# RouterBOARD 411

# User's Manual

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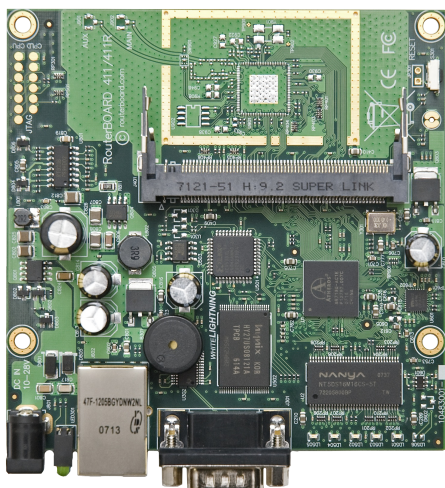
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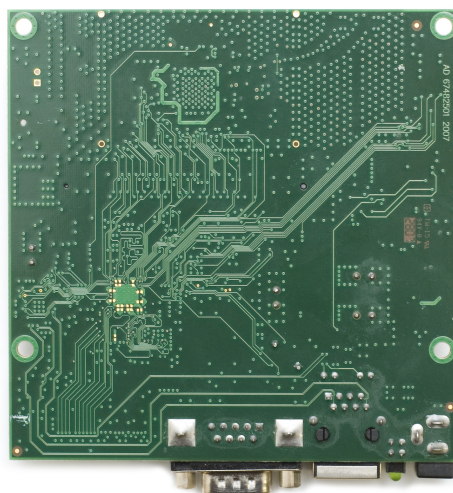
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# System Board View

RB411:



Top view



Bottom view

# System Board Layout



JP301
S301

miniPCI

CPU

Beeper

NAND Storage

Memory

LED1 LED2 LED3 LED4 LED5

Power LED LAN1

SERIAL



9..28V DC power jack

12..28V PoE

LAN 1 - 100BaseTX
(with PoE in)

Power Supply

CPU

Onboard RAM

Onboard Flash (NAND)

Serial port

User LED

Speaker

PCI

MiniPCI slot
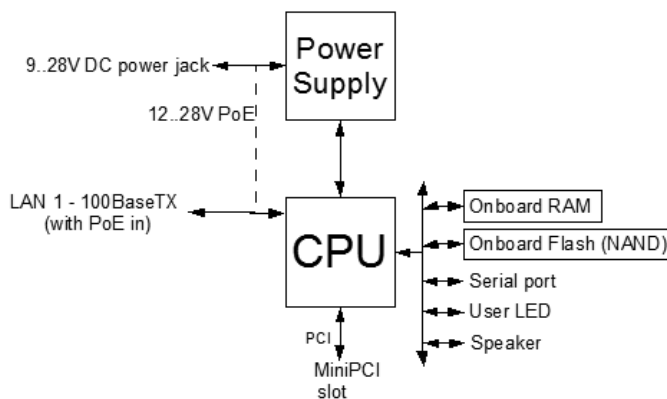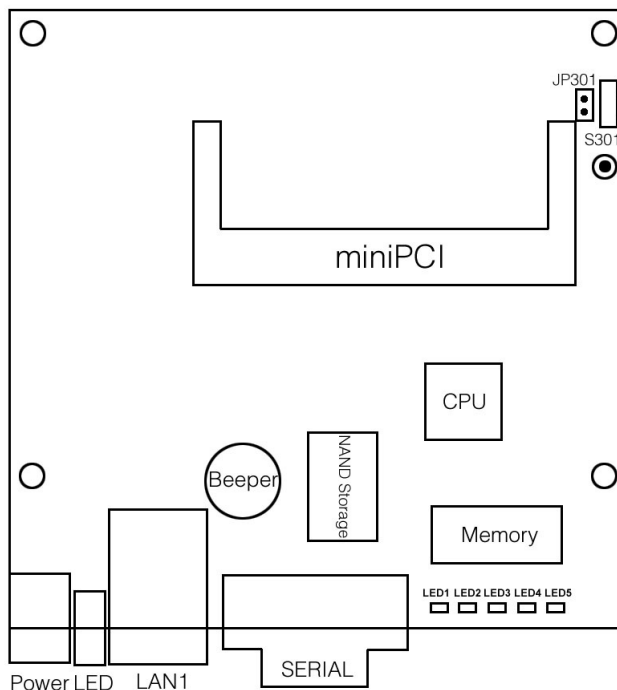
# Specifications

|  | **RouterBOARD 411** |
|---|---|
| **CPU** | MIPS24k based, Atheros AR7130 300MHz CPU |
| **Memory** | **32**MB SDRAM onboard memory |
| **Boot loader** | RouterBOOT |
| **Data storage** | 64MB onboard NAND memory chip |
| **Ethernet** | **One** 10/100 Mbit/s Fast Ethernet ports supporting Auto-MDI/X |
| **MiniPCI slot** | **One**  MiniPCI Type IIIA/IIIB slot |
| **Serial port** | One DB9 RS232C asynchronous serial port |
| **LEDs** | Power and User LED, 5 status LEDs |
| **Speaker** | Mini PC-Speaker |
| **Power options** | Power over Ethernet: 12..28V DC (except power over datalines)<br>Power jack: 9..28V DC |
| **Dimensions** | 105mm x 105mm |
| **Weight** | 115 g (4.06 oz) |
| **Temperature** | Operational: -20°C to +65°C (-4°F to 149°F) |
| **Humidity** | Operational: up to 70% relative humidity (non-condensing) |
| **Power consumption** | 3-4W without extension cards, maximum – 14W |

# Hardware Guide

## Memory and Storage Devices

### Onboard Memory

The board is equipped with 32 MB DDR onboard memory.

### Onboard NAND Storage Device

The boards are equipped with one 64MB NAND nonvolatile memory chip.

## Extension Slots

### MiniPCI Slots

The board has one MiniPCI Type IIIA slot with 3.3V only power signaling. It also accepts MiniPCI Type IIIB standard cards. The board has been tested to operate with high power cards if ambient temperature and adequate cooling is ensured.

**NOTE:** that RB411 currently does not support Senao 8602 cards, Atheros AR5211 or older chipset and Prism chipset based cards. Wireless compression is not supported on RB400 series devices.

Supplied power for the extension cards (excluding CPU and onboard Ethernet ports):

+3.3V: 3.3A max

## Input/Output Ports

### LAN1 Port with PoE

This Fast Ethernet port is recognized as the first LAN interface. It is compatible with passive (non-standard) Power over Ethernet. The board accepts voltage input from 12 to 28 V DC. It is suggested to use higher voltages for power over long cables because of better efficiency (less power is lost in the cable itself and power supply is more efficient).

See **Connector Index** for pinout of the standard cable required for PoE. All cables made to EIA/TIA 568A/B cable specifications will work correctly with PoE. Note that this port supports automatic cross/straight cable correction (Auto MDI/X), so you can use either straight or cross-over cable for connecting to other devices.

### DB9 Serial Port

The RS232C standard male DB9 asynchronous serial port may be used for initial configuration, or for attaching a modem or any other RS232 serial device. TxD (pin 3) of this port has -5V DC power when idle. RTS and DTR signals are not connected. **Note** that the device does not fully implement the hardware (RTS/CTS) flow control, so it is suggested to try to disable hardware flow control in the terminal emulation program in case the serial console does not work as expected, and if it does not help, make a new cable using the pinout given in the User's manual.

### LEDs

### Power LED

Power LED is on when the board is powered.

### User LED

User LED may be programmed at user's option. It is lit by default when the board starts up, then it is turned off when the bootloader runs kernel.

### Status LEDs

Five LEDs (LD 501-505) may be used to show bootup activity, wireless signals, and user programmed values.

# User's Guide

## Assembling the Hardware

First to use the board:

- Insert MiniPCI cards and connect antenna wires, if needed;
- Install the board in a case;
- Connect other peripherals and cables.

### Powering

Power options:

- **J801** power jack:
  10..28V DC (supports overvoltage protection)
- Power over Ethernet (PoE) on the **J602** LAN1 Ethernet port:
  10..28V DC (18..28 V suggested) non-standard PoE powering support

The board has a direct-input power jack **J801** (5.5mm outside and 2mm inside diameter, female, pin positive plug) and can as well be powered with PoE. All power inputs are always active, but only one should be used at the same time.

RouterBOARD 411 is equipped with a reliable 14W onboard power supply with overvoltage protection. 9..28 V DC input voltages are accepted, but when powered over long cables, it is suggested to use at least 18V. The system is tested with 24V solar/wind/RV systems with 27.6 charge voltage. Overvoltage protection starts from about 28V (up to 100V), so the board will not be damaged if connected to a 48V or 60V power line.

RouterBOARD 411 series boards are compatible with non-standard (passive) Power over Ethernet injectors (except power over datalines) and accept powering over up to 100m (330 ft) long Ethernet cable connected to the Ethernet port (**J602**). The board **does not** work with IEEE802.3af compliant 48V power injectors.

The maximum output of the power supply to the extension cards is normally at about 3.3A

## Booting options

First, RouterBOOT loader is started. It displays some useful information on the onboard RS232C

asynchronous serial port, which is set to 115200bit/s, 8 data bits, 1 stop bit, no parity by default. The loader may be configured to boot the system from the onboard NAND module or from Ethernet network. See the respective section of this manual for how to configure booting sequence and other boot loader parameters.

### Onboard NAND Storage Device

The RouterBOARD may be started from the onboard NAND storage chip. As there is no partition table on the device, the boot loader assumes the first 4MiB form a YAFFS filesystem, and executes the file called "kernel" stored in the root directory on that partition.

### Booting from network

Network boot works similarly to PXE or EtherBoot protocol, and allows you to boot a RouterBOARD 411 series computer from an executable image stored on a TFTP server. It uses BOOTP or DHCP (configurable in boot loader) protocol to get a valid IP address, and TFTP protocol to download an executable (ELF) kernel image combined with the initial RAM disk (inserted as an ELF section) to boot from (the TFTP server's IP address and the image name must be sent by the BOOTP/DHCP server).

To boot the RouterBOARD computer from Ethernet network you need the following:

- An ELF kernel image for the loader to boot from (you can embed the kernel parameters and initrd image as ELF sections called *kernparm* and *initrd* respectively)

- A TFTP server which to download the image from

- A BOOTP/DHCP server (may be installed on the same machine as the TFTP server) to give an IP address, TFTP server address and boot image name

See the RouterBOOT section on how to configure loader to boot from network.

Note that you must connect the RouterBOARD you want to boot, and the BOOTP/DHCP and TFTP servers to the same broadcast domain (i.e., there must not be any routers between them).

# RouterBOOT

The RouterBOOT firmware (also referred as "boot loader" here) provides minimal functionality to boot an Operating System. It supports serial console via the onboard serial port at the boot time. The loader supports booting from the onboard NAND device and from a network server (see the respective section for details on this protocol).

# Boot Loader Configuration

Loader parameters may be configured through the onboard RS232C DB9 asynchronous serial interface. To connect to it, use a standard null-modem cable. By default, the port is set to 115200bit/s, 8 data bits, 1 stop bit, no parity. **Note** that the device does not fully implement the hardware (RTS/CTS) flow control, so it is suggested to try to disable hardware flow control in the terminal emulation program in case the serial console does not work as expected, and if it does not help, make a new cable using the pinout given in the Appendix.

To enter the loader configuration screen, press any key (or only [Delete] key (or [Backspace] key – see the note for the respective configurable option), depending on the actual configuration) just after the loader is asking for it:

```
RouterBOOT booter 2.12

RouterBoard 411

CPU frequency: 300 MHz
  Memory size:  32 MB

Press any key within 2 seconds to enter setup

RouterBOOT-2.12
What do you want to configure?
   d - boot delay
   k - boot key
   s - serial console
   o - boot device
   u - cpu mode
   r - reset configuration
   e - format nand
   g - upgrade firmware
   i - board info
   p - boot protocol
   t - do memory testing
```

```
    x - exit setup
your choice:
```

To select a menu point, press the indicated key. Pressing [Enter] selects the option marked with '*'.

## Configurable Options

**boot delay** – how much time to wait for a key stroke while booting (1..9 seconds; **2 second** by default).

**boot key** – which key will cause the loader to enter configuration mode during **boot delay** (any key | <Delete> key only; **any key** by default). Note that in some serial terminal programs, it is impossible to use the [Delete] key to enter the setup – in this case it might be possible to do this with the [Backspace] key.

**serial console** – to configure initial serial console bitrate (1200 | 2400 | 4800 | 9600 | 19200 | 38400 | 57600 | 115200; **115200** bps by default).

**boot device** – initial boot device (boot over Ethernet | boot from NAND | boot Ethernet once, then NAND; **boot from NAND** by default). You can also select **boot chosen device** option to boot from the device selected immediately, without saving the setting.

**cpu mode** – whether to enter CPU suspend mode on WAIT instruction (power save | regular; **power save** by default). Most OSs use WAIT instruction during CPU idle cycle. When CPU is in suspend mode, it consumes less power, but in low-temperature conditions (below 0°C) it is recommended to choose regular mode, so that overall system temperature would be higher.

**reset configuration** – whether to reset all the boot loader settings to their respective default values (yes | no; **no** by default).

**format nand** – perform a low-level NAND format. During this operation, all previously marked bad sectors are retested to find out if they are faulty indeed.

**upgrade firmware** – receive a new boot loader image using XModem protocol over serial line or using DHCP/BOOTP and TFTP protocols through the Ethernet network (upgrade firmware over ethernet | upgrade firmware over serial port).

**board info** – prints the serial number, boot loader version, CPU frequency, memory size and MAC addresses of the onboard Ethernet ports

**boot protocol** – network booting protocol (bootp protocol | dhcp protocol; **bootp protocol** by default).

**do memory testing** – performs a full memory test.

# Boot Loader Upgrading

The boot loader is needed to initialize all the hardware and boot the system up. Newer loader versions might have support for more hardware, so it's generally a good idea to upgrade the loader once a newer version is available. You can upgrade the loader through the onboard serial port using XModem protocol (programs available for all major OSs). For example, you can use HyperTerminal for Windows or Minicom for Linux to upload the boot loader. Alternatively if you have a DHCP/BOOTP and TFTP servers available, you can specify the loader image as a boot image and choose the **bios upgrade over ethernet** option in the boot loader configuration menu. The loader will get the image from the TFTP server and upgrade itself. The most current loader image is available for download on www.routerboard.com.

The boot loader upgrading is supported also from MikroTik RouterOS. The procedure is described in the MikroTik RouterOS manual.

# Appendix

## Serial Null-modem (Console) Cable with Loopback

| DB9f | Function | DB9f | DB25f |
|------|----------|------|-------|
| 1 + 4 + 6 | CD + DTR + DSR | 1 + 4 + 6 | 6 + 8 + 20 |
| 2 | RxD | 3 | 2 |
| 3 | TxD | 2 | 3 |
| 5 | GND | 5 | 7 |
| 7 + 8 | RTS + CTS | 7 + 8 | 4 + 5 |

# Connector Index

| J401 | MiniPCI Type type IIIA/B connector | |
|------|------|------|
| J301 | RS232C male DB9 serial port | |
| | 1 | DCD (Data Carrier Detect) |
| | 2 | RxD (Receive Data) |
| | 3 | TxD (Transmit Data) |
| | 5 | GND |
| | 6 | DSR (Data Set Ready) |
| | 8 | CTS (Clear to Send) |
| J602 | RJ45 Fast Ethernet 100Base-TX port LAN1 with passive PoE extension | |
| | 1 | Data TX+ |
| | 2 | Data TX- |
| | 3 | Data RX+ |
| | 4 | PoE power + |
| | 5 | PoE power + |
| | 6 | Data RX- |
| | 7 | PoE power - |
| | 8 | PoE power - |
| J801 | Power jack (9..28 V DC, positive contact is the central pin) | |

# Button Index

| S301 | Software reset button |
|------|------|

# Ethernet Cables

| RJ45 Pin | Color | Function | RJ45 pin for Straight cable (MDI, EIA/TIA568A) | RJ45 pin for Crossover cable (MDI-X, EIA/TIA568B) |
|------|------|------|------|------|
| 1 | Green | TX+ Data | 1 | 3 |
| 2 | Green/White | TX- Data | 2 | 6 |
| 3 | Orange | RX+ Data | 3 | 1 |
| 4 | Blue | - | 4 | 4 |
| 5 | Blue/White | - | 5 | 5 |
| 6 | Orange/White | RX- Data | 6 | 2 |
| 7 | Brown | - | 7 | 7 |
| 8 | Brown/White | - | 8 | 8 |