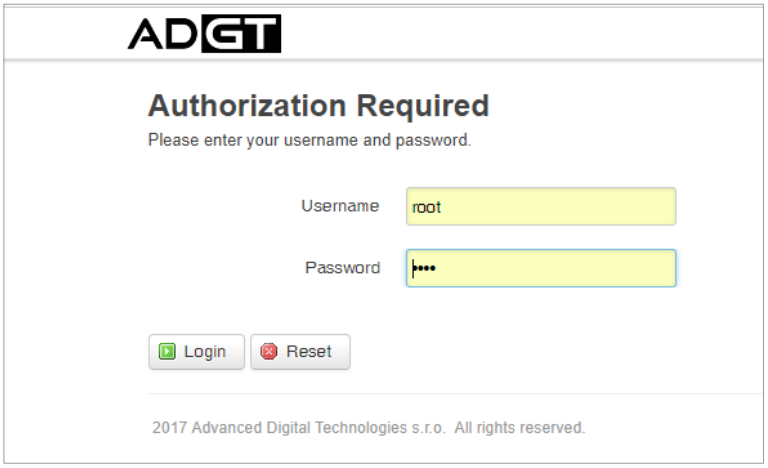


Fig. 16. Web interface. Authorization window.

2. Enter the authorization information and click **Sign In**.
   The default login/password are: **root/root.**

NOTE:
If you continue to work with the router, you can set the password to the administrator account in web interface menu: **System** -> **Administration** -> **Router Password**.

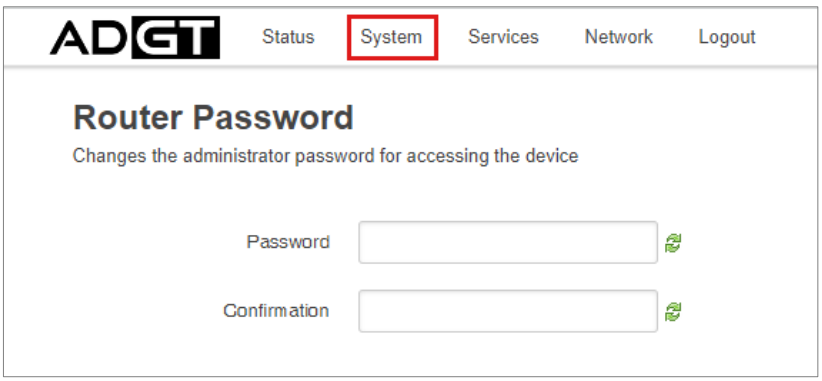


Fig. 17. Changing the router password.

3. After entering login and password, the web interface main page will open.

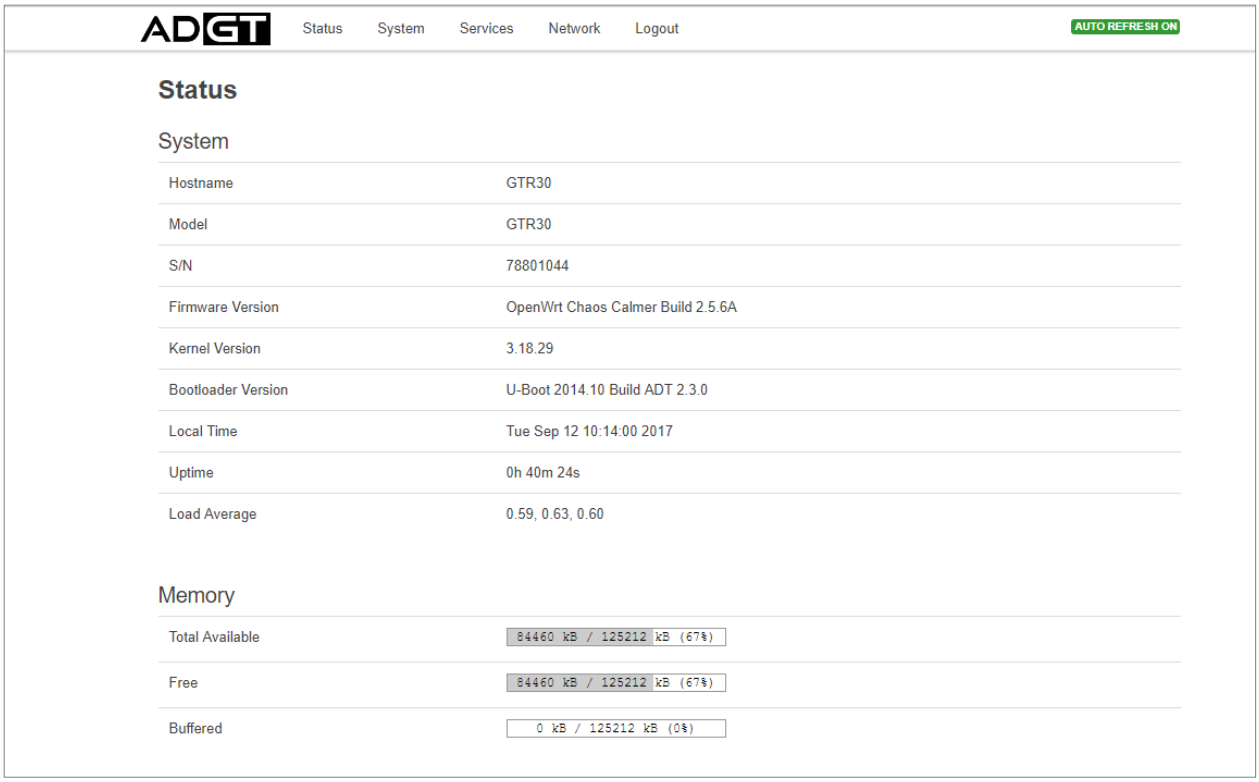


Fig. 18. GTR router web interface. Main page.

2.7. Configuring GTR Router via the Command Line Interface

In order to configure the router via the command line connect to the router using any terminal program (Putty, HyperTerminal or Picocom) according to the SSH protocol (port 22). In the program select the **SSH** as the connection type and enter the router IP address (Host name) **192.168.88.1**.

The default login and password - **root/root**.
The command line window after connection is shown in the figure below.

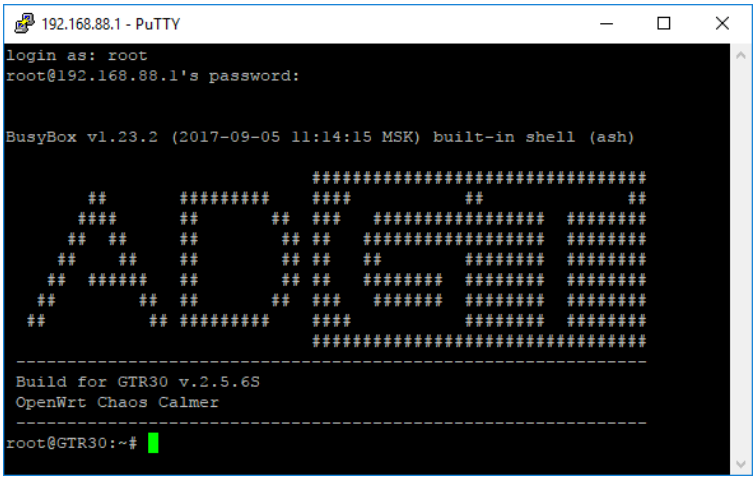


Fig. 19. GTR Router command line window.

Chapter 3. Configuring Network Interfaces

3.1. Configuring Local Connection (LAN)

Using the web interface, you could configure the default LAN/WAN interfaces and create the new ones. By default, ETH1 and ETH2 are merged to bridge; and connection to each port could be performed using the following address: **192.168.88.1**.

Changing IP address

IP addresses of ethernet interfaces can be changed in the menu **Network -> Interfaces -> LAN -> Edit -> General Setup**.

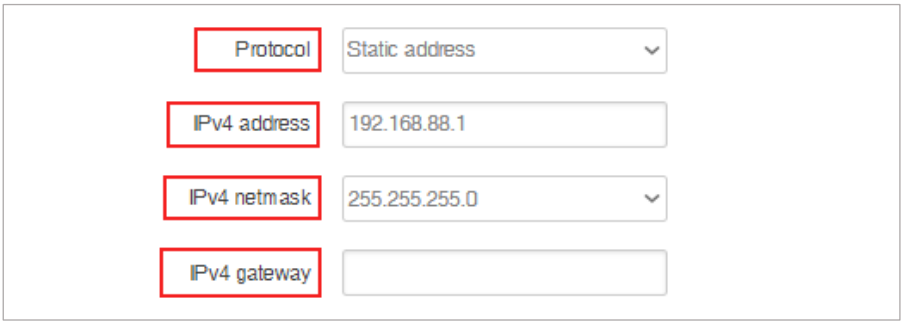


Fig. 20. Change IP settings.

- **Protocol**. IP settings vary depending on protocol. In most cases automatic IP acquisition (**DHCP client**) or static IP (**Static address**) is used.
- **IPv4 address** – router IP address. You can use this address to access the router's settings.
- **IPv4 netmask** – the subnet mask.
- **IPv4 gateway** – needs to be specified if the router is integrated into an existing network.

DHCP server settings

DHCP settings can be changed in the menu **Network -> Interfaces -> LAN -> Edit -> General Setup**. Addresses are distributed depending on the specified static address. For example, the default IPv4 address is 192.168.88.1 and the netmask is 255.255.255.0. Accordingly, the DHCP server can hand out addresses in the range of **192.168.88.100** – **192.168.88.250.**

- **Ignore interface.** By default, DHCP server is enabled. Check this box to disable the DHCP server for this interface.
- **Start –** shows from which address to start handing out IP addresses to client devices.
- **Limit –** determines how many addresses can be distributed (*150, by default*).
- **Leasetime** – the time after which the IP binding to the MAC address of the client devices will expire.

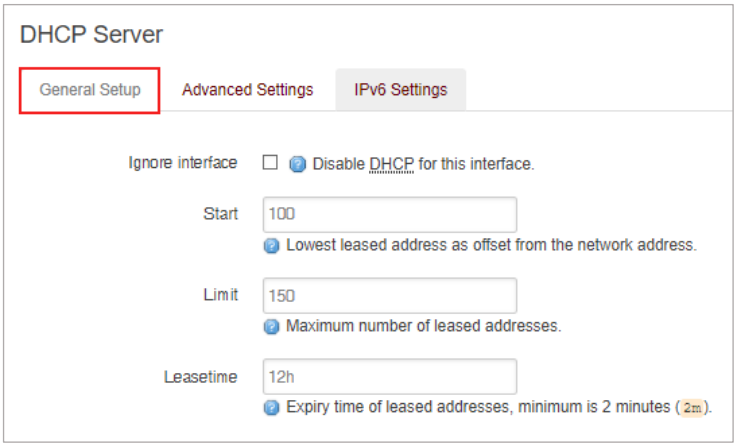


Fig. 21. DHCP server settings.

Based on the default settings (Fig. 21), we will get the following range of distributed IP addresses: **192.168.88.100–192.168.88.250**

Separating LAN bridge (br-lan):

In some cases, it is necessary to separate the existing interface bridge (br-lan) into two independent interfaces. There are two ways to do this:

Via Web interface:

1. Go to **Network -> Interfaces** and click **Edit** in LAN interface window.

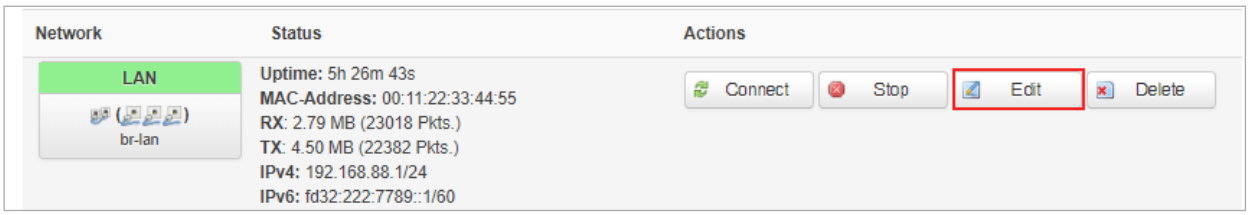


Fig. 22. Configuring LAN settings.

2. In the opened window on the **Physical settings** tab disable the bridge (uncheck the box **Bridge interfaces**) and clear the check box for one Ethernet adapter, for example, the "***eth1***" (Fig. 23).
3. Click **Save and apply**. Now the LAN interface is connected only to the "***eth0***" adapter.

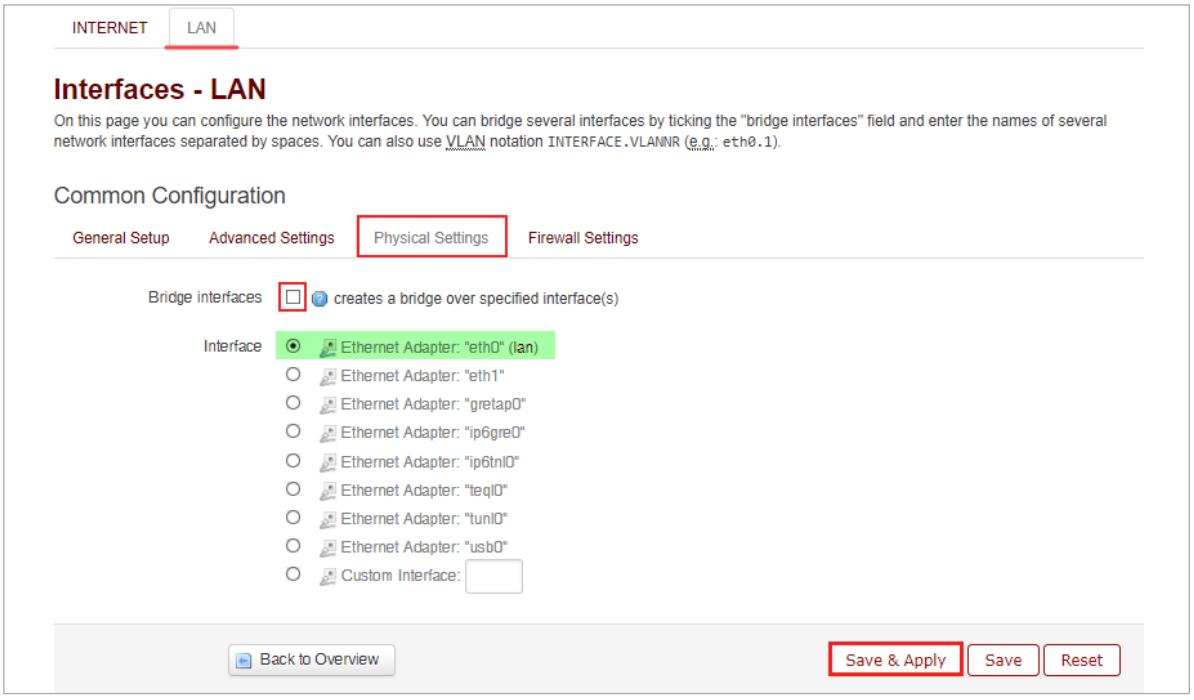


Fig. 23. Separating LAN bridge.

Via Console port:

Edit file **/etc/config/network**:

```
nano /etc/config/network
```

Make changes to the structure and save the file:

```
config interface 'lan'
   option proto 'static'
   option ipaddr '192.168.88.1'
   option netmask '255.255.255.0'
```

```
    option ip6assign '60'
    option ifname 'eth0'

config interface 'lan2'
    option proto 'static'
    option ipaddr '192.168.99.1'
    option netmask '255.255.255.0'
    option ifname 'eth1'
```

Edit file **/etc/config/firewall**:

```
nano /etc/config/firewall
```

Make changes to the structure and save the file:

```
config zone
    option name 'lan'
    option input 'ACCEPT'
    option output 'ACCEPT'
    option forward 'ACCEPT'
    option network 'lan lan2'
```

Edit file **/etc/config/dhcp**:

```
nano /etc/config/dhcp
```

Make changes to the structure and save the file:

```
config dhcp 'lan2'
    option start '100'
    option leasetime '12h'
    option limit '150'
    option interface 'lan2'
```

Restart he required services:

```
/etc/init.d/network restart
/etc/init.d/firewall restart
/etc/init.d/odhcpd restart
```

Check configuration:

```
ifconfig
```

Bridge separation is completed.

Creating a new LAN interface

After separating the bridge let's create a new interface for the second subnet (*eth1* adapter):

1. Go to **Network -> Interfaces** and click **Add new interface.**

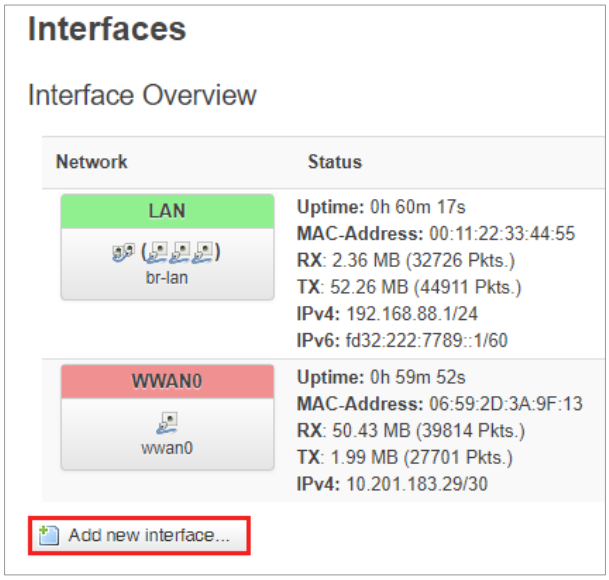


Fig. 24. Adding a new interface.

2. Set the **Name of the new interface** (for example, *lan2*) and in the line **Cover the following interface** tick the Ethernet adapter, which is free to connect (for example, *eth1*) (Fig. 25). Click **Submit**.

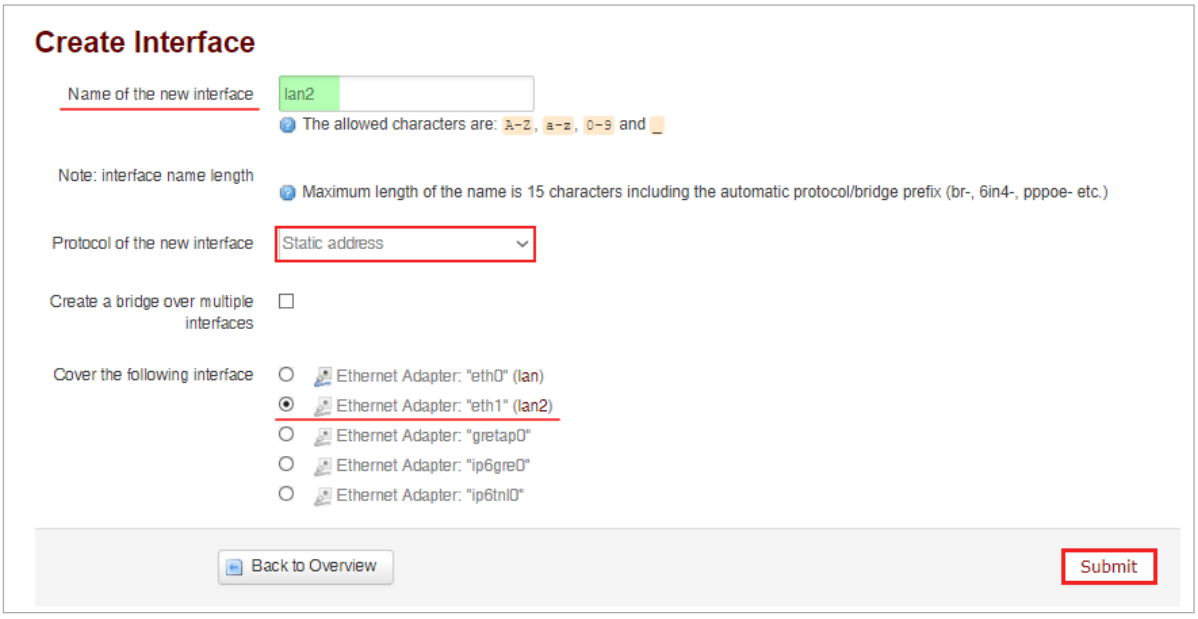


Fig. 25. Configuring a new interface.

3. After creating the interface, you will be taken to **General setup** menu. Enter the remaining interface settings (IP address, netmask etc.), click **Save** and go to **Firewall Settings**.

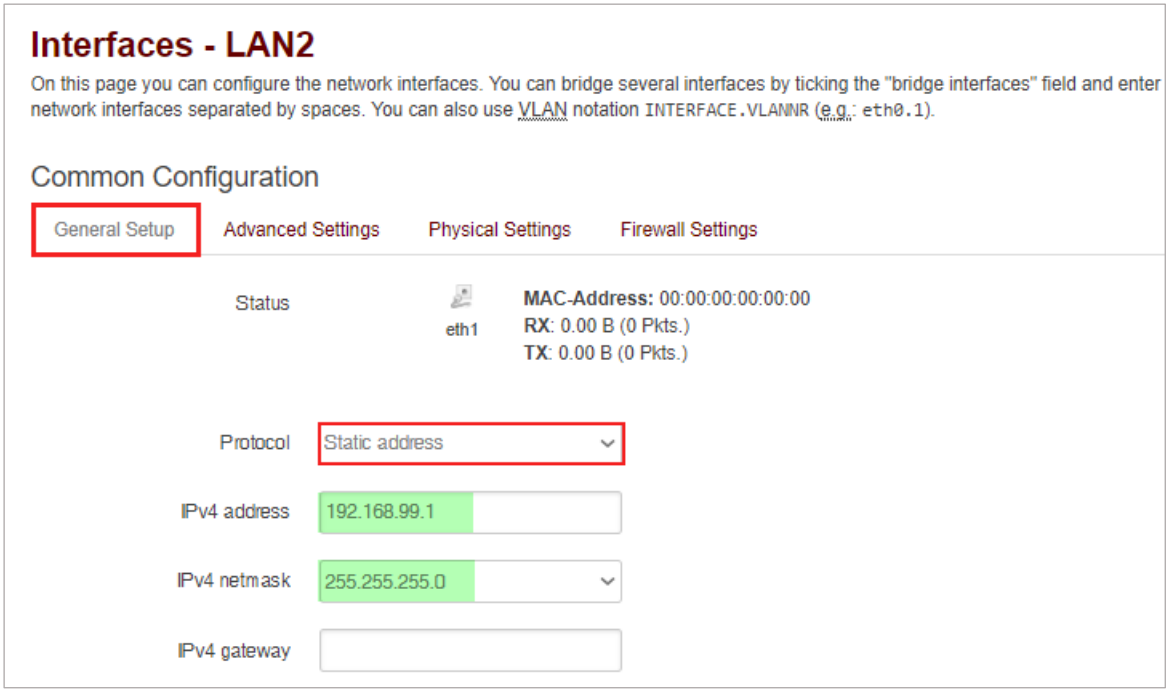


Fig. 26. Configuring a new interface.

Assigning interface to firewall zone

When creating a new interface, it's necessary to assign it to firewall zone. All Internet connections must belong to a group *WAN* (highlighted in red), local interfaces — to a group *LAN* (highlighted in green). When creating a virtual private network use *VPN* zone (create it yourself).

1. Go to **Network -> Interfaces -> *Interface name/* -> Edit** -> **Firewall settings** and select the zone to which the interface belongs (*LAN, WAN* or create your own zone, e.g., *VPN* etc.).
2. Click **Save & Apply**.

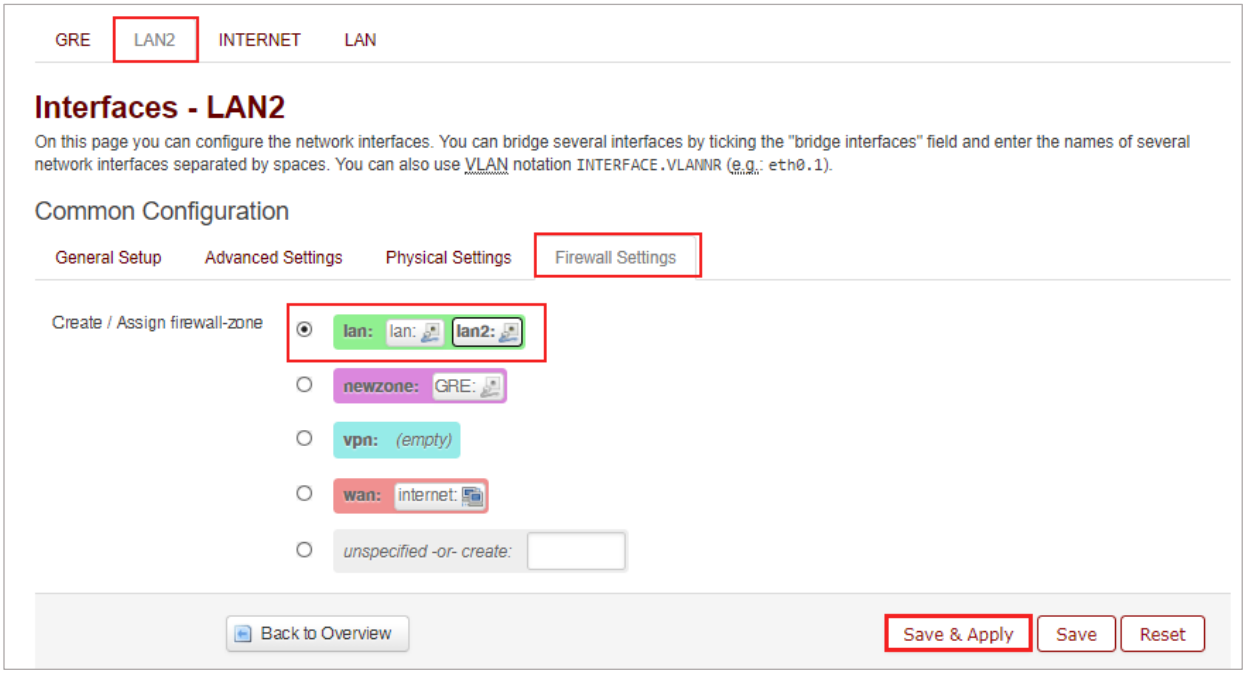


Fig. 27. Assigning interface to a firewall zone.

Adding interfaces to bridge

In order to merge two network interfaces to bridge (e.g. *LAN1* and *LAN2*):

1. In **Network -> Interfaces** menu select the *LAN* interface and click **Edit**.
2. In **Physical Settings** tab check the box **Bridge interfaces** and select an Ethernet adapter that would be bridged with the selected interface.

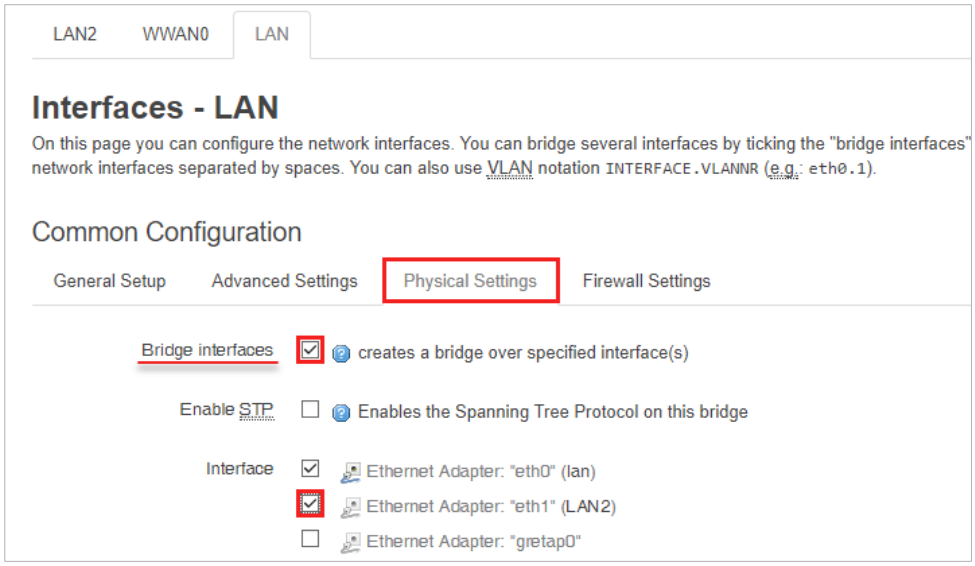


Fig. 28. Bridging interfaces.

3. Click **Save and Apply**.

3.2. Configuring 3G (4G) Connection (WAN)

GTR router is already delivered with the pre-configured 3G (4G) settings (Table 5). WAN parameters can be changed through web interface as well as via console port.

Via web interface:

Go to **Services –> Simman** menu.
In **SIM1 settings** or **SIM2 settings** tabs you can configure the following settings:

- **SIM cards priority**: *high* or *low*.
- **APN**: name of the cellular operator access point.
- **PIN**: SIM card PIN code (*optional*).
- **User name** and **password** of cellular operator (if needed).

For advanced SIM setup see section **6.1. SIM Manager**.

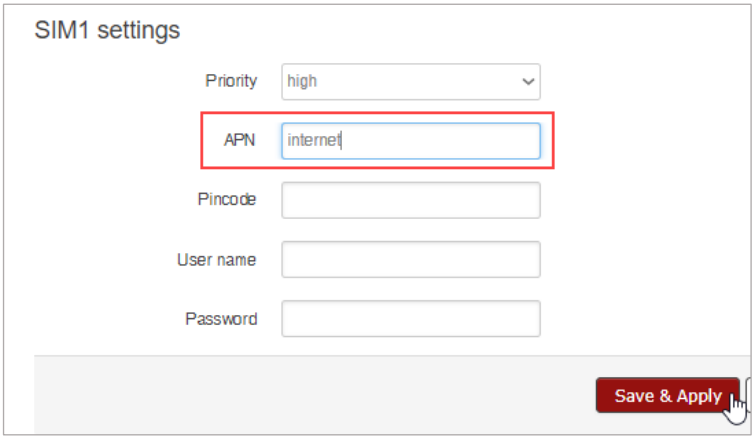


Fig. 29. Configuring 3G/4G (WAN) connection.

Via console port:

To change 3G/4G settings via console port:

1. Edit file **/etc/config/simman**:

   ```
   nano /etc/config/simman
   ```

   Change the required 3G/4G network settings, e.g. for SIM1:

   `config sim0` — configuring SIM1

   `option priority '1'` — SIM1 priority (*high*)
   `option GPRS_apn 'internet'` — APN (e.g. *internet*)
   `option pin '1234'` — PIN code (e.g. *1234*)
   `option GPRS_user 'user1'` — user name (e.g. *user1*)
   `option GPRS_pass 'pass1'` — password (e.g. *pass1*)

2. Save settings (**Ctrl+X**) and confirm saving into the same file '*simman*' (Fig. 30).

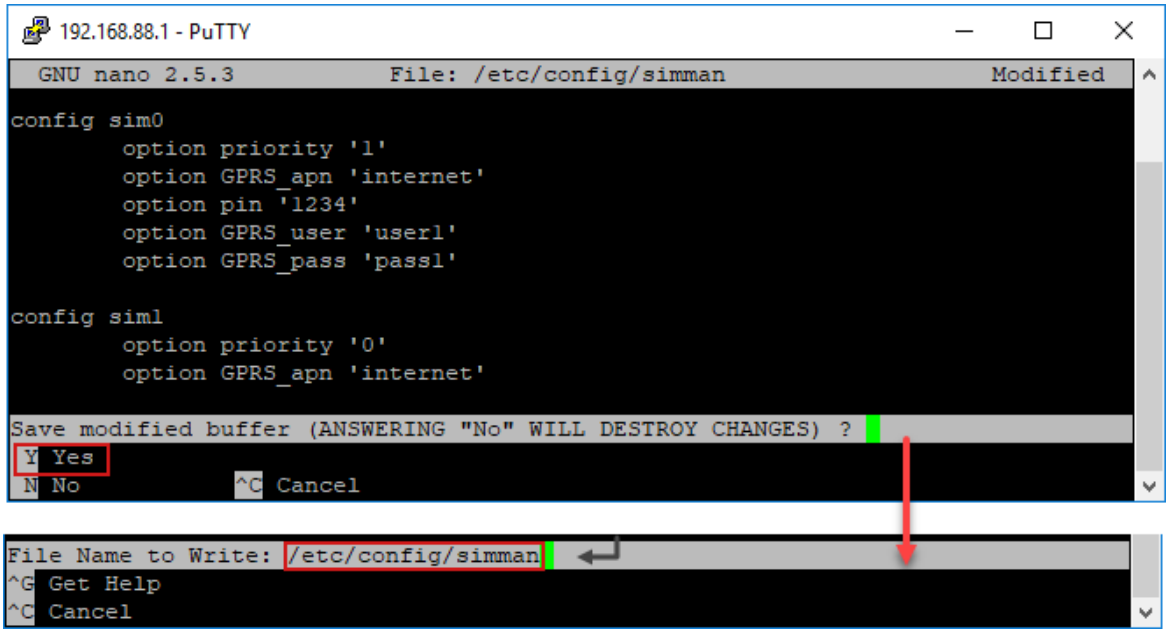


Fig. 30. Configuring SIM settings via Putty.

3. Restart **Simman**:

   ```
   /etc/init.d/simman restart
   ```

   For more reliability you can restart router:

   ```
   reboot
   ```

4. Check interfaces and connection.

Chapter 4. Polling of Serial Ports over TCP

GTR routers have RS-232 and RS-485 serial ports for connecting meters and other devices, and provide data transmission over TCP/IP network.

In cases when your need to connect devices with a serial Modbus RTU interfaces to TCP/IP Ethernet network, you can configure protocol conversion between Modbus RTU/ASCII and Modbus TCP. Conversion algorithm is described in section 1.9. Converting Modbus RTU/ASCII to Modbus TCP.

Configuring is performed via Web interface: **Services -> PollMyDevice** menu.

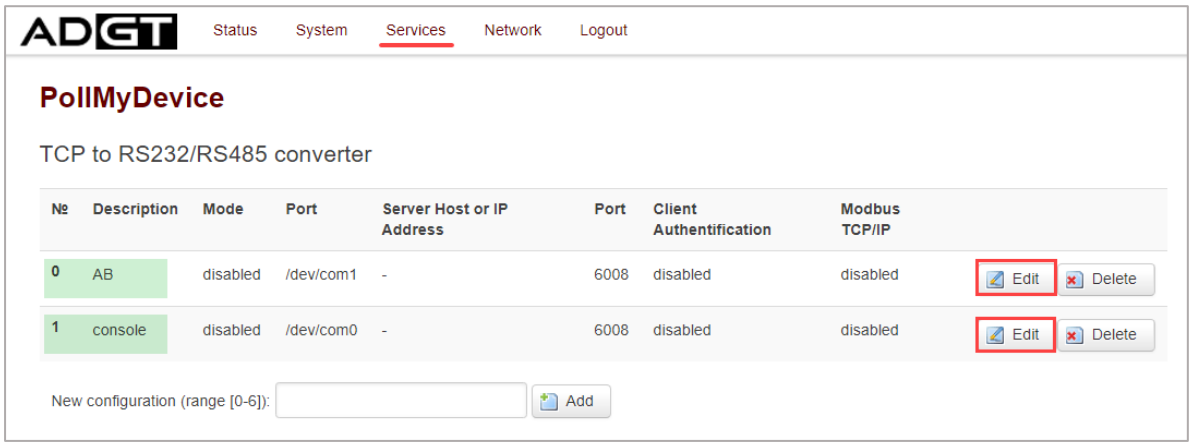


Fig. 31. Poll My Device menu.

- **0 (AB)** port corresponds to RS-485 interface.
- **1 (console)** port corresponds to RS-232 interface and by default works in the console mode for configuring the router. To transfer data, you can disable the console mode later.

By default, both ports are disabled.

To configure serial port:

1. **PollMyDevice** menu, select the desired port (**AB** or **console**) and click **Edit.**
2. In the window that opens, in the **Mode** line, enable the port by selecting the desired operating mode: **server** or **client**.

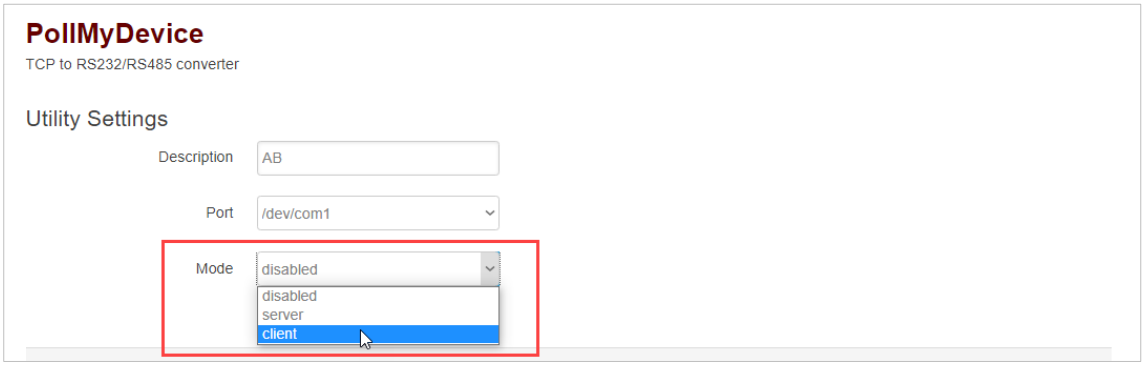


Fig. 32. PollMyDevice menu. Selecting serial port operation mode.

3. Configure serial port settings according to Table below.

Table. 7 Configuring Serial Port Settings.

Parameter	RS-232		RS-485	
Mode	**server**	**client**	**server**	**client**
Description	Name of the interface in the router By default - **console**		Name of the interface in the router By default - **AB**	
Port (in Linux)	**/dev/com0** (*unchangeable parameter*)		**/dev/com1** (*unchangeable parameter*)	
Disable log messages	Option to enable or disable the output of debug messages to the system log (**Status** → **System Log**)			
BaudRate	The port speed must match the rate of the connected device. Optional: 300-921600 baud (default - 9600 baud)			
ByteSize	The number of data bits must match the data bit of the connected device. Optional: 5,6,7,8 (default)			
StopBits	The length of the stop bit, must match the stop bit of the connected device. Optional: 1 (default), 2			
Parity	The parity value must match the value of the connected device. Optional: none (default), even, odd			
Flow Control	Flow control option to prevent data loss: XON/XOFF (software), RTS/CTS (hardware) and none (no control - default)			
Connection Hold Time (sec)	If no data is transmitted within the specified time, the connection is closed. Optional: 0-100000 sec. By default - 60sec.	—	If no data is transmitted within the specified time, the connection is closed. Optional: 0-100000 sec. By default - 60sec.	—
Minimum packet size [0-255] (byte) [5]	The number of bytes at which the packet will be sent. Optional: 0-255 bytes. 0 – no packet size separation (default). If the value is set to ≥ 1 byte, an additional parameter appears – **Packet Timeout**			
Packet Timeout [0-255] (x100ms) [5]	The time at which a packet with the accumulated number of bytes will be sent. The parameter appears only if the **Minimum packet size** is ≥ 1 byte. Optional: 0-255 ms. 0 - no packet time separation (default). **Attention!** Calculate the timeout as follows: <*your value*> is x 100ms. For example, if the data transfer should occur 1 time/1 sec, the timeout value should be 10 ms (10 ms x 100 ms = 1000ms (or 1 sec)).			
Server Host or IP Address	—	The address of the server to which the router will connect.	—	The address of the server to which the router will connect.
Server Port	The port of the router to which the devices in the client mode will connect. Default value - **33001**	The port of the remote server to which the router will connect in the client mode. Default value - **6008**	The port of the router to which the devices in the client mode will connect. Default value - **33000**	The port of the remote server to which the router will connect in the client mode. Default value - **6008**

[5] The **Minimum packet size** and **Packet Timeout** parameters are interrelated.
If the number of bytes in the packet reaches the value specified by the **Minimum Packet Size** parameter before the time specified by the **Packet Timeout** parameter expires, the packet will be sent immediately.
Conversely, if the time set by the **Packet Timeout** parameter comes faster than the number of bytes in the packet reaches the value set by the **Minimum Packet Size** parameter, the packet will be sent immediately.
If both parameters = 0, all received data will be immediately transmitted to the serial port.

Parameter	RS-232		RS-485	
Client Reconnection Timeout (sec)	—	The time interval since the last packet was transmitted, after which the session with the server will be terminated. Optional: 0-100000 sec. Default – 60 seconds	—	The time interval since the last packet was transmitted, after which the session with the server will be terminated. Optional: 0-100000 sec. Default – 60 seconds
Client Authentication	—	*Not used*	—	*Not used*
Modbus TCP/IP	**disabled –** disables Modbus RTU/ASCII – Modbus TCP conversion mode **RTU** – conversion from Modbus TCP to the Modbus RTU protocol (data is encoded in binary format, and the silence interval is the packet separator) **ASCII** - conversion from Modbus TCP to Modbus ASCII protocol (data is encoded with ASCII characters and transmitted in hexadecimal format. The beginning of the packet is the start character ':', and the end is the stop sequence ' CR+LF'			
Disable console port	By default, the console output of the OS and bootloader is set to the RS-232 port. Click **Disable** when using the port for meter polling or when connecting to the server.		—	
Enable console port	Click **Enable** when using the port in console mode to configure the router (enabled by default).		—	

4. Click **Save and Apply** to save changes.

Chapter 5. Configuring I/O Lines

GTR routers universal I/O lines can be programmed as inputs or outputs and envisage the following operation modes (detailed description of operation modes is given in 1.7. Universal Input/Output Lines):

1) voltage measurement;
2) load control.

I/O lines configuration can be performed via Web interface as well as using a command line.

5.1. Configuring I/O Lines via Web interface

In order to switch I/O lines operation mode using Web interface:

1. Go to **Services –> I/O lines** menu. You will see a list of I/O ports, each of which is configured by default to **Mode 1** – Voltage measurement.
2. In the **Mode** column select a required mode from the dropdown list:
   - **Mode 1** — voltage measurement mode
   - **Mode 2** — *temporarily not used*
   - **Mode 3** — load control mode.

ATTENTION:

- If you want to save the current operation mode configuration the next time you reload the router, check the box **Run on Startup**, otherwise the configuration will be lost after the reload.

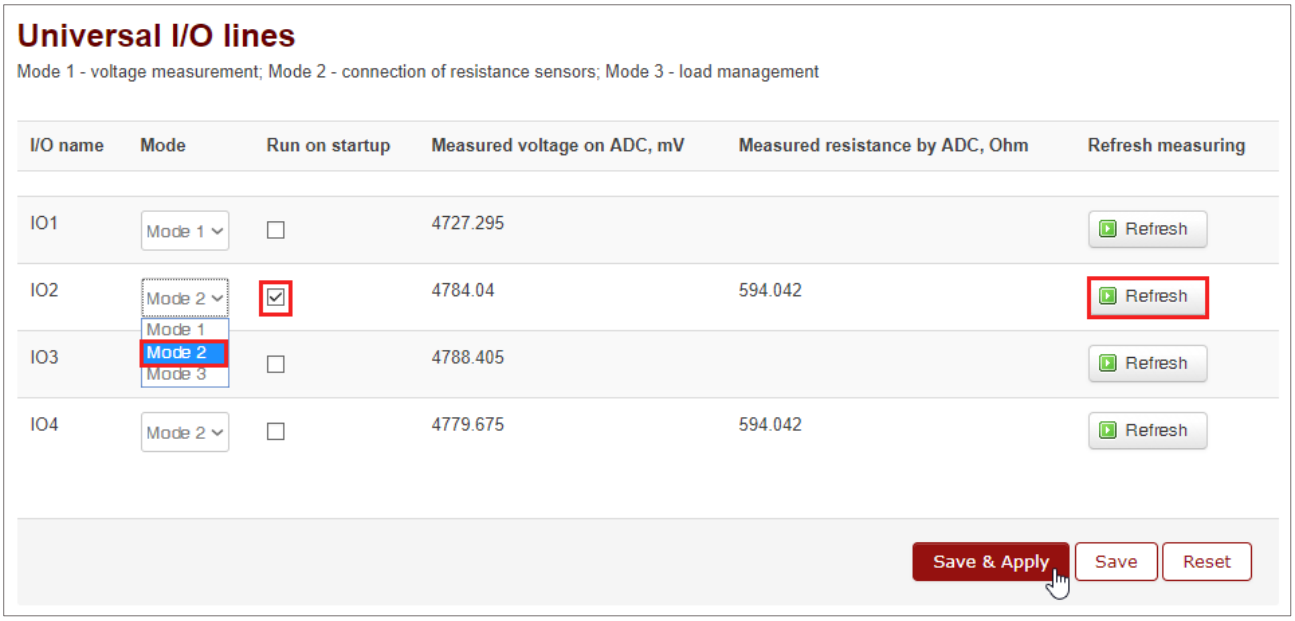


Fig. 33. Configuring I/O lines operation mode via Web.

3. Click **Save & Apply.**
4. To read current values from the router click **Refresh** button.

5.2. Configuring I/O Lines via the Command Line

Every GPIO port of the router has a Symlink for each direction in operating system, see the table below (a detailed list of all I/O ports is given in Application 3. GTR Routers Port Map).

Table 1. I/O ports in Linux.

I/O Port	Application	Symlink in Linux	Default Directions
IO1	IO0PULLUP #[6]	/dev/pu0	IN/OUT
	IO0PULLDOWN	/dev/pd0	OUT
	ADC0 (LRADC0)	/dev/io0	IN
IO2	IO1PULLUP #	/dev/pu1	IN/OUT
	IO1PULLDOWN	/dev/pd1	OUT
	ADC1 (LRADC1)	/dev/io1	IN
IO3	IO2PULLUP #	/dev/pu2	IN/OUT
	IO2PULLDOWN	/dev/pd2	OUT
	ADC2 (LRADC4)	/dev/io2	IN
IO4	IO3PULLUP #	/dev/pu3	IN/OUT
	IO3PULLDOWN	/dev/pd3	OUT
	ADC3 (LRADC6)	/dev/io3	IN

Three signals can be used to control each IO line:

- **ADC** — channel, measuring the line voltage.
- **PULLDOWN** — “lower key”, pulls the IO line down to ground. Can take the following states:

  1 – PULLDOWN switched ON
  0 – PULLDOWN switched OFF

- **PULLUP #** - “upper key”, pulls up current source in IO line. **Attention**: signal is inverted, so the commands are given as follows:

  1 – PULLUP # switched OFF
  0 – PULLUP # switched ON

Switching IO port to Mode 1 (Voltage measurement):

Mode 1 (Voltage measurement) is active by default for all IO lines.
To turn the input (*e.g. IO1*) to Mode 1 run the following commands:

`echo in > /dev/pu0/direction` — configuring port as input (disabling “upper key”).
`echo out > /dev/pd0/direction` — configuring port as output.
`echo 0 > /dev/pd0/value` — disabling “lower key”.

[6] # – inverted signal.

Switching IO port to Mode 3 (Load control):

To turn the input (*e.g. IO1*) to Mode 3 run the following commands:

`echo out > /dev/pu0/direction` — configuring port as output.
`echo 1 > /dev/pu0/value` — disabling “upper key”.
`echo out > /dev/pd0/direction` — configuring port as output.
`echo 1 > /dev/pd0/value` — enabling “lower key”.

To control current run the command:

`echo 1 > /dev/pd0/value` — the operating current goes through the load.
`echo 0 > /dev/pd0/value` — the operating current doesn’t go through the load.

Other ports are configured the same way.

Reading values from I/O lines

To read values from I/O lines run the following command:

`cat /symlink/` — see Table 1. I/O ports in Linux. for Symlink.

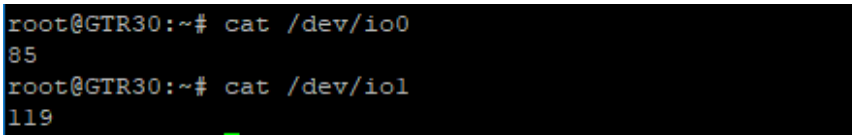


Fig. 34. Reading IO values from the command line.

You will obtain a raw value (**N**). Using this value, you can calculate resistance or voltage values (depending on the operation mode) according to the following formulas:

- Voltage measurement (for **Mode 1**), in volts[7]:

  $$V_{in} = N * 4{,}365 * 10^{-3}$$

  where **N** – raw value
  4.365 – coefficient for converting raw ADC values to voltage (mV)
  *** 10^{-3}** – mV to V conversion.

NOTE:

- If we work with PULLDOWN, #PULLUP should be switched off.
- If we work with PULLUP, #PULLDOWN should be switched off.

[7] Please note: in the web interface (Services -> I/O lines), the voltage values are given in millivolts (mV).

Chapter 6. Router Administration

6.1. SIM Manager

In order to display information from the built-in 3G (4G) modem and control the SIM cards, **SIMMAN** utility (SIM cards manager) is provided in the router, access to which could be executed using the web interface menu: **Services –> Simman**.

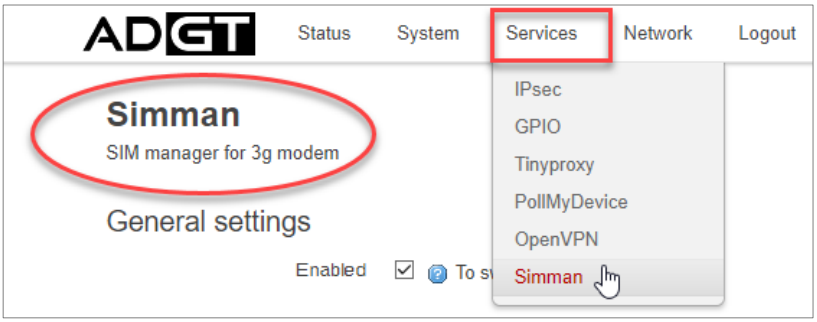


Fig. 35. SIM card manager.

The following parameters and functions could be configured in the **Simman** Section:

Table 2. SIM cards configuration parameters.

Parameter	Description	Default
SETTINGS		
Enabled	Service operation switched on/off.	Switched on
Use only high priority SIM	Tick the field if only one SIM card is going to be used. When the checkbox is selected, if high priority is assigned to SIM1, router will not switch to SIM2 when connection fails.	Switched off
Number of failed attempts	Number of failures to connect to the test servers; if this number is exceeded, the router shall switch to the other SIM card.	3
Period of check	Frequency of checking the access to the test servers (set in seconds). Servers accessibility is specified for both SIM cards.	60 seconds
Return to priority SIM	Frequency of checking the access to the test servers (set in seconds). Servers accessibility is checked with both SIM cards. *For example, if SIM1 ran out of money and the router switched to SIM2, which has a lower priority level, after 100 minutes the router will try again to switch to SIM1.*	6000 seconds (100 minutes)
AT modem device name	Virtual COM port number that is responsible for server processes engaged in SIM card management	/dev/ttyUSB2 (GTR30) /dev/ttyUSB3 (GTR40)
Ping iface name	The name of interface that is checked by SIMMAN service	3g-internet (GTR30) wwan0 (GTR40)
IP address of remote servers	Test addresses to check Internet connection. By default, Google DNS server addresses are employed.	8.8.8.8 8.8.4.4
Switches before modem reset	A number of modem attempts to switch from one SIM card to the other; if this number is exceeded, modem will reset.	3
Switches before reboot	A number of modem attempts to switch from one SIM to the other before router reboot (if the router reboot is needed). A number must exceed the value, specified in the parameter **Switches before modem reset**.	0
SIM1 and SIM2 settings		
Priority	SIM priority: high/low. If both SIM cards have the same priority, the router, by default, shall be switched to SIM1.	SIM1: high SIM2: low

Parameter	Description	Default
APN	Access point name (APN) is set by the communication operator.	internet
Pincode	PIN code for SIM cards.	Disabled
User name	Set by the communication operator.	Not set
Password	Set by the communication operator.	Not set

The SIMMAN Section also displays the entire information about the current 3G (4G) connection. The COM port **ttyUSB2** of the built-in 3G (4G) module is responsible for presenting information about the built-in modem and the router SIM-cards: signal level, frequency channel, GPRS status, etc.

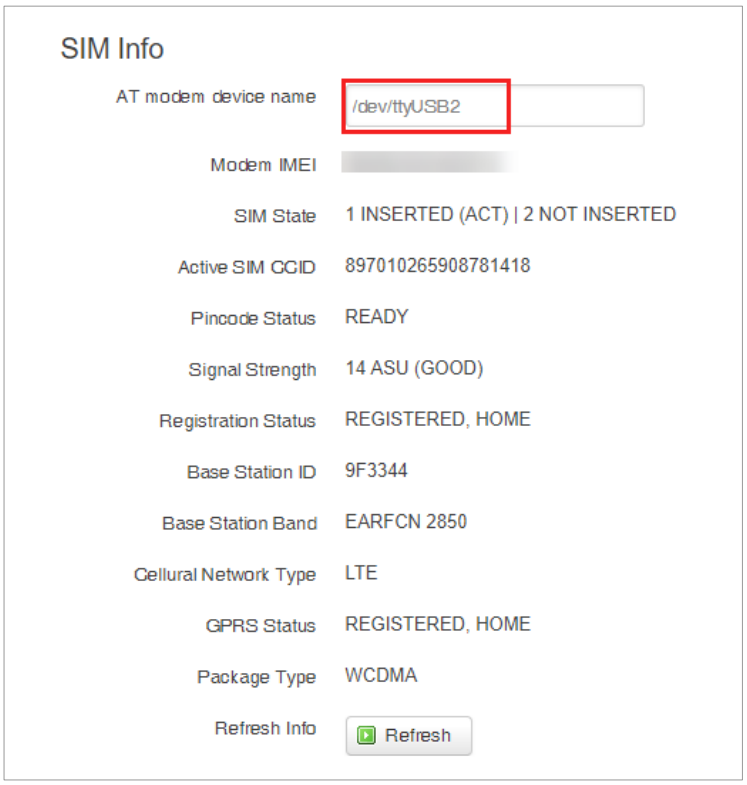


Fig. 36. 3G/4G connection info.

In order to get the current information from the modem, click the **Refresh** button. The data will be updated in 5 - 10 seconds.

6.2. Router Firmware Upgrading

Checking current firmware version

The current version of the firmware could be checked on the main page of the web interface after entering login and password. The firmware version is the OS build version, designated as Build x.x.x.

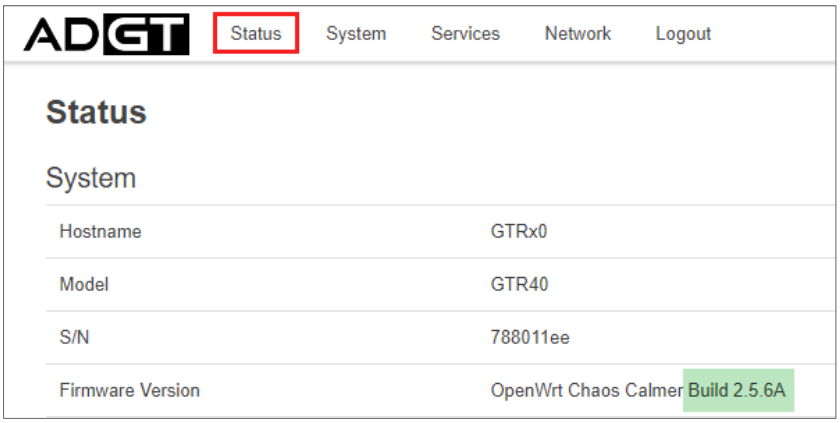


Fig. 37. OpenWrt Web interface. Firmware version.

To get the firmware version from the command line, enter the following command:

```
cat /etc/banner
```

Firmware upgrade

Before upgrading the firmware make sure that the device is connected to a reliable power supply source. If the power supply is interrupted during the OS upgrade process, the system will be lost, and its upgrading shall be possible only from the loader console (via the RS-232 interface). Besides, if the power supply is interrupted, the ROM could be damaged.

Upgrading via Web interface

1. Go to **System** → **Backup/Flash Firmware** (section **Flash new firmware image**).
2. Using the **Choose file** button point the location of tar-archive with the new firmware and then click **Flash image**. If everything is done correctly router will reboot with the new firmware.

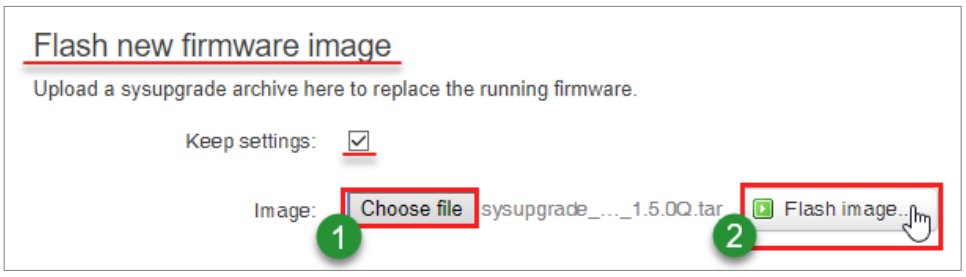


Fig. 38. Updating router firmware via web interface.

Upgrading via Command line

1. Save the current configuration via web interface (see section **6.4. Configuration Settings Saving and Recovery**)
2. In any convenient way copy the **sysupgrade_GTR.tar** archive to the **/tmp/** directory of the router.
3. Enter **sysupgrade** in the command line. A warning will appear in response:

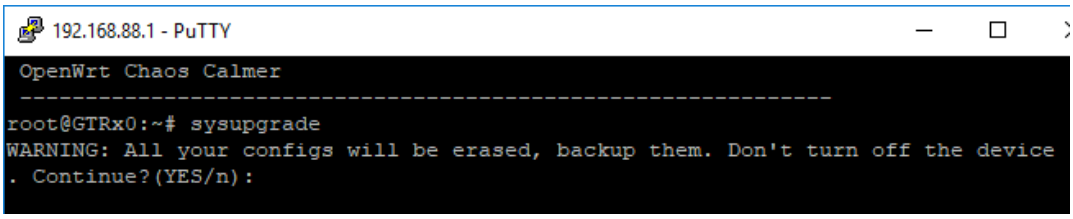


Fig. 39. Firmware upgrade.

4. Enter "**YES**" and wait for the system to reboot.
5. After reboot you could restore your configuration files.

6.3. Router Reboot

Via the Web interface:

System –> **Reboot** –> **Perform reboot** (Fig. 40).

From the command line:

```
reboot
```

ATTENTION!

After reboot, the system will require to enter the authorization data (username and password).

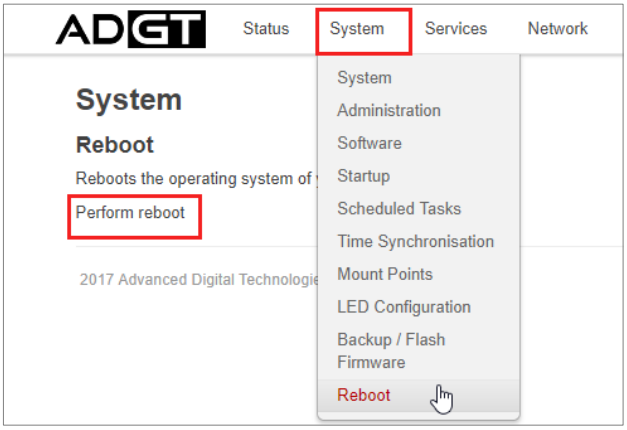


Fig. 40. Router reboot.

6.4. Configuration Settings Saving and Recovery

1. In order to save the current settings, create a backup configuration copy. In the menu **System** -> **Backup/Flash Firmware** click **Generate archive** (Fig. 41). The system will create and upload to your computer the tar-archive of the current configuration with the following extension: ***.tar.gz

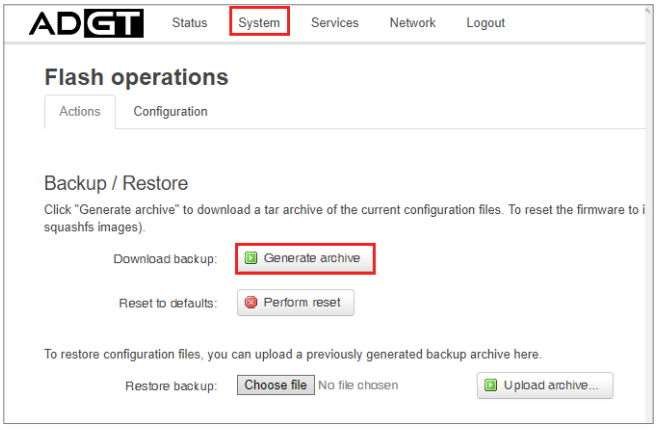


Fig. 41. Generating a backup configuration copy.

2. In order to restore the saved configuration, in the **System** -> **Backup/Flash Firmware** menu using the **Choose file** button point the location of the configuration tar-archive and click **Upload archive**.

ATTENTION!

It is permitted to restore the settings of only that version of the router firmware, for which the archive was initially created

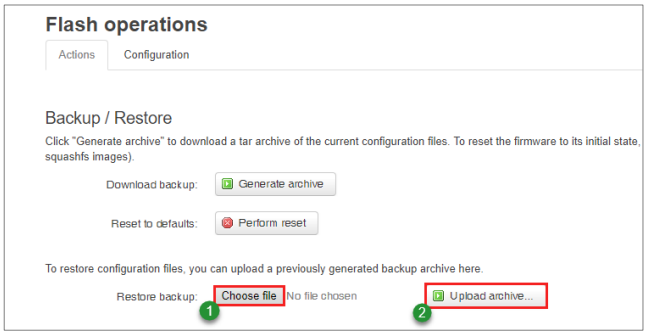


Fig. 42. Restoring the configuration.

6.5. Resetting to Factory Defaults

Via the Web interface:

1. Go to **System -> Backup/Flash Firmware** menu and click **Perform Reset** on the **Actions** tab.
2. In the opened window click **OK** to confirm the reset. Immediately after this, deleting of the configuration section will start followed by the system reboot.

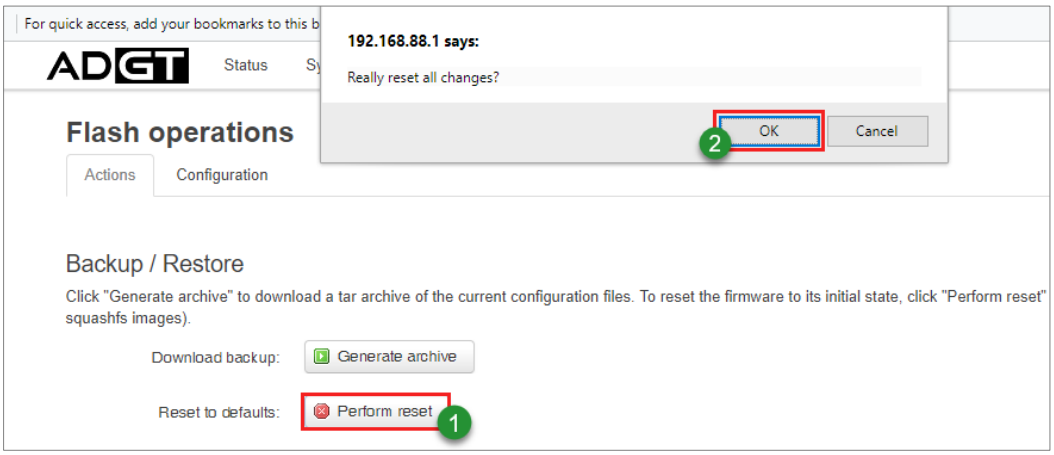


Fig. 43. Reset to factory configuration.

Via the command line:

Resetting via the **command line** is carried out by entering two consecutive commands:

```
firstboot
reboot -f
```

Resetting from the **bootloader console** (via the RS-232 interface) is carried out by entering the following command:

```
run factory_reset
```

Application 1. GTR Router Series Model Line

The full device name is determined by the device modification, including network type, mounting type and all additional options. In order to select required options, use the table below.

Table 3. GTR Router Series Model Line.

	GPS module with high accuracy time synchronization unit	Supercapacitor
3G GTR ROUTER MODELS		
GTR30	–	–
GTR30-G	•	–
GTR30-S	–	•
GTR30-GS	•	•
4G GTR ROUTER MODELS		
GTR40	–	–
GTR40-G	•	–
GTR40-S	–	•
GTR40-GS	•	•
MOUNTING TYPE (see the label on the enclosure)		
H + S	two plastic fasteners for DIN rail mounting and desktop rubber feet	
R	metal fastener for DIN rail mounting	
T	fasteners for wall mounting	
V	single plastic fastener on the enclosure narrow side for DIN rail mounting	

Application 2. GTR Routers Network Options and Services

The OpenWrt operating system on the Linux core built in the GTR30/GTR40 router appears to be a flexible easily modifiable software platform, which allows to configure the router to perform any user tasks by embedding the custom software. The system possesses a convenient file system manager with a repository, which includes more than 3500 software packages. Read more about the OpenWrt OS capabilities following the links:

- https://wiki.openWrt.org/

The table below demonstrates the basic GTR router network functions.

Table 4. Router network functions.

Function	Description
DHCP	Network service allowing computers to automatically obtain IP addresses and other parameters required to operate within the TCP/IP network. Operates according to the Client/Server model: • **DHCP Clients** request addressing parameters from DHCP server within the configuration process. • **DHCP Server** submits the addressing parameters to users (*switched on by default*). **IP Pool Start: 192.168.88.100 — IP Pool End 192.168.88.255**
DNS	Domain name system designed to transform the symbol names into the IP addresses and vice versa.
Routing tables creating techniques	
Static routing	All the routes are registered and changed manually, without using protocols (suitable for small networks).
Dynamic routing	Routes formation using special protocols. Dynamic routing protocols supported by GTR routers: **OSPF v1/v2/v3** — internal gateway protocol designed to ensure information exchange between routers within a single autonomous system. Calculates the shortest path to subnets in the inter network environment using the Dijkstra algorithm. The protocol creates a network map (link state database) and updates it, when changes in the network structure appear. **BGP v4/v4+** - is the border gateway protocol, designed to ensure information exchange between autonomous systems. The best route is chosen based upon the rules adopted in the network. The protocol uses summation of routes to reduce the routing tables.
Secure network	
Open VPN	An open source technology that allows to establish connection between the network nodes without changing the NAT and Firewall rules. Security and encryption are ensured by the OpenSSL library and the TLS transport layer protocol. This technology is suitable for small size companies, employees working remotely and for secure networking of territorially separated units.
IPSec	Internet Protocol Secure – a protocol which is most commonly used to encrypt traffic on IP networks.
PPTP	Point-to-Point Tunneling Protocol – a network protocol used in the implementation of Virtual Private Networks (VPN). PPTP uses a TCP control channel and a GRE tunnel to encapsulate PPP packets.
GRE	Generic Routing Encapsulation – is a tunneling protocol designed to encapsulate a wide variety of network layer packets inside IP tunneling packets.
Network protocols	
NAT	Transformation of private local IP addresses into unique global IO addresses required to

Function	Description
	ensure communication with the other network hosts (*switched on by default*).
Firewall	**Netfilter** network gateway protocol performs the network nods protection (switched on by default). Netfilter ensures the network packages control and filtering in accordance with the prescribed rules. The packages processing is carried out consecutively by chain. Filtering is provided using the IP and MAC addresses.
Other services	
TinyProxy	Service to create small HTTP proxy servers.
Ipv4	IP (Internet Protocol) fourth version using the 32-bit addresses.
IPv6	IP (Internet Protocol) sixth version using the 128-bit address length instead of the 32-bit address.
Administration	
LuCI web interface	Graphic web interface used for router configuration and written in the Lua programming language.
Command line interface	Remote control of the router through any SSH-Client (for example, PuTTY) using the following protocols: **SSH** — application level network protocol (uses TCP port 22 for operation). Encrypts the entire data, which provides secure authentication and protected access to a remote device. **Telnet** – network level protocol (uses TCP port 23 for operation). Transmits data in the open and unencrypted format, and due to this reason it is not recommended for use in an external network.
Connection via console port (COM port)	Access to the router console. It is designed for the router initial setting and restoring access to the device, for example, if the password is lost, and when the software restoration is required, as well as in cases, where it is impossible to obtain access to the router using the IP-address.

Application 3. GTR Routers Port Map

Table 11 presents the lines designation of external interfaces for the software configuration.

Table 5. GTR Router port map.

Application	Port/Output	Designation in Linux	SymLink	Default Directions	Enclosure Designation
Modem control (USB1)					
SIMDETECT	GPIO 2.14	/sys/class/gpio/GPIO78		OUT	-
SIMDET0 # [8]	GPIO 2.15	/sys/class/gpio/GPIO79		IN	-
SIMDET1 #	GPIO 3.08	/sys/class/gpio/GPIO104		IN	-
SIM.ADDR	GPIO 2.18	/sys/class/gpio/GPIO82		OUT	-
GSM.VCCEN #	GPIO 2.19	/sys/class/gpio/GPIO83		OUT	-
GSM.PWRKEY	GPIO 3.09	/sys/class/gpio/GPIO105		OUT	-
Configured Input/Output lines					
IO0PULLUP #	GPIO 1.19	/sys/class/gpio/GPIO51	/dev/pu0	IN/OUT	-
IO0PULLDOWN	GPIO 1.18	/sys/class/gpio/GPIO50	/dev/pd0	OUT	-
IO1PULLUP #	GPIO 1.22	/sys/class/gpio/GPIO54	/dev/pu1	IN/OUT	-
IO1PULLDOWN	GPIO 1.21	/sys/class/gpio/GPIO53	/dev/pd1	OUT	-
IO2PULLUP #	GPIO 1.25	/sys/class/gpio/GPIO57	/dev/pu2	IN/OUT	-
IO2PULLDOWN	GPIO 2.00	/sys/class/gpio/GPIO64	/dev/pd2	OUT	-
IO3PULLUP #	GPIO 2.02	/sys/class/gpio/GPIO66	/dev/pu3	IN/OUT	-
IO3PULLDOWN	GPIO 2.01	/sys/class/gpio/GPIO65	/dev/pd3	OUT	-
ADC0	LRADC0	/sys/bus/iio/devices/iio:device0/in_voltage0…	/dev/io0	IN	IO1
ADC1	LRADC1	/sys/bus/iio/devices/iio:device0/in_voltage1…	/dev/io1	IN	IO2
ADC2	LRADC4	/sys/bus/iio/devices/iio:device0/in_voltage4…	/dev/io2	IN	IO3
ADC3	LRADC6	/sys/bus/iio/devices/iio:device0/in_voltage6…	/dev/io3	IN	IO4
IOFAULT #	GPIO 1.01	/sys/class/gpio/GPIO33		IN	
USB connector power					
USBHOST.VCCEN.TRIG.STATE C	GPIO 3.25	/sys/class/gpio/GPIO121		OUT	-
USBHOST.VCCEN.TRIG.CLK D	GPIO 3.26	/sys/class/gpio/GPIO122		OUT	-
Ethernet management (common for 2 connections)					
ETHRESET #	GPIO 1.28	/sys/class/gpio/GPIO60		OUT	-
LED management					
LEDTOP	GPIO 2.03	/sys/class/leds/top:power		OUT	PWR
LEDMIDDLE	GPIO 2.08	/sys/class/leds/middle:net		OUT	NET
LEDBOTTOM	GPIO 2.09	/sys/class/leds/bottom:act		OUT	ACT
LEDLEFT	GPIO 1.12	/sys/class/leds/left:mmc0		OUT	
LEDRIGHT	GPIO 1.16	/sys/class/leds/right:mmc0		OUT	
CONSOLE/RS-232 interface					
TXD	UART4 TXD	/dev/ttyAPP4	/dev/com0	OUT	CONSOLE
RXD	UART4 RXD			IN	
RTS	UART4 RTS			OUT	

[8] # - inverted signal.

Application	Port/Output	Designation in Linux	SymLink	Default Directions	Enclosure Designation
CTS	UART4 CTS			IN	
RS-485 interface					
rs485		/dev/ttyAPP2	/dev/com1	IN/OUT	A1, B1
RTC Module (on internal I2C bus)					
rtc1		/dev/rtc1		IN/OUT	-
PPS signal					
pps0		/dev/pps0	/dev/gpspps0	IN	-
GPS Module					
gps		/dev/ttyAPP1	/dev/gps0	IN	-