RouterBOARD 153 Series

User's Manual

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Caution

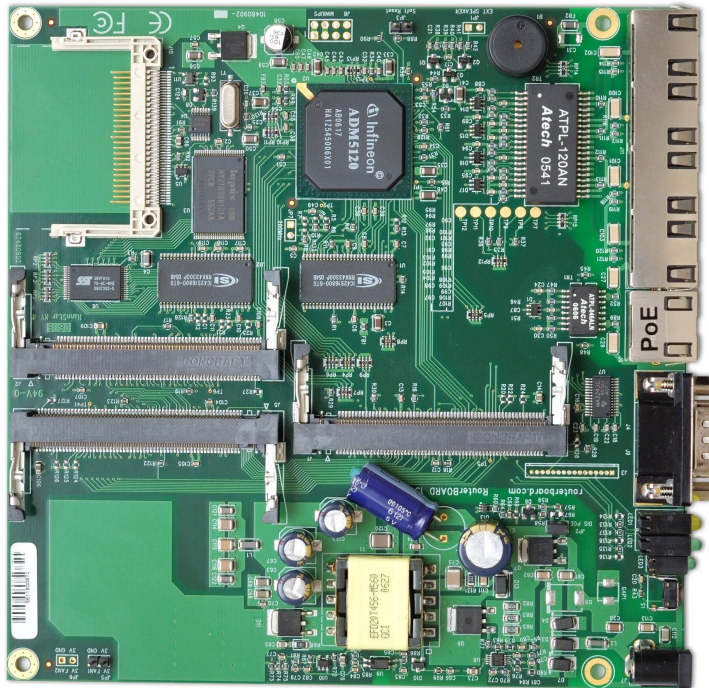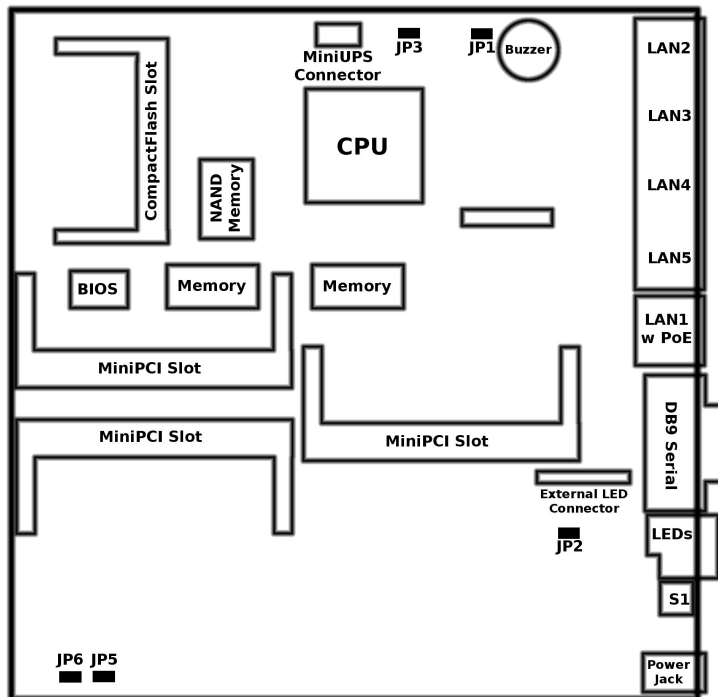To avoid damage of the system, use the correct DC input voltage range.

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System Board View

System Board Layout

Specifications

	RouterBOARD 153
CPU	MIPS32 4Kc based 175MHz embedded processor
Memory	32MB SDRAM onboard memory chip
Boot loader	RouterBOOT, 1Mbit Flash chip
Data storage	64MB onboard NAND memory chip
Ethernet	Five 10/100 Mbit/s Fast Ethernet ports supporting Auto-MDI/X
MiniPCI slot	Three MiniPCI Type IIIA/IIIB slots
Serial port	One DB9 RS232C asynchronous serial port
LEDs	Power, 3 LED pairs for MiniPCI slots, 1 user LED
Speaker	Mini PC-Speaker
Power options	IEEE802.3af Power over Ethernet: 12V or 48V DC (including power over datalines) Power jack: 11..60V DC
Dimensions	16.0 cm x 16.0 cm (6.30 in x 6.30 in)
Weight	183 g (6.5 oz)
Temperature	Operational: -20°C to +70°C (-4°F to 158°F)
Humidity	Operational: up to 70% relative humidity (non-condensing)
Power consumption	3-4W without extension cards. Maximum – 13W

Block Diagram
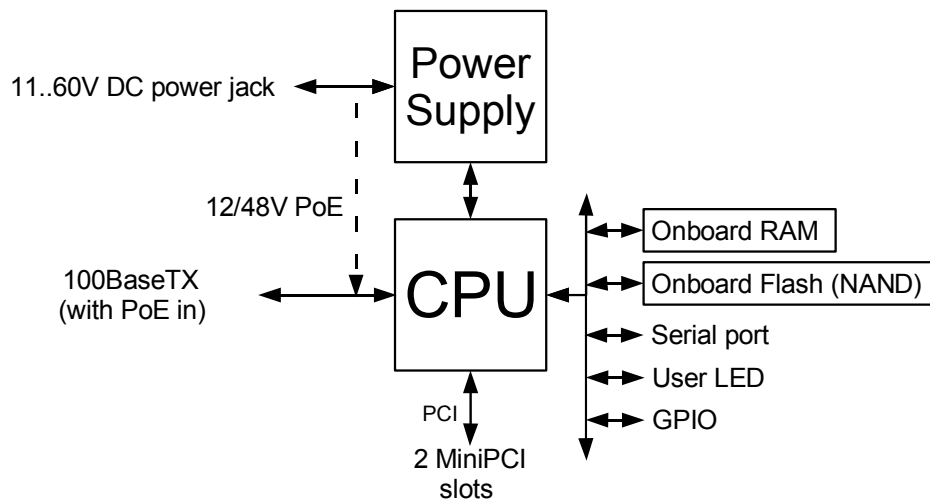
Hardware Guide

Memory and Storage Devices

Onboard Memory

The boards are equipped with 32MB SDRAM memory (2 chips).

Onboard NAND Storage Device

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

CompactFlash Interface

You can use any CompactFlash Type I or II cards, as well as IBM/Hitachi Microdrive hard drives. **Warning! The RouterBOARD 153 series boards do not support hot insert of CompactFlash/Microdrive devices.**

Extension Slots

MiniPCI Slot

MiniPCI Type IIIA slots has 3.3V only power signaling. The slots also accept MiniPCI Type IIIB standard cards.

Supplied power (shared between all the devices, including the CPU):

+3.3V: 4.0A

Input/Output Ports

LAN1 Port with PoE

This Fast Ethernet port is recognized as first LAN interface in most OSs. It is compatible with IEEE802.3af Power over Ethernet standard (including power over datalines) and passive PoE (non-standard). The board accepts non-standard voltage input in wide range: from 11 to 60 V DC.

The RouterBOARD 51 power injector may be used to power the board with up to 100m (330 ft) long Ethernet cable. It is suggested to use 48V DC power for power over long cables because of better efficiency (less power is lost in the cable itself and power supply is more efficient on higher voltage).

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 network devices.

Four LAN Ports without PoE

These Fast Ethernet ports are recognized as four independent LAN interfaces: LAN2 (at the corner of he board) to LAN5 (near the PoE-enabled LAN1 connector). These ports are not intended to be used with PoE. **CAUTION! You will seriously damage the board by connecting PoE injector to these ports**.

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 network 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. This implementation may not be considered to support full hardware flow-control so software flow-control (XON/XOFF) should be used.

LEDs

Power LED

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.

MiniPCI LEDs

3 pairs of MiniPCI LEDs are connected to MiniPCI slots (two LEDs per slot) according to standards.

User's Guide

Assembling the Hardware

First to use the board:

- In most cases you do not need to configure jumpers. **JP2** PoE control is disabled by default, you may want to enable it to comply with IEEE802.3af requirements. See Jumper Index for details**.**

- If the onboard NAND memory is not sufficient for your needs, you can install a CompactFlash module or Microdrive hard drive, which can be used as an alternative boot device or an additional storage medium. **Warning! The RouterBOARD 153 series does not support hot insert of CompactFlash/Microdrive devices.**

- Insert MiniPCI cards on the board itself.

- Install the board in a case.

- Connect other peripherals and cables

You can also order a pre-assembled system with RouterBOARD and extension cards of your choice already installed in a case.

Powering

Power options:

- **J7** power jack:
  11..60V DC (**JP2** should be closed)

- IEEE802.3af Power over Ethernet (PoE) on the LAN1 Ethernet port:
  48V DC (**JP2** PoE control must be open to comply with standard requirements)

- Passive (non-standard) PoE powering on the LAN1 Ethernet port:
  11..60V DC at the board (**JP2** PoE control should be closed)

RouterBOARD 153 series boards are equipped with a reliable 13W onboard power supply that accepts a wide range of input voltage. The board has a direct-input power jack **J7** (5.5mm outside and 2mm inside diameter, female, pin positive plug) and can as well be powered with PoE. Both power inputs are always active, but only one should be used at the same time.

RouterBOARD 153 series boards are compliant with IEEE802.3af Power over Ethernet standard (including power over datalines) and accept 48V powering over up to 100m (330 ft) long Ethernet cable connected to the **J6** Ethernet port. The board also accepts non-standard PoE input voltage. **CAUTION! Only LAN1 port supports PoE, you may seriously damage the board by connecting PoE injector to the other 4 ports**.

The maximum output of the power supply is normally 4.0A, but the efficiency is decreased on lower voltages, so it is about 2.5A when powered from 12V DC. The "Disable PoE controller" jumper **JP2** may only be opened when standard 48V PoE is used.

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, CompactFlash 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. It is possible to partition the rest of the medium by patching the kernel source.

Internal Storage Device

The RouterBOARD may be started from a CompactFlash module or a Microdrive hard drive. At least two partitions must exist on the device, first of which being the ELF image the board is to be booted from (normally, it is a Linux kernel, appended with the *kernparm* ELF section that specifies the root partition name and, optionally, other kernel parameters of your choice).

Booting from network

Network boot works similarly to PXE or EtherBoot protocol, and allows you to boot the RouterBOARD 153 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 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).

Operating System Support

System Architecture

RouterBOARD 153 series embedded boards are fully compatible with the standard MIPS32 architecture with PCI bus.

CPU. RouterBOARD 153 series has MIPS32 little-endian based embedded processor using MIPS 4Kc CPU core. It is fully binary-compatible with all software developed for MIPS32 little-endian (mipsel) instruction set architecture. The MIPS 4Kc core includes TLB Memory Management Unit and does not include Float Point Unit (so it is optimized for integer operations).

Ethernet. RouterBOARD 153 series has five onboard Ethernet ports controlled by ADMtek MAC/PHY controllers embedded in the CPU.

MikroTik RouterOS

MikroTik RouterOS (special RouterBOARD 100/500 series edition, starting from version 2.9.12) is fully compatible with RouterBOARD 153 series embedded boards.

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, CompactFlash or IBM Microdrive, and from a network server (see the respective section for details on this protocol).

Supported OSs:

- MikroTik RouterOS starting with version 2.9.12
- Linux 2.4

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 1.9

RouterBoard 153

CPU frequency: 175 MHz
  Memory size:  32 MB

Press any key within 1 seconds to enter setup

RouterBOOT-1.9
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 key written at the beginning of this line. 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, if fail then Ethernet | boot Ethernet once, then NAND | boot from NAND only; **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 really bad.

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.

If you are using a Microsoft Windows series operating system, you can use the remote upgrading application available on www.routerboard.com. This program boots the RouterBOARD from network and upgrades the loader. Note that the upgrade may only take place within the same broadcast domain (i.e. there must not be any routers between the Windows-based machine and the upgradable RouterBOARD).

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

Appendix

Connector Index

J1	MiniPCI Type type IIIA/B connector 1	
J2	MiniPCI Type type IIIA/B connector 2	
J3	External LED connector	
	1	Red MiniPCI 1 LED +
	2	Red MiniPCI 1 LED -
	3	Red MiniPCI 2 LED +
	4	Red MiniPCI 2 LED -
	5	Red MiniPCI 3 LED +
	6	Red MiniPCI 3 LED -
	7	Green MiniPCI 1 LED +
	8	Green MiniPCI 1 LED -
	9	Green MiniPCI 2 LED +
	10	Green MiniPCI 2 LED -
	11	Green MiniPCI 3 LED +
	12	Green MiniPCI 3 LED -
	13	Power LED +
	14	GND
	15	User LED +
	16	GND
J4	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)
J5	MiniPCI Type type IIIA/B connector 3	

J6	RJ45 Fast Ethernet 100Base-TX port with IEEE802.3af 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 -
J7	Power jack (11..60 V DC, positive contact is the central pin)	
J9	External serial port header	
	1	DCD (Data Carrier Detected)
	2	DSR (Data Set Ready)
	3	RxD (Receive Data)
	4	TxD (Transmit Data)
	5	CTS (Clear to Send)
	6	GND
J10	CompactFlash type I/II (with Microdrive support) slot	
J11	Four standard RJ45 Fast Ethernet 100Base-TX ports (no PoE support!)	
JP1	External speaker header	
JP5	3V power output	
JP6	3V power output	

Jumper Index

JP2	Disable IEEE802.3af Power over Ethernet controller. The controller is only stable for standard-compliant 48V DC PoE powering, so when using lower voltages, it should be disabled (default setting). Note that the controller is active for both PoE and J7 power jack, so even when not using PoE, disable the controller.	
	Open	Normal operation according to IEEE802.3af Power over Ethernet standard
	Closed	Disable PoE controller (for passive PoE injectors and/or input voltage less than 24V)
JP3	Software reset: user-defined jumper (GPIO4)	

Button Index

S1	User-defined button (GPIO7)

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

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