

MODBUS OpenWRT User Guide



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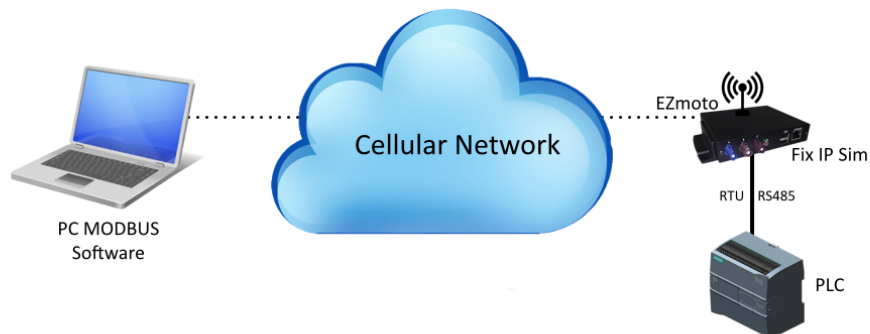
1. Product Description

The MODBUS RTU system consists of the following components:

- PC with MODBUS software
- EZmoto unit – with Fix IP Sim
- PLC

The EZmoto has two configurable IPv4 interfaces:

- 3G Interface (optional 4G)
- Ethernet Interface



The PC communicates with the EZmoto through a cellular network. The PC sends and receives data to and from the EZmoto and processes it with dedicated MODBUS software. The EZmoto is connected to the PLC through RS485, and communicates through MODBUS RTU. The EZmoto translates the MODBUS RTU to TCP and forwards the data to the PC.

The EZmoto unit has 16 GPIO's that consist of 4*ADC, 1*1WIRE (4 temperature sensors), 8*counter, 3*open collectors.

2. Setting-up Equipment

2.1

1. Insert the micro SD card to the EZmoto units.
2. Connect the EZmoto units to power.
3. Open putty with the correct com at 115200 baud rate (instructions for putty install are in section 5)

2.2. If this is the first use of the EZmoto you need to get the IP of the EZmoto.

To do so use the following steps:

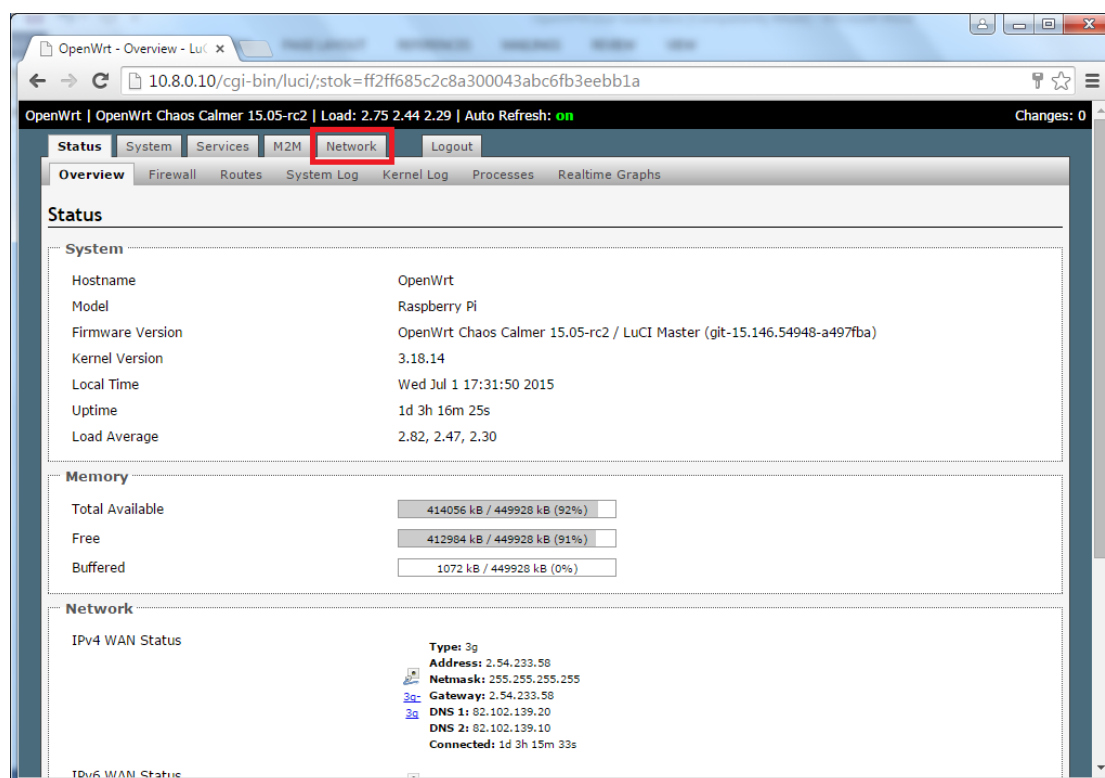
1. In the putty window enter the ifconfig cmd.
2. Write down the IP address under the br-lan interface.

3. APN configuration

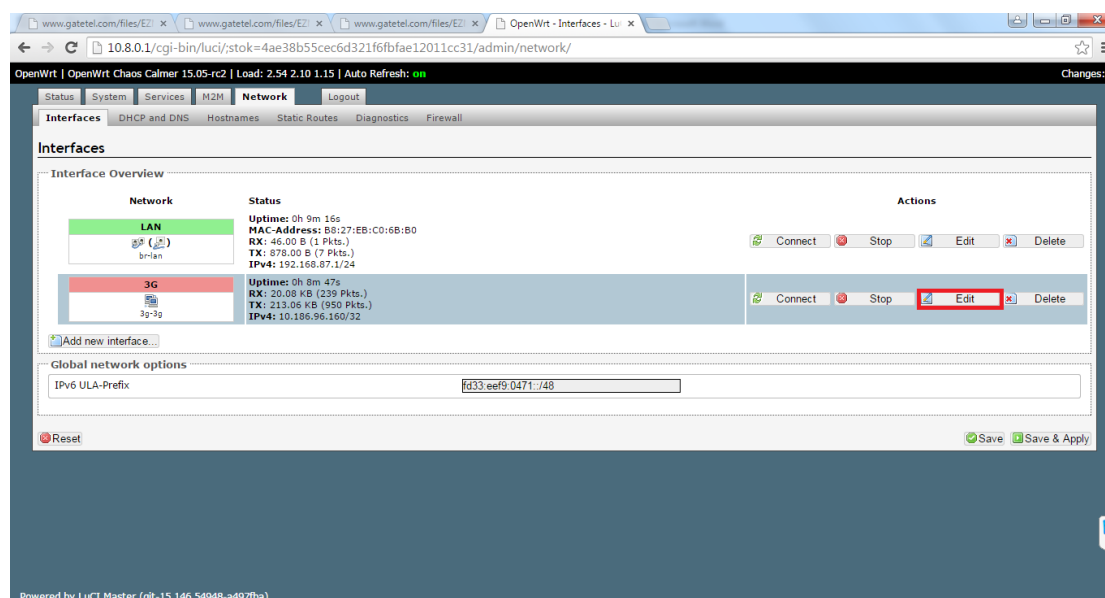
The First time setup requires configuring the APN.

1. Connect the Ethernet cable, set-up your computer's LAN IP so it would match the EZmoto's network Address (refer to section 3 in this manual for how-to setup IP Address in your local computer).
2. Open the Web Browser and enter the EZmoto IP Address.
Refer to appendix B for first use of the OpenWRT.

3. Open Network tab



4. Edit the 3G interface



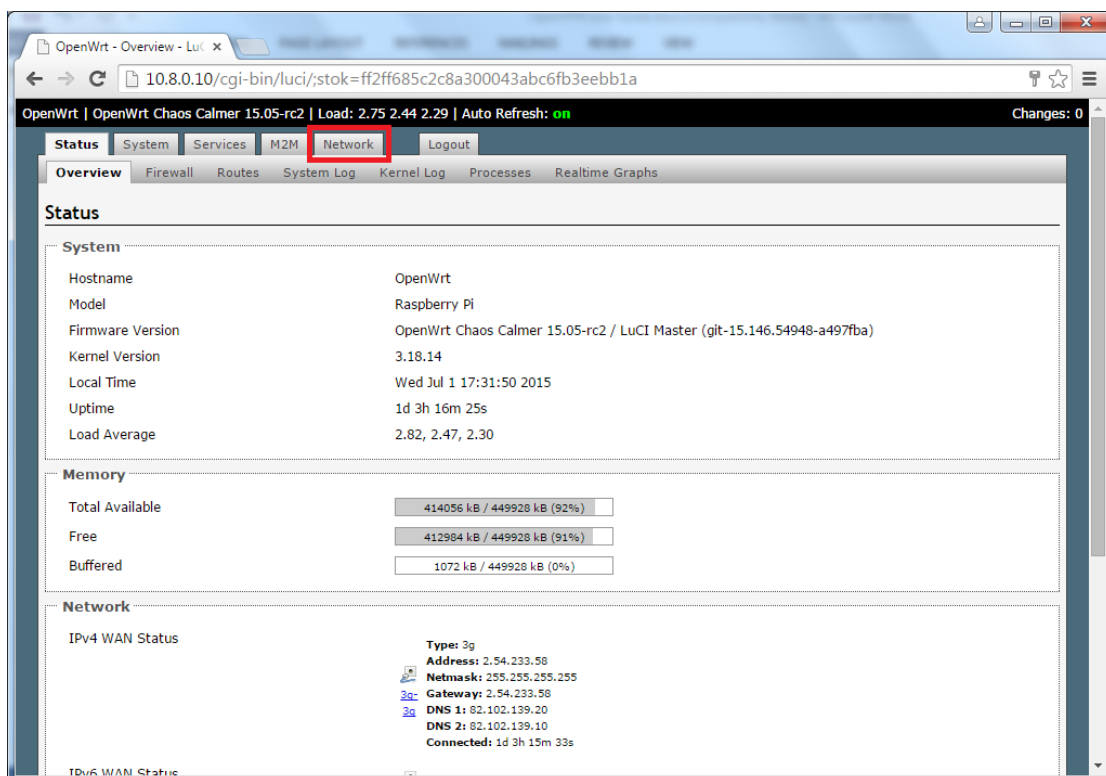
5. Enter the APN and click Save & Apply

The screenshot shows the GateTel web interface for configuring 3G settings. The browser address bar shows the URL: `10.8.0.1/cgi-bin/luci/stok=4ae38b55cec6d321f6fbfae12011cc31/admin/network/network/3g`. The interface has a top navigation bar with tabs for Status, System, Services, M2M, and Network. The 'Network' tab is active, and the 'Interfaces' sub-tab is selected. Below the navigation bar, there's a section titled 'Interfaces - 3G'. A status box shows 'Uptime: 0h 10m 2s', 'RX: 22.02 KB (263 Pkts.)', 'TX: 223.07 KB (999 Pkts.)', and 'IPv4: 10.186.96.160/32'. The main configuration area has three tabs: General Setup, Advanced Settings, and Firewall Settings. The 'General Setup' tab is active, displaying a form with fields for Protocol (UMTS/GPRS/EV-DO), Modem device (/dev/ttyACM3), Service Type (UMTS/GPRS), APN (m2m.co.il), PIN, PAP/CHAP username (root), PAP/CHAP password, and Dial number. The 'APN' field is highlighted with a red box. At the bottom right, there are two buttons: 'Save' and 'Save & Apply', with the latter being highlighted by a red circle. The footer indicates the system is 'Powered by LuCI Master (git-15.146.54948-a497ba)'.

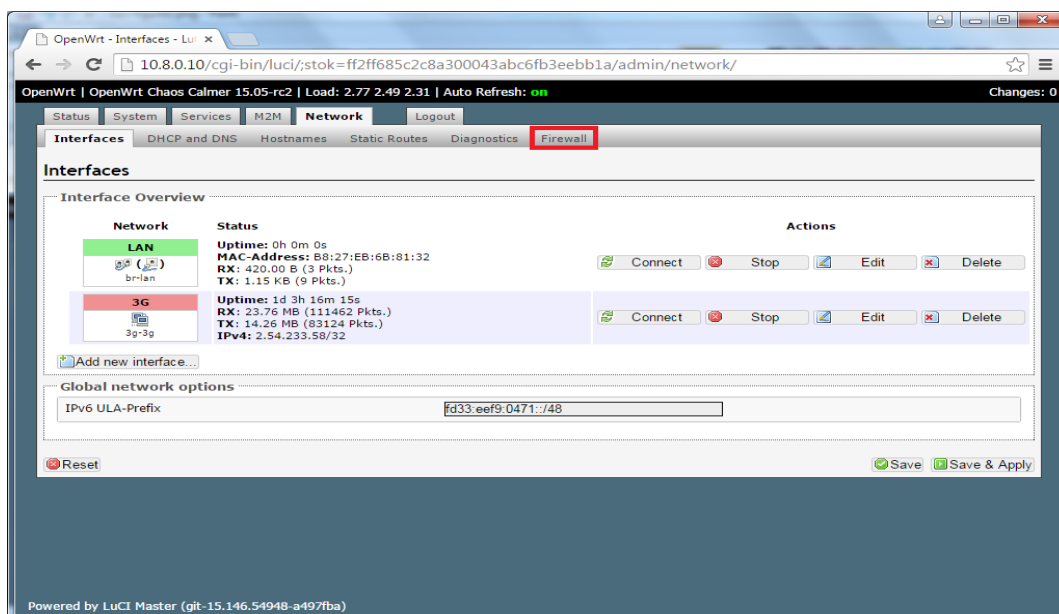
3. Firewall settings

To open port in the OpenWRT firewall, follow the next steps:

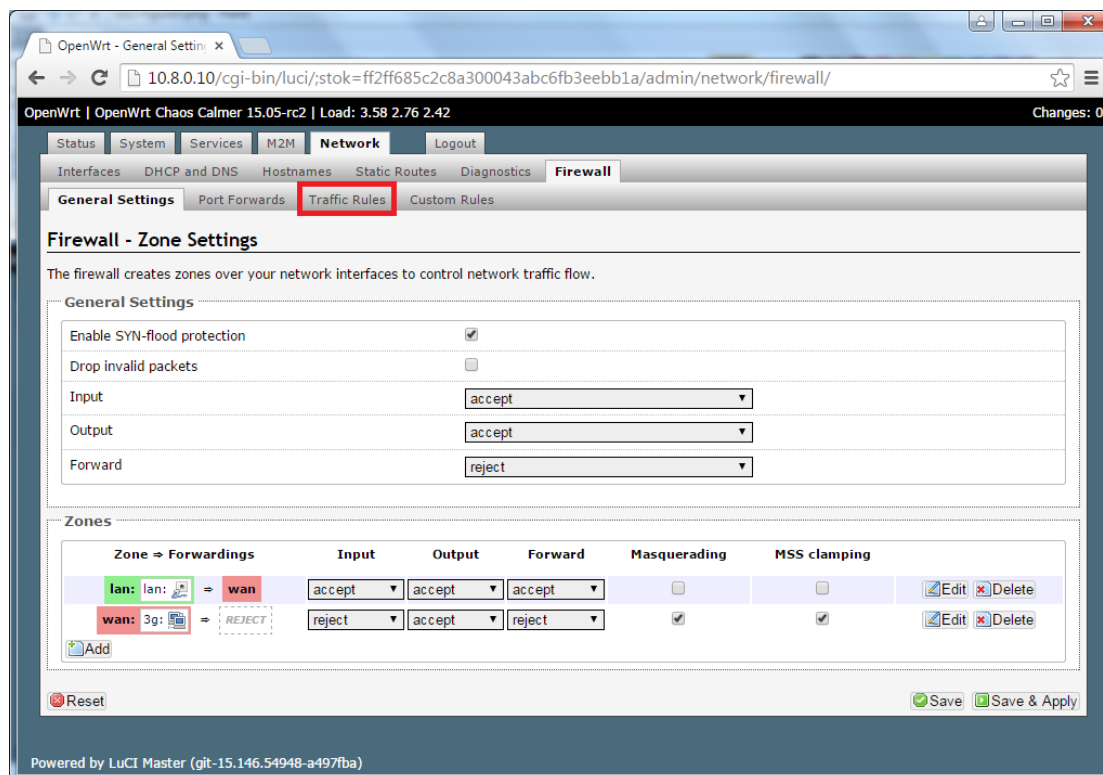
1. Click on the Network menu.



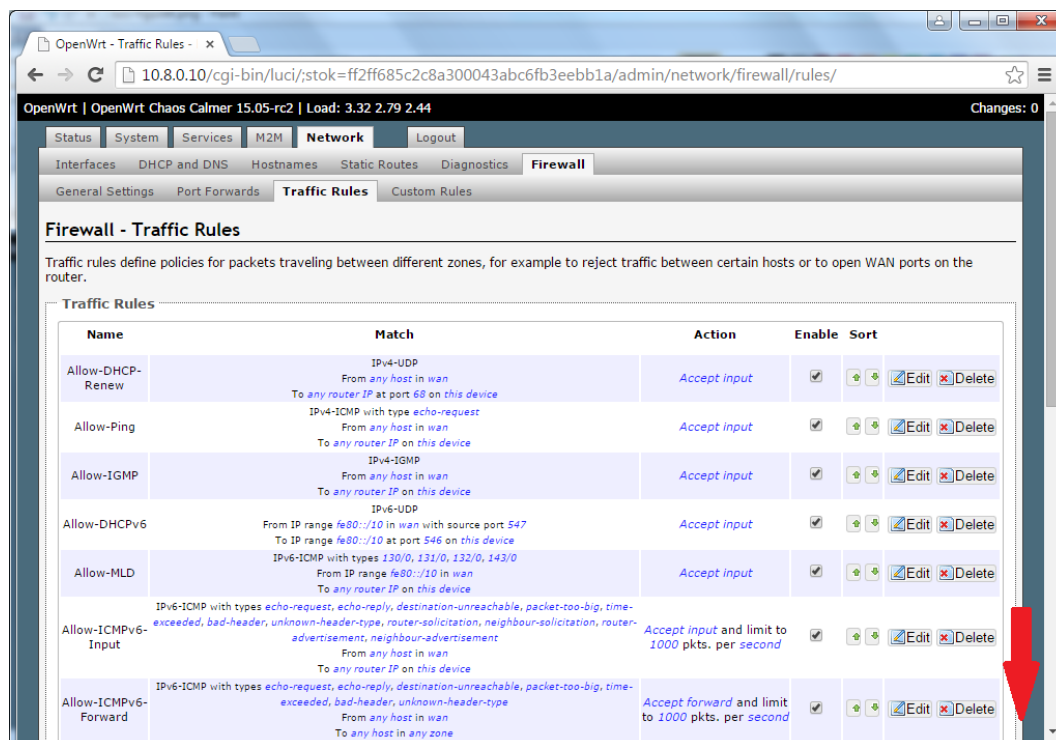
2. Click on the Firewall tab.



3. Click on the Traffic Rules.



4. Scroll down and look for the "Open ports on router" section of the page.



5. Assign a name to the new Firewall Rule, and enter the protocol and port details. When you are done click Save & Apply.

OpenWrt - Traffic Rules - x

10.8.0.10/cgi-bin/luci/stok=ff2ff685c2c8a300043abc6fb3eebb1a/admin/network/firewall/rules/

Name	Protocol	External port	Action	Enable	Sort	Edit	Delete
modbus-tcp-port-9998-rtu	Any TCP	To any host in wan	Accept input	☒			
test_open_502	Any TCP	To any host in wan	Accept input	☒			
Allow-SSH	Any TCP	To any host in wan	Accept input	☒			
Allow-Openvpn-1194	Any UDP	To any host in wan	Accept input	☒			

Open ports on router:

Name	Protocol	External port	Add
New input rule	TCP+UDP		Add

New forward rule:

Name	Source zone	Destination zone	Add and edit...
New forward rule	lan	wan	Add and edit...

Source NAT

Source NAT is a specific form of masquerading which allows fine grained control over the source IP used for outgoing traffic, for example to map multiple WAN addresses to internal subnets.

Name	Match	Action	Enable	Sort
This section contains no values yet				

New source NAT:

Name	Source zone	Destination zone	To source IP	To source port	Add and edit...
New SNAT rule	lan	wan	-- Please choose --	Do not rewrite	Add and edit...

OpenWrt - Traffic Rules - x

10.8.0.10/cgi-bin/luci/stok=ff2ff685c2c8a300043abc6fb3eebb1a/admin/network/firewall/rules/

Name	Protocol	External port	Action	Enable	Sort	Edit	Delete
test_open_502	Any TCP	To any host in wan	Accept input	☒			
Allow-SSH	Any TCP	To any host in wan	Accept input	☒			
Allow-Openvpn-1194	Any UDP	To any host in wan	Accept input	☒			

Open ports on router:

Name	Protocol	External port	Add
Allow-FTP	TCP	21	Add

New forward rule:

Name	Source zone	Destination zone	Add and edit...
New forward rule	lan	wan	Add and edit...

Source NAT

Source NAT is a specific form of masquerading which allows fine grained control over the source IP used for outgoing traffic, for example to map multiple WAN addresses to internal subnets.

Name	Match	Action	Enable	Sort
This section contains no values yet				

New source NAT:

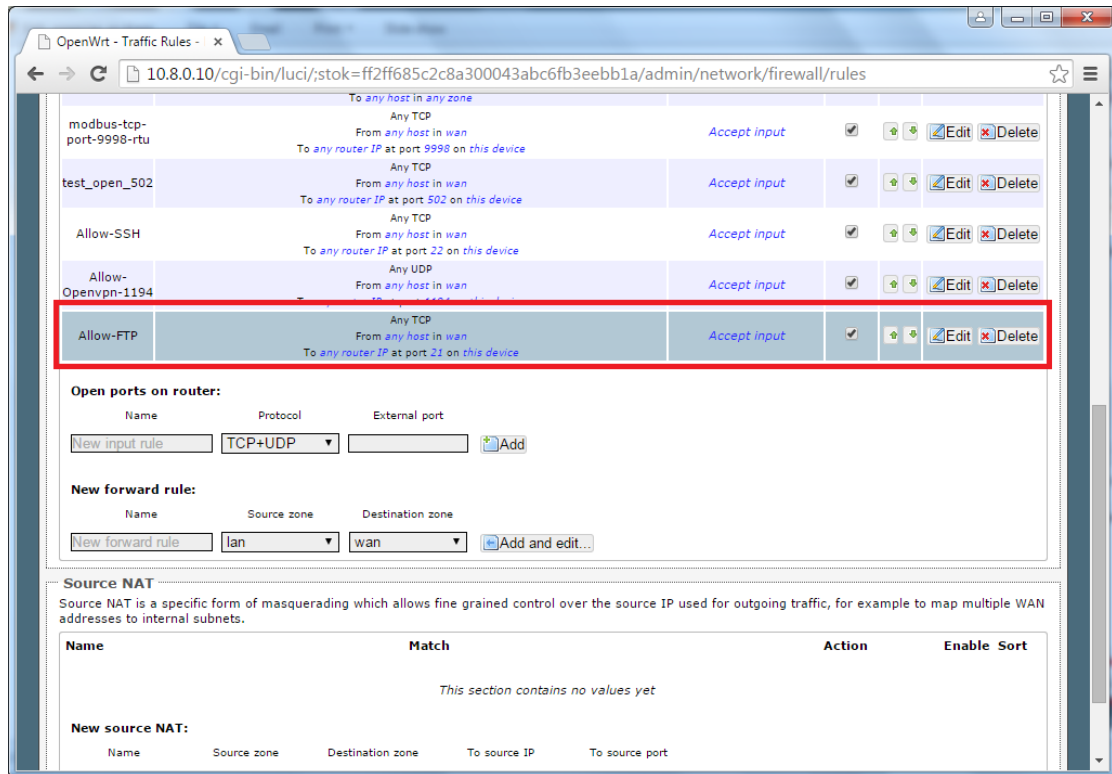
Name	Source zone	Destination zone	To source IP	To source port	Add and edit...
New SNAT rule	lan	wan	-- Please choose --	Do not rewrite	Add and edit...

Reset Save **Save & Apply**

Powered by LuCI Master (git-15.146.54948-a497fba)

**** DO NOT FORGET TO SAVE AND APPLY ****

6. Check to see the updated rules.



Instructions for opening ports for the OpenWRT MODBUS (or any other application for that matter) can be found in section appendix D

4. Modbus configuration

Software client setup

Open your client Modbus software and choose a remote TCP/IP Modbus connection, port 503.

The Modbus works at higher rates than the cellular network can handle, because of that the data frames may be received with delay. Set scan rate to the Modbus application according to the performance of the cellular network (if there is a timeout error extend the scan rate).

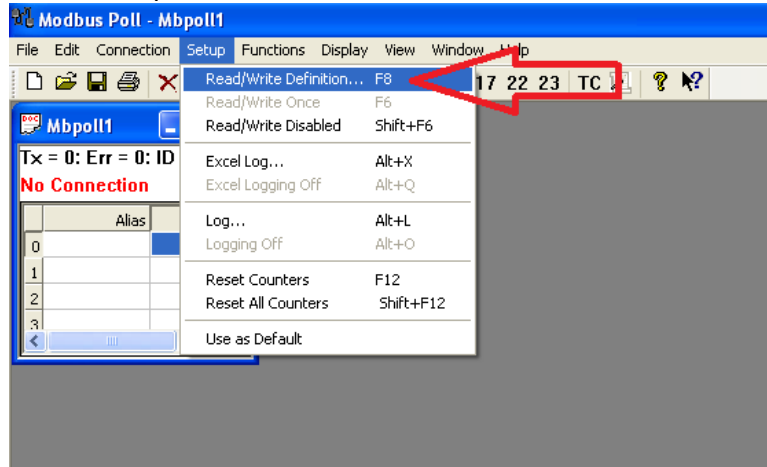
Choose the function code, address and quantity in case of a reading function.

The EZmoto supports function codes 1, 2, 3, 4, 5, 6, 15, 16.

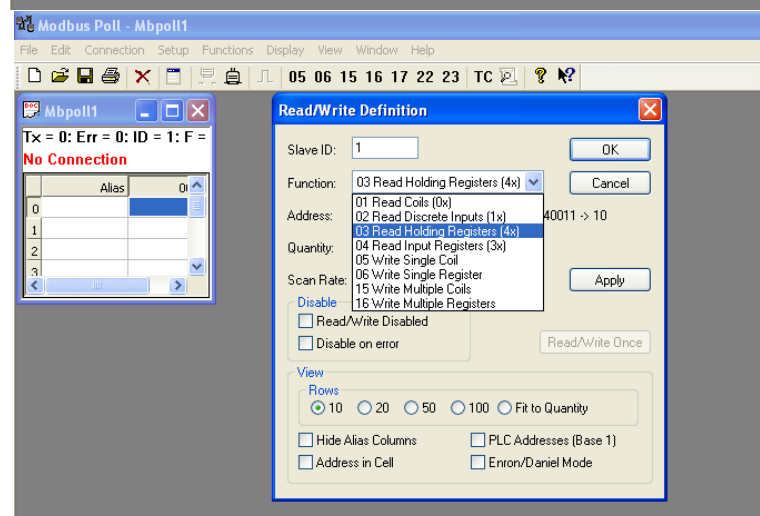
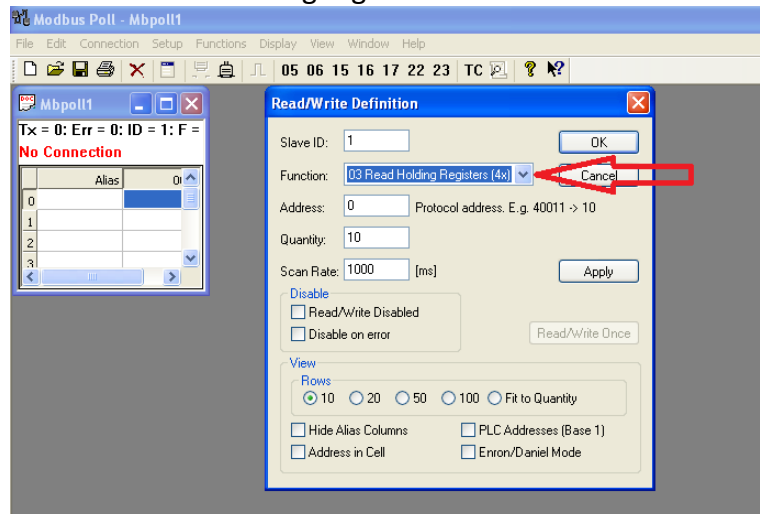
5. Modbus software

Case study: read holding register and write single coil in modbus software

1. Read holding register- function code 3
Go to setup → read/write definition

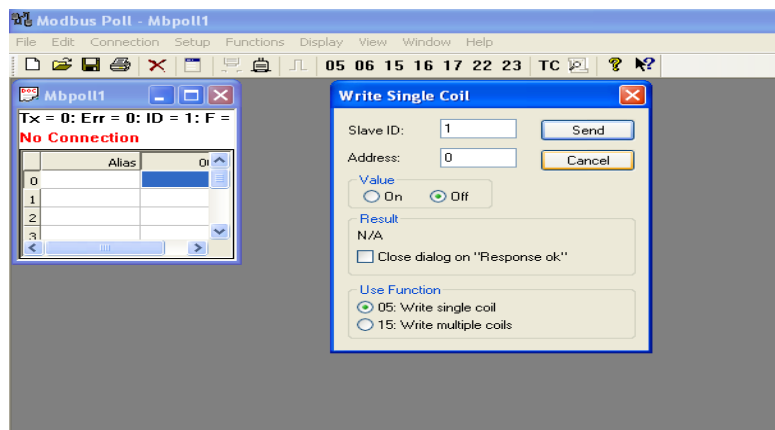
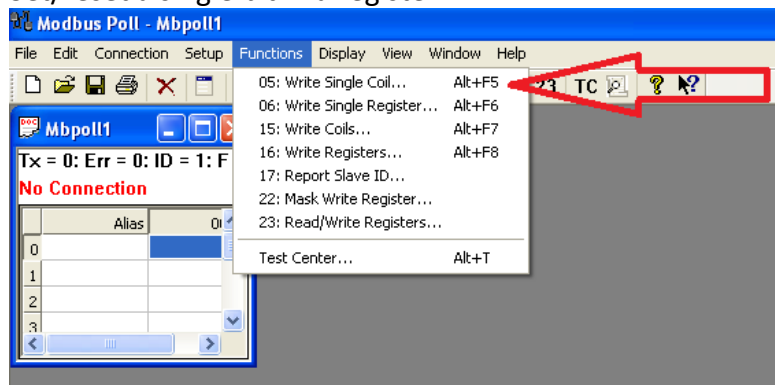


Choose 03 read holding registers



Choose the address from which to read the registers in Address field.
Choose the amount of registers to be read in the Quantity field.

- Write single coil – function code 5
Set/reset a single bit in a register.

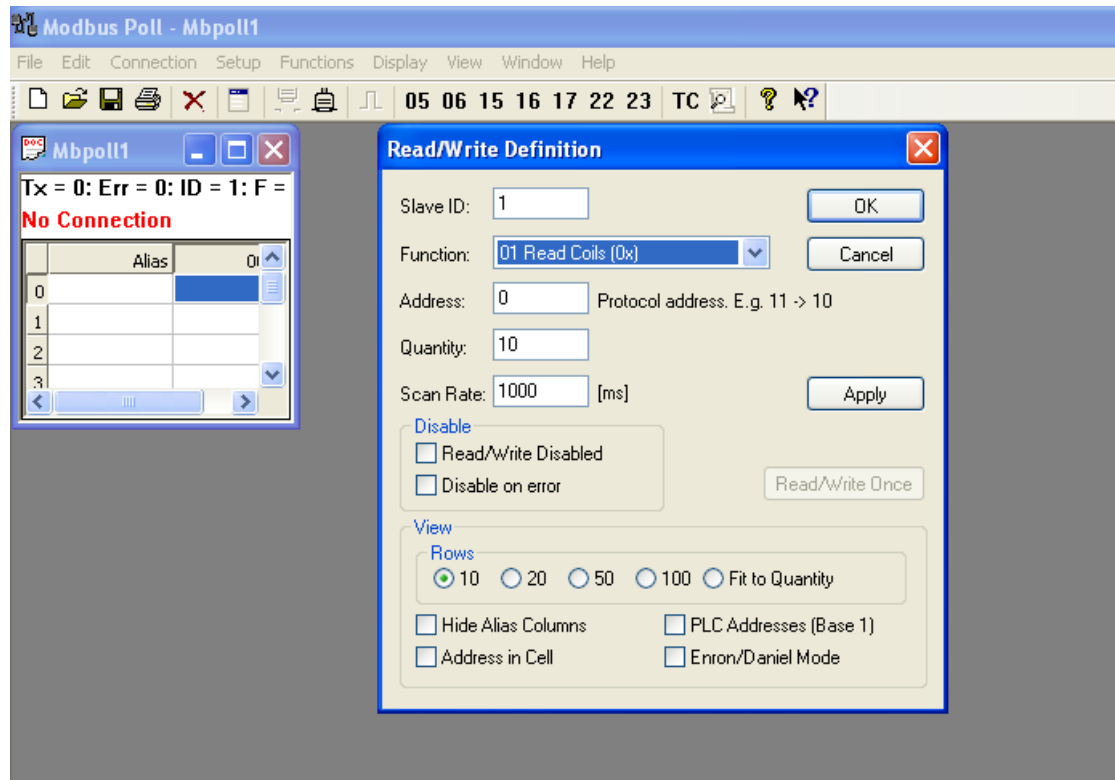


Slave id- which PLC to write to.

Address- the address of the coil to write to.

Value- On=1 Off=0.

3. Read single coil



Choose read coils in Function field.

Choose the address of the coils to be read.

Choose the amount of coils to be read in the Quantity field.

6. Register mapping

a. Unit status

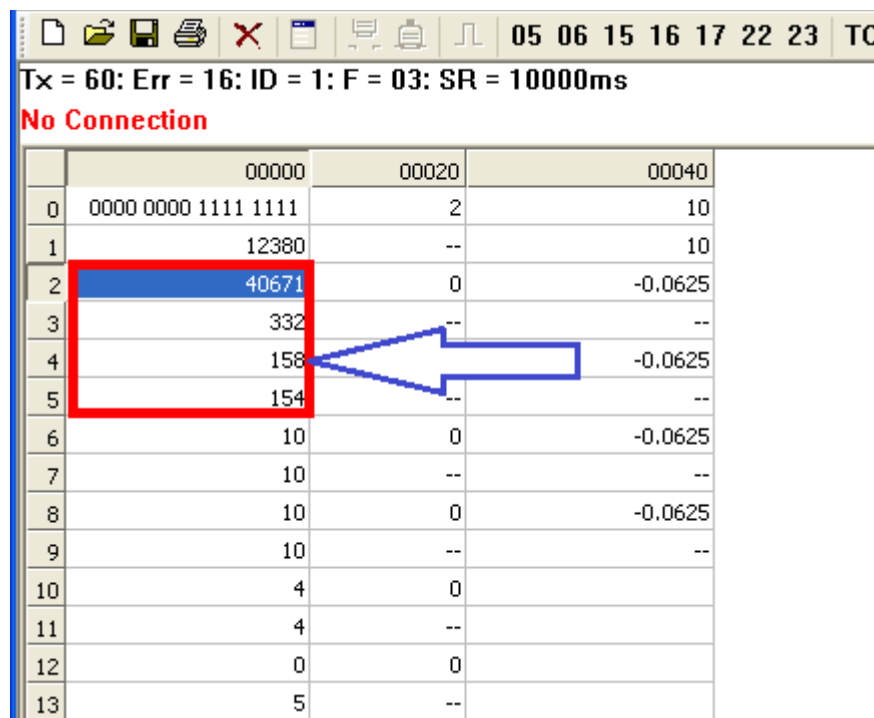
Register	Function	comments	range
0	display inputs	0-register in use, 1- not in use	0-1 (8 times)
1	input voltage	general register	0-12000[mV]

Display inputs example 00010100

b. Analog to digital convert registers

register	function	comment	range
2	ADC		0-65535
3	ADC		0-65535
4	ADC		0-65535
5	ADC		0-65535

Example:



Tx = 60: Err = 16: ID = 1: F = 03: SR = 10000ms			
No Connection			
	00000	00020	00040
0	0000 0000 1111 1111	2	10
1	12380	--	10
2	40671	0	-0.0625
3	332	--	--
4	158	--	-0.0625
5	154	--	--
6	10	0	-0.0625
7	10	--	--
8	10	0	-0.0625
9	10	--	--
10	4	0	
11	4	--	
12	0	0	
13	5	--	

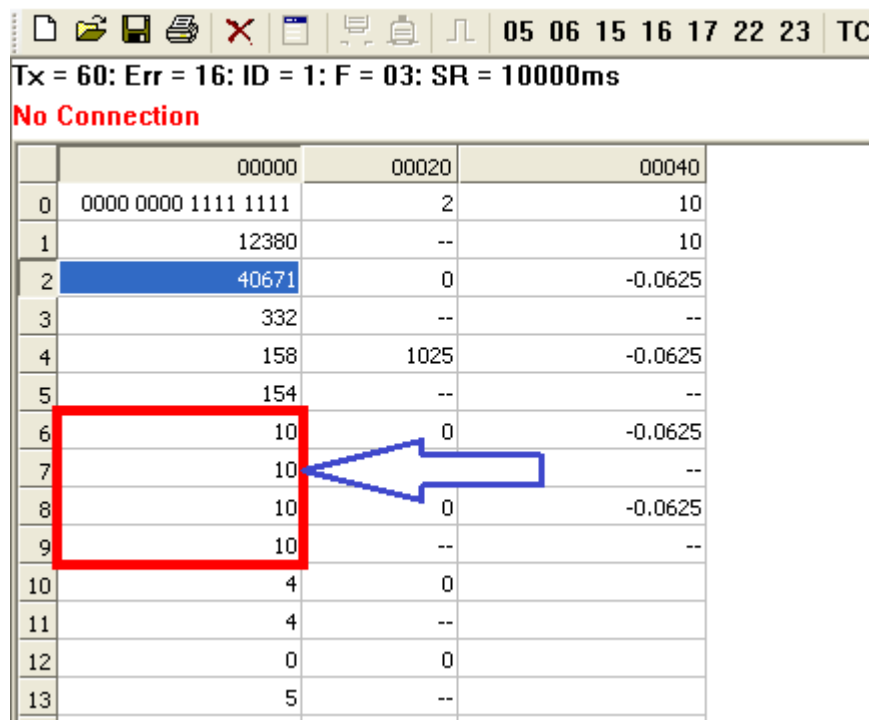
The picture shows the four ADC registers.

The arrow points to ADC 3 (reg#4) and the ADC's raw value is 158.

c. RC filter for the ADC's

register	Function	comment	range
6	ADC filter		1-255
7	ADC filter		1-255
8	ADC filter		1-255
9	ADC filter		1-255

Example:



Tx = 60: Err = 16: ID = 1: F = 03: SR = 10000ms
No Connection

	00000	00020	00040
0	0000 0000 1111 1111	2	10
1	12380	--	10
2	40671	0	-0.0625
3	332	--	--
4	158	1025	-0.0625
5	154	--	--
6	10	0	-0.0625
7	10	0	--
8	10	0	-0.0625
9	10	--	--
10	4	0	
11	4	--	
12	0	0	
13	5	--	

The picture shows the four RC filter values.

The arrow points to the filter of ADC2 (reg#7)

The ADC's shown value is 10 (tenths of a second)

d. Counter triggers

register	function	trigger	comment	range
10	counter	R/F/BOTH		4-6
11	counter	R/F/BOTH		4-6
12	counter	R/F/BOTH		4-6
13	counter	R/F/BOTH	BOTH-both rising & falling(4)	4-6
14	counter	R/F/BOTH	F-falling(5)	4-6
15	counter	R/F/BOTH	R-rising(6)	4-6
16	counter	R/F/BOTH		4-6
17	counter	R/F/BOTH		4-6

05 06 15 16 1

Tx = 60: Err = 16: ID = 1: F = 03: SR = 10000ms

No Connection

	00000	00020	00040
0	0000 0000 1111 1111	2	10
1	12380	--	10
2	40671	0	-0.0625
3	332	--	--
4	158	1025	-0.0625
5	154	--	--
6	10	0	-0.0625
7	10	--	--
8	10	0	-0.0625
9	10	--	--
10	4	0	
11	4	--	
12	0	0	
13	5	10	
14	0	10	
15	0	10	
16	0	10	
17	0	0	
18	8	10	
19	--	10	

Example:

The picture shows the triggers of the 8 counters.

The arrow points to the trigger of counter4 (reg#13), its value is 5, which means that the counter will increase on falling edge.

e. Counter value

register	function	comment	range
18, 19	counter value(consists of 2 registers)	long CD AB	0-4294967295
20, 21	counter value(consists of 2 registers)	long CD AB	0-4294967295
22, 23	counter value(consists of 2 registers)	long CD AB	0-4294967295
24, 25	counter value(consists of 2 registers)	long CD AB	0-4294967295
26, 27	counter value(consists of 2 registers)	long CD AB	0-4294967295
28, 29	counter value(consists of 2 registers)	long CD AB	0-4294967295
30, 31	counter value(consists of 2 registers)	long CD AB	0-4294967295
32, 33	counter value(consists of 2 registers)	long CD AB	0-4294967295

05 06 15 16 17

Tx = 60: Err = 16: ID = 1: F = 03: SR = 10000ms

No Connection

	00000	00020	00040
0	0000 0000 1111 1111	CNT2 2	10
1	12380	--	10
2	40671	CNT3 0	-0.0625
3	332	--	--
4	158	CNT4 1025	-0.0625
5	154	--	AB
6	10	CNT5 0	-0.0625
7	10	--	--
8	10	CNT6 0	-0.0625
9	10	--	--
10	4	CNT7 0	--
11	4	--	--
12	0	CNT8 0	--
13	5	--	--
14	0	10	--
15	0	10	--
16	0	10	--
17	0	0	--
18	CNT1 8	10	--
19	--	10	--

The picture shows the 8 counter values.

The arrows point to Counter 4 (regs#24, 25). The format is CDAB (which indicates reg#24 as LSB, and reg#25 as MSB).

f. Counter de-bounce value

register	function	comment	range
34	de-bounce value		0, 5-255
35	de-bounce value		0, 5-255
36	de-bounce value		0, 5-255
37	de-bounce value		0, 5-255
38	de-bounce value		0, 5-255
39	de-bounce value		0, 5-255
40	de-bounce value		0, 5-255
41	de-bounce value		0, 5-255

Tx = 60: Err = 16: ID = 1: F = 03: SR = 10000ms

No Connection

	00000	00020	00040
0	0000 0000 1111 1111	2	10
1	12380	--	10
2	40671	0	-0.0625
3	332	--	--
4	158	1025	-0.0625
5	154	--	--
6	10	0	-0.0625
7	10	--	--
8	10	0	-0.0625
9	10	--	--
10	4	0	
11	4	--	
12	0	0	
13	5	--	
14	0	10	
15	0	10	
16	0	10	
17	0	0	
18	8	10	
19	--	10	

Example: The picture shows the de-bounce value of the counters.

The arrow points to counter 1 de-bounce (reg#34).

The value 0 means no de-bounce. Otherwise set a de-bounce value between 5 and 255 ms.

g. Temperature sensor

register	function	comment	range
42, 43	temperature sensor	float	format BA DC
44, 45	temperature sensor	float	format BA DC
46, 47	temperature sensor	float	format BA DC
48, 49	temperature sensor	float	format BA DC

Tx = 60: Err = 16: ID = 1: F = 03: SR = 10000ms

No Connection

	00000	00020	00040
0	0000 0000 1111 1111	2	10
1	12380	--	10
2	40671	0	
3	332	--	Temp 1 -0.0625
4	158	1025	Temp 2 -0.0625
5	154	--	Temp 3 -0.0625
6	10	0	Temp 4 -0.0625
7	10	--	--
8	10	0	--
9	10	--	--
10	4	0	
11	4	--	
12	0	0	
13	5	--	
14	0	10	
15	0	10	
16	0	10	
17	0	0	
18	8	10	
19	--	10	

Example:

The picture shows the four temperature sensors in BA DC format.

The arrow points to temperature sensor 1 (regs#43, 44) and the value is -0.0625 (not available)

WRITE:

a.

register	function	comment	range
6	ADC filter		1-255
7	ADC filter		1-255
8	ADC filter		1-255
9	ADC filter		1-255

The ADC filter shows the time in tenths of a second for the RC filter, its range is between 1 and 255.

b.

register	function	trigger	comment	range
10	counter	R/F/BOTH		4-6
11	counter	R/F/BOTH		4-6
12	counter	R/F/BOTH	BOTH-both rising & falling(4) F-falling(5) R-rising(6)	4-6
13	counter	R/F/BOTH		4-6
14	counter	R/F/BOTH		4-6
15	counter	R/F/BOTH		4-6
16	counter	R/F/BOTH		4-6
17	counter	R/F/BOTH		4-6

The counters can be triggered at a rising, falling or both rising and falling edge of the GPIO

4- Both

5- Falling

6- Rising

c. Counter value

register	function	comment	range
18, 19	counter value(consists of 2 registers)	long CD AB	0-4294967295
20, 21	counter value(consists of 2 registers)	long CD AB	0-4294967295
22, 23	counter value(consists of 2 registers)	long CD AB	0-4294967295
24, 25	counter value(consists of 2 registers)	long CD AB	0-4294967295
26, 27	counter value(consists of 2 registers)	long CD AB	0-4294967295
28, 29	counter value(consists of 2 registers)	long CD AB	0-4294967295
30, 31	counter value(consists of 2 registers)	long CD AB	0-4294967295
32, 33	counter value(consists of 2 registers)	long CD AB	0-4294967295

The counter value can be set manually, the range is 0-4294967295

d.

register	function	comment	range
34	de-bounce value		0, 5-255
35	de-bounce value		0, 5-255
36	de-bounce value		0, 5-255
37	de-bounce value		0, 5-255
38	de-bounce value		0, 5-255
39	de-bounce value		0, 5-255
40	de-bounce value		0, 5-255
41	de-bounce value		0, 5-255

The de-bounce value can be set to:

0- No de-bounce.

1- 5 to 255 de-bounce time in milliseconds.

e.

register	function	comment	range
42	temperature sensor interval	float	0-255

Temperature sensor interval is the time between two temperature samples in 10*second.

The range of the register can be between 0 and 255 (disabled)

7. Modbus serial parameters configuration

1. Edit the configuration file '/etc/modbus_config.py'

You can choose nano or vi.

```
root@OpenWrt:~# nano /etc/modbus_config.py
```

2. Edit the SerialParams variable in the file:

```
#
# App imports this file to sock_modbus.py
#
# Choose one of the following options: 'tcpserver', 'tcpclient', 'rtuserver', 'rtuclient', 'tcp2rtu', 'rtu2tcp'
mode='tcp2rtu'
# Choose TCP/IP parameters
ip='10.0.0.202'
port=9999
# Choose Serial parameters (uses pySerial default values). Port is mandatory. To Config use one of the following:
#
# string: sets port only (all else uses default values) e.g.
# e.g. '/dev/ttyUSB2' Most simple config, uses default values
# tuple: set values in this order: (port, baudrate, bytesize, parity, stopbits, timeout, xonxoff ..)
# e.g. ('/dev/ttyUSB2', 115200, 8, 'N', 1, 0.4, True) Config in a row (must be the same order as default values)
# e.g. ('/dev/ttyUSB2', 9600, 7, 'E', 1)
# dictionary: sets specific parameter use (all else uses default values)
# e.g. {'port': '/dev/ttyUSB2', 'baudrate': 115200} Config in a selective manner (non-configured uses default)
# e.g. {'port': '/dev/ttyUSB2', 'parity': 'E'}
# default values; baudrate = 9600, bytesize = 8, parity = 'N', stopbit = 1, timeout = 0.1 (cannot be in blocking mode), xonxoff = False ...
SerialParams={'port': '/dev/ttyUSB2', 'parity': 'E'}
```

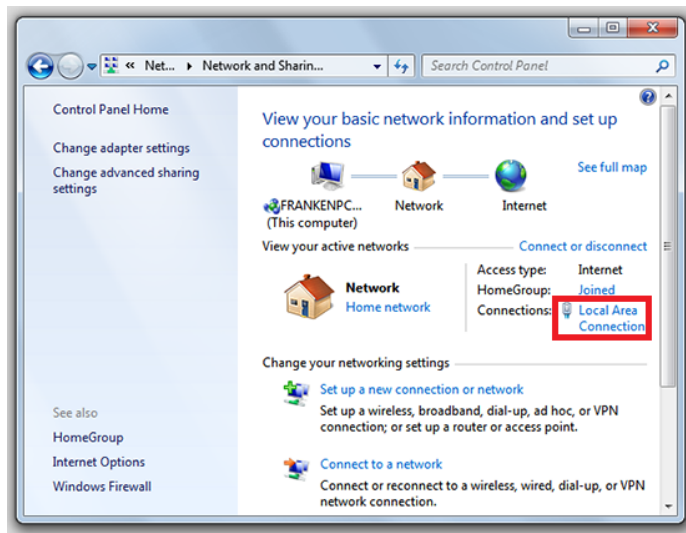
3. Reboot to save

8. Appendix A

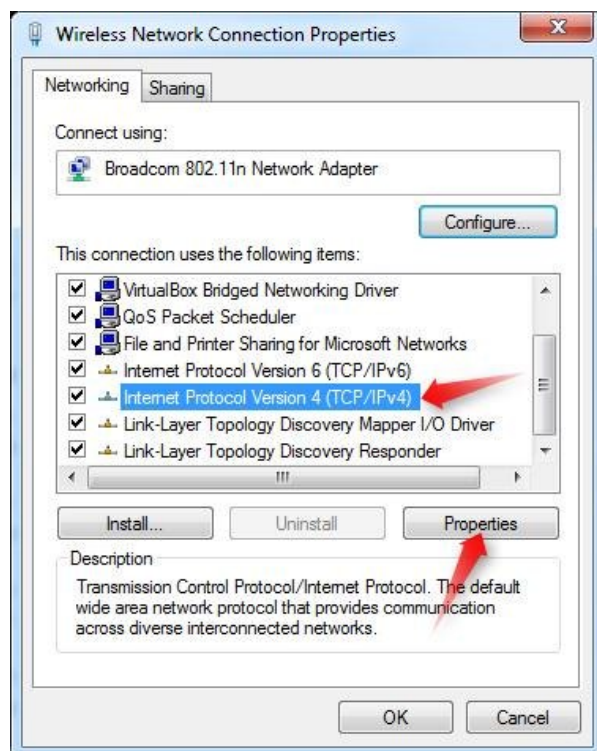
(Windows)

To set an IP address, go to control panel, and choose Network and Sharing Center.

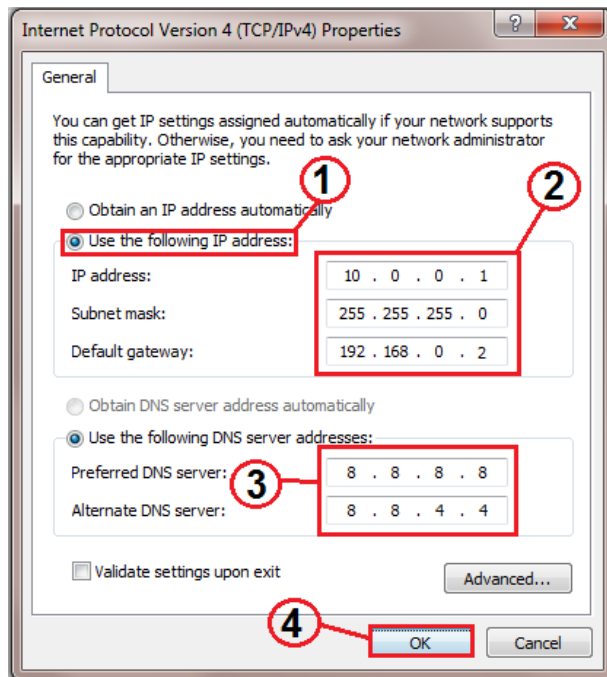
Click on the Local Area Connection and choose properties



Select Internet Protocol Version 4 (TCP/IPv4) and choose Properties



Set up the IP address, Subnet mask and Default gateway, you can also set up DNS Servers if you wish.

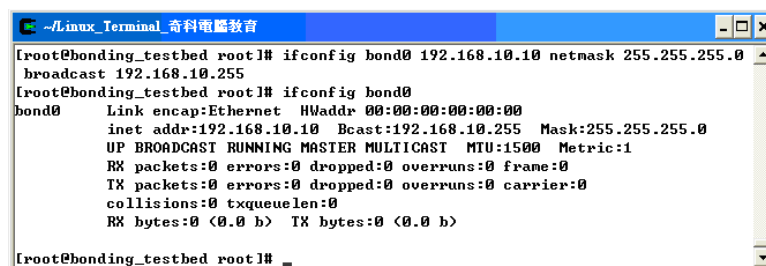


When you are done, press ok to save.

(Linux)

Open a command line terminal, and issue the ifconfig command the following way:

Ifconfig <intf> <ip-address> netmask <subnet-mask>



When you're done you can view the interface with the ifconfig command (you must have privileges to change these settings, be root or use sudo accordingly).

To check connectivity, in any OS, use the ping command in command line.

Here is an example of a working connectivity between two stations:

```
C:\WINDOWS\system32\cmd.exe

C:\Documents and Settings\Administrator>ping 69.147.114.224

Pinging 69.147.114.224 with 32 bytes of data:
Reply from 69.147.114.224: bytes=32 time=400ms TTL=43
Reply from 69.147.114.224: bytes=32 time=403ms TTL=43
Reply from 69.147.114.224: bytes=32 time=382ms TTL=43
Reply from 69.147.114.224: bytes=32 time=402ms TTL=43

Ping statistics for 69.147.114.224:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 382ms, Maximum = 403ms, Average = 396ms

C:\Documents and Settings\Administrator>ping gmail.com

Pinging gmail.com [209.85.153.19] with 32 bytes of data:
Reply from 209.85.153.19: bytes=32 time=140ms TTL=49
Reply from 209.85.153.19: bytes=32 time=131ms TTL=49
Reply from 209.85.153.19: bytes=32 time=131ms TTL=49
Reply from 209.85.153.19: bytes=32 time=131ms TTL=49

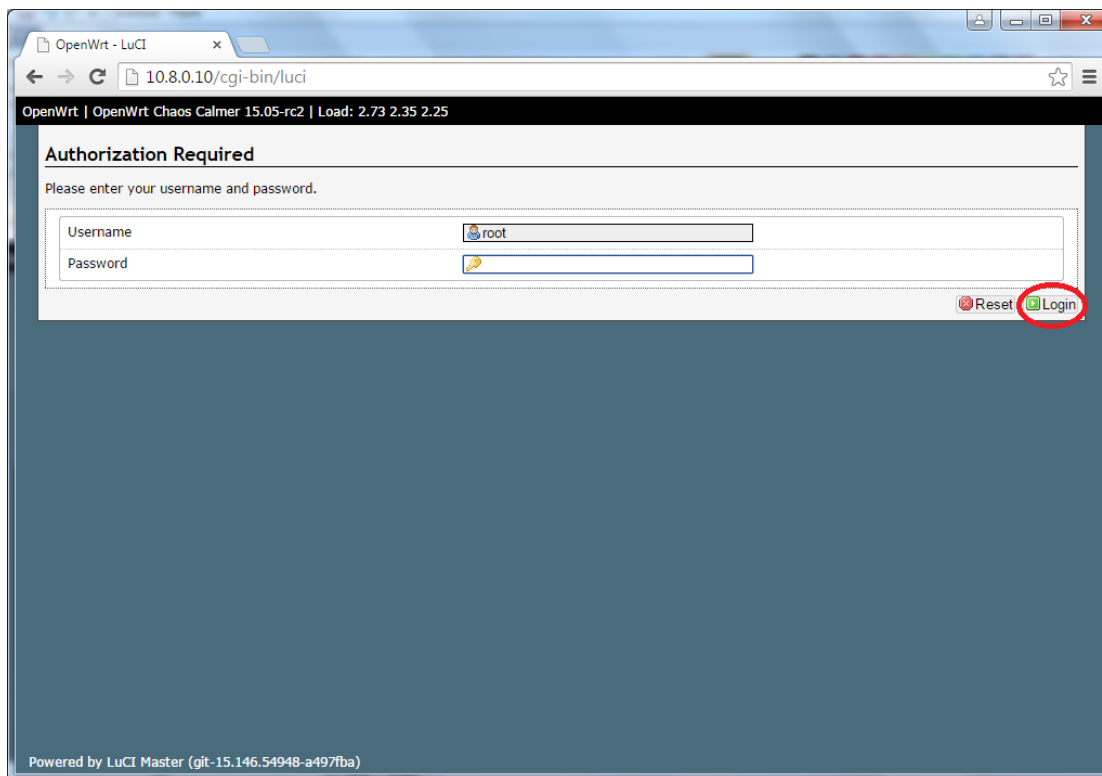
Ping statistics for 209.85.153.19:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 131ms, Maximum = 140ms, Average = 133ms

C:\Documents and Settings\Administrator>_
```

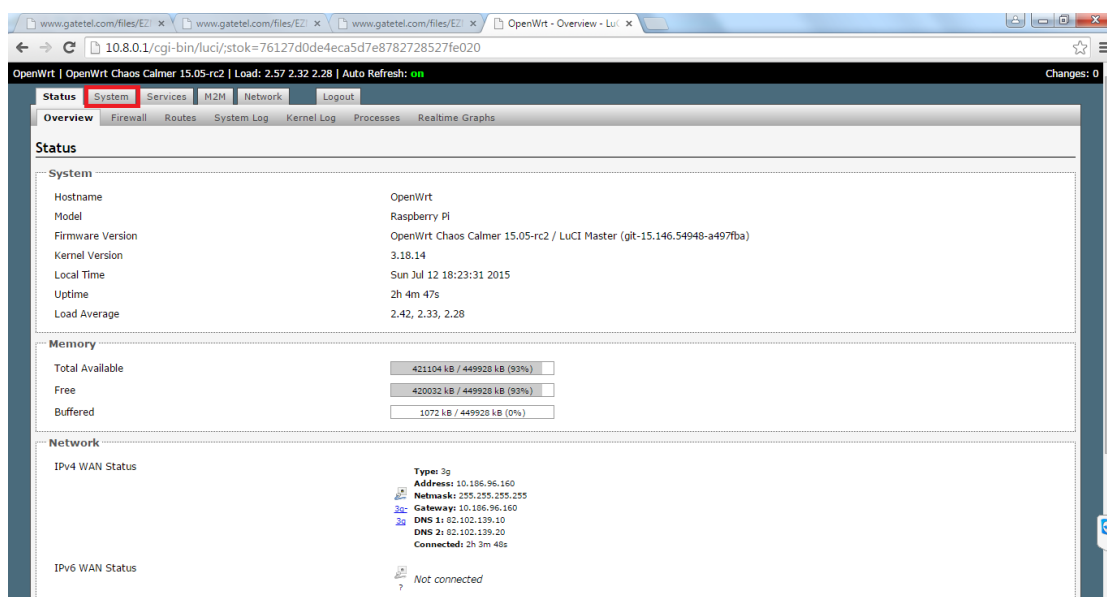
9. Appendix B

Entering the OpenWRT for the first time

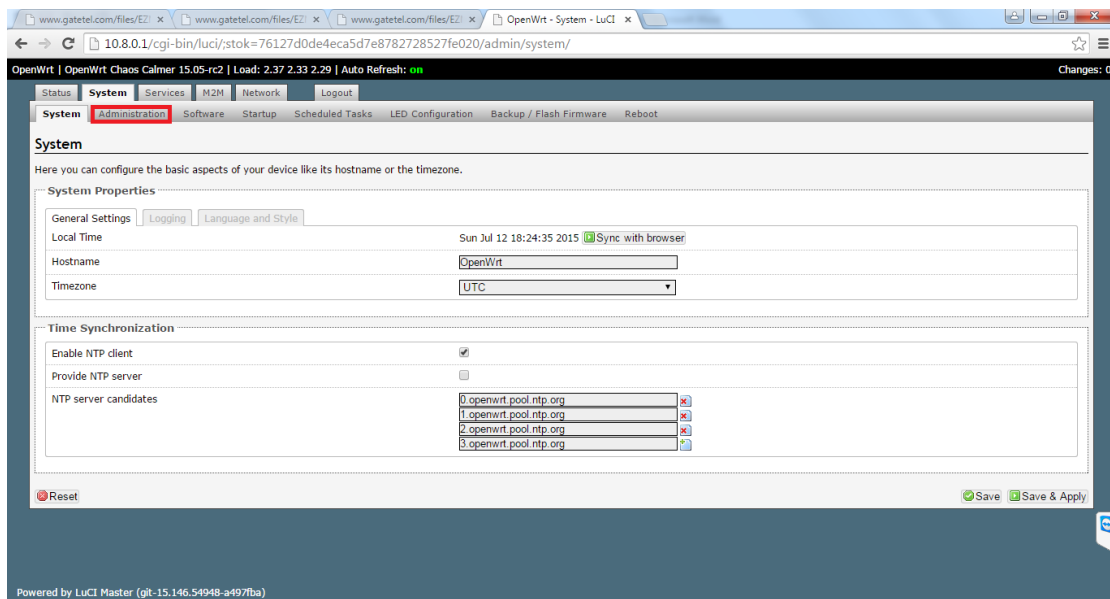
1. Open your browser and enter the EZmoto IP Address.



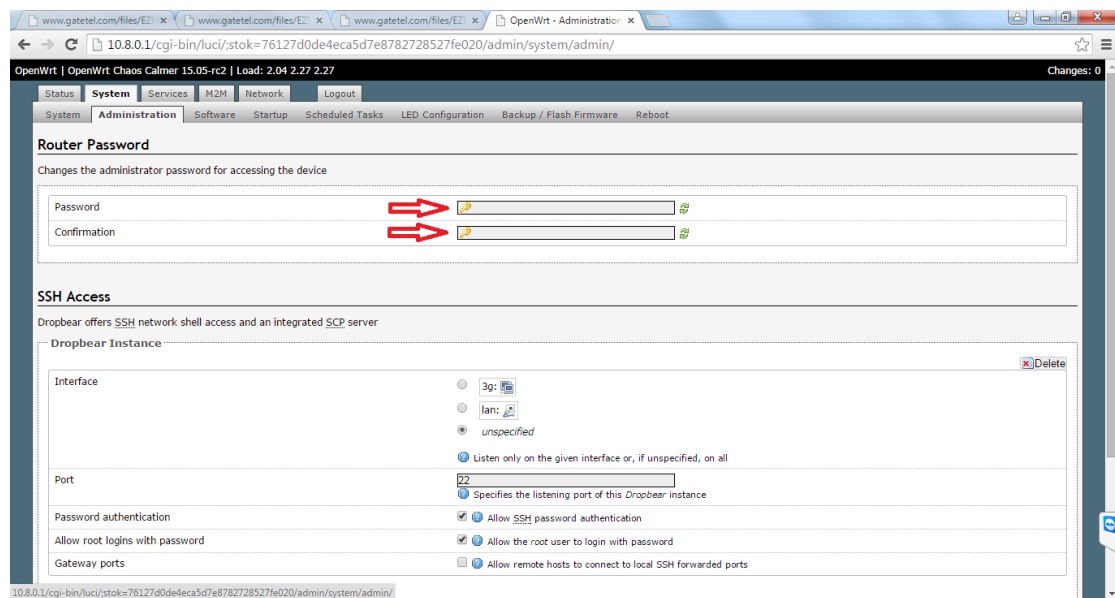
2. Enter the password and click Login (the default password is 123456).
3. Go to system tab.



4. Go to administration tab.



5. Enter your new password.



6. Click save & apply.

SSH Access

Dropbear offers SSH network shell access and an integrated SCP server

Dropbear Instance

Interface

3g: ☐ lan: ☐ unspecified: ☒

Listen only on the given interface or, if unspecified, on all

Port

22

Specifies the listening port of this Dropbear instance

Password authentication

☒ Allow SSH password authentication

Allow root logins with password

☒ Allow the root user to login with password

Gateway ports

☐ Allow remote hosts to connect to local SSH forwarded ports

Add

SSH - Keys

Here you can paste public SSH-keys (one per line) for SSH public-key authentication.

Reset Save Save & Apply

Powered by LuCI Master (git-15.146.54948-a497fba)

Changing the password is highly recommended.

10. Appendix C

- a. Download and install terminal program. Putty is available in [THIS LINK](#)
- b. insert the usb side of the usb to uart cable to the computer
- c. check which com is connected: right click on my computer → manage → device manager → COM & LPT → USB Serial Port(COMx)
- d. Open putty.
- e. Under connection type, mark serial option. Under serial line enter COMx. Under speed enter 115200.
- f. Open.

11. Product variations

1. Pure OpenVPN
2. Cellular Modbus to RTU
3. OpenVPN modbus