![SSV logo]
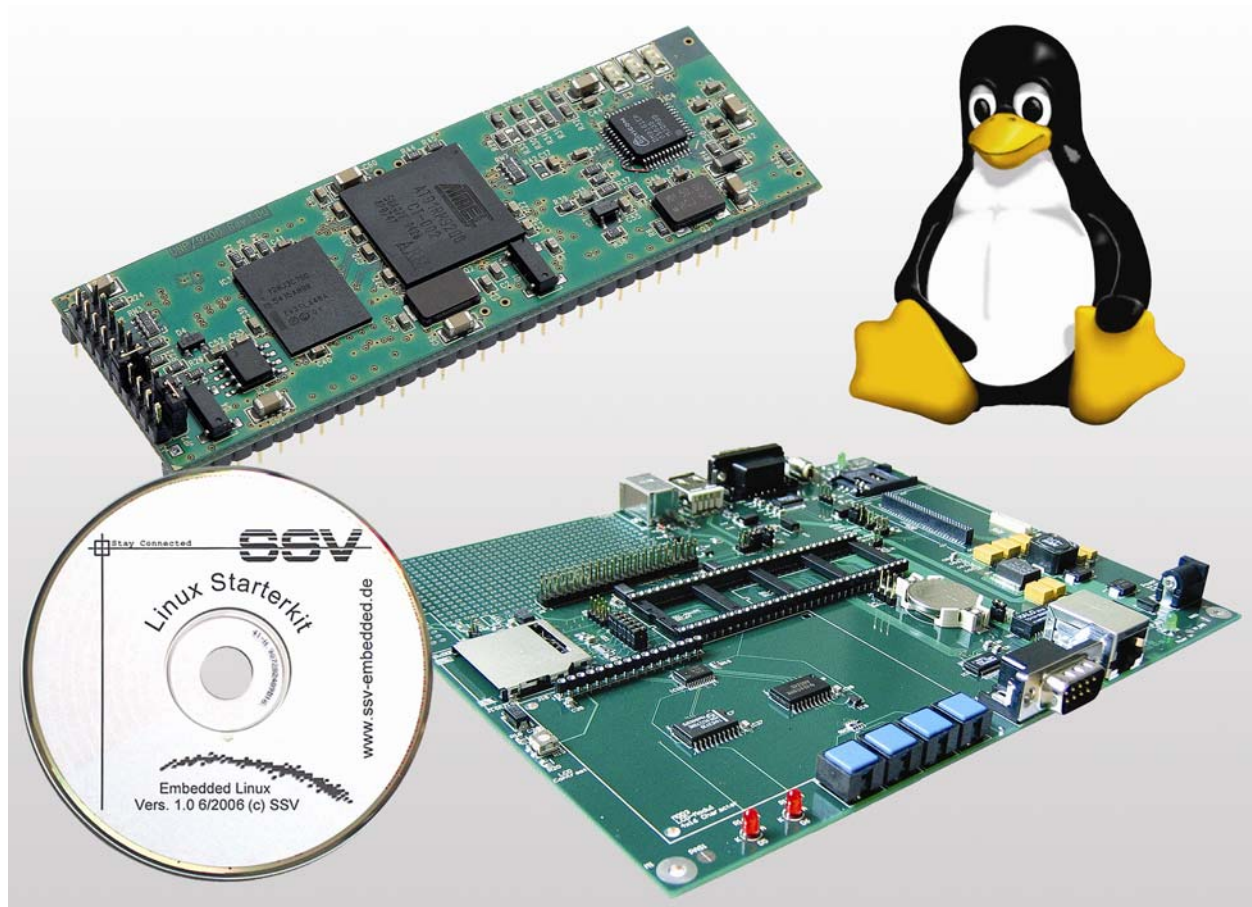
DNP/SK23
Embedded Linux Starter Kit

First Steps

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CONTENT

1   INTRODUCTION

The DIL/NetPC DNP/9200 Starter Kit contains everything you need to get started with your Atmel AT91RM9200 ARM9-based embedded networking application. The Starter Kit includes a DNP/9200 module with a pre-installed U-Boot boot loader and an embedded Linux, the Evaluation Board DNP/EVA9, power supply, serial interface (null modem) cable, a CD-ROM with software and documentation and a printed user manual for the first steps with the Starter Kit.

The Starter Kit CD-ROM comes with a full GNU cross tool chain for C/C++ software development. The binary files of this pre-build tool chain runs on an x86 Linux-based host (SuSE, Red Hat or other) and builds executable files for the Atmel AT91RM9200 ARM9-based microcontroller.

For using the DNP/SK23 Embedded Linux Starter Kit you need a development system. The minimal configuration for this system is a Windows-based PC with the HyperTerminal terminal emulation program and a free COM port (COM1, COM2 or USB-based COMx) for the RS232 serial link between the DNP/9200 and HyperTerminal.

For using the Ethernet link, your PC needs an Ethernet adapter with 10 Mbps or 10/100 Mbps LAN interface. This environment allows web server programming (HTML pages, Java Applets) and Linux shell script programming. For using the GNU C/C++ cross tool chain, it is necessary to run Linux on the development system.

1.1 Features and Technical Data

The DIL/NetPC DNP/9200 comes with a pre-installed U-Boot boot loader and an Embedded Linux operating system. The DNP/9200 Linux consists of two main components: 1. the Linux kernel and 2. the root file system.

The DNP/9200 U-Boot boot loader allows the downloading of new Linux kernel versions and root file systems to the DNP/9200 RAM and Flash. This in-system programming feature can be used by a simple serial and Ethernet link between the development system and the DNP/9200.

- DIL/NetPC DNP/9200 with Atmel AT91RM9200, 16 Mbytes Flash and 32 Mbytes SDRAM, 3.3 VDC Vcc

- U-Boot boot loader and Embedded Linux pre-installed in Flash memory

- Evaluation Board DNP/EVA9

- Null modem cable

- 110 VAC or 230 VAC to 5 VDC international power supply

- CD-ROM with user manual and hardware/programmers manuals

- Embedded Linux with source

- GNU cross tool chain for C/C++ software development for Linux-based PCs

- GNU gdb and gdbserver for Ethernet-based remote debugging

- Linux remote login with Telnet

- Web server setup sample

- FTP server setup sample

- Many source code samples

2 GETTING STARTED

2.1 Serial Link between DNP/EVA9 and PC

Setup the serial link between the Evaluation Board DNP/EVA9 and your PC. Use a null modem cable for this connection.
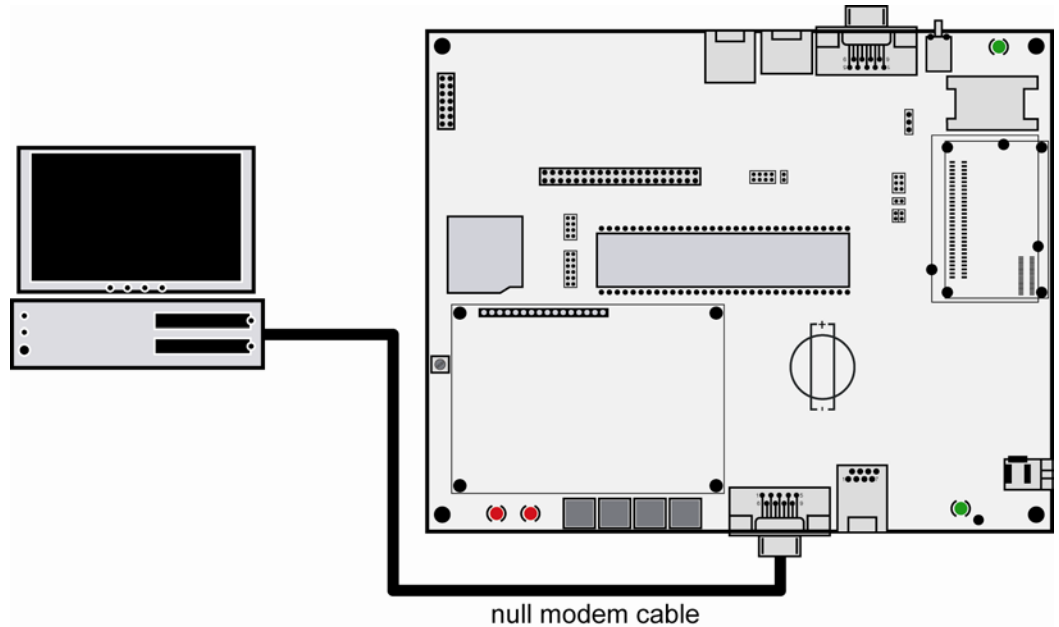

null modem cable

Figure 1: Serial link between Evaluation Board and PC

Connect one end of the null modem cable with an unused COM port of your PC. Make sure that this PC COM port supports 115.200 bps.
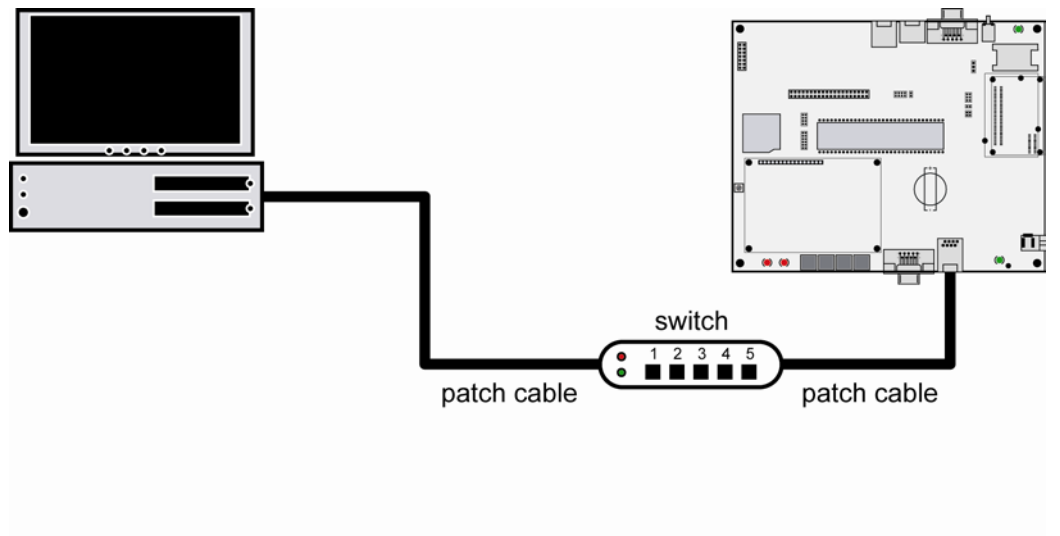
2.2 Ethernet Link between DNP/EVA9 and PC

Setup the Ethernet LAN link between the Evaluation Board DNP/EVA9 and your PC. Use an Ethernet cross-over cable or a switch-based infrastructure for the first LAN connection.
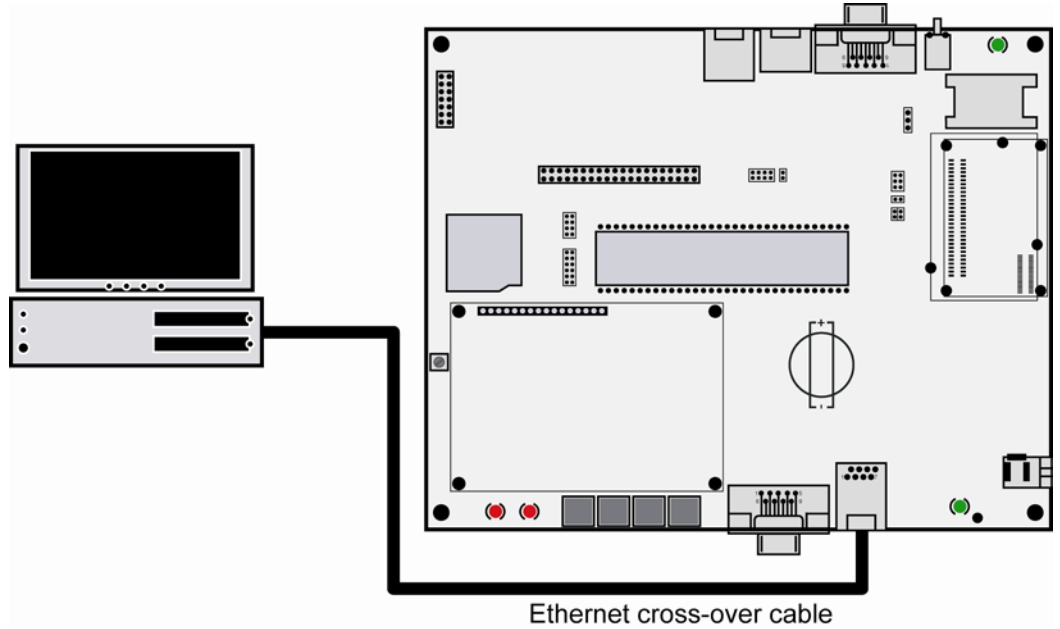
**Figure 2: Ethernet link between Evaluation Board and PC**

Please note: The DNP/9200 comes with the default IP address 192.168.0.126. Please make sure that your PC can work with the IP address range 192.168.0.x.

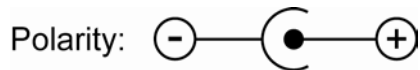**Figure 3: Switch-based Ethernet link between Evaluation Board and PC**

2.3   Connecting Power Supply and Power-up the Starter Kit

Connect a 5 VDC power supply with a 5.5 mm x 2.5 mm jack plug to the Evaluation Board DNP/EVA9.
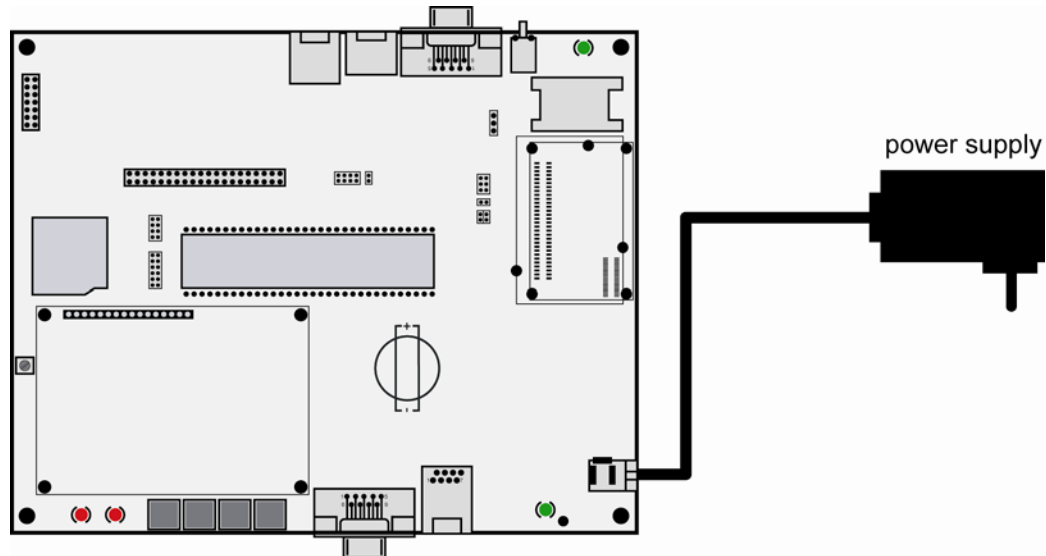
Figure 4:   Power supply for the Evaluation Board

Please pay attention to the polarity of the power connector: the **+ pole is in the center!**

Figure 5:   Polarity of the power connector

Please note: Make sure that all cable connections are OK. Then power-up the Starter Kit.
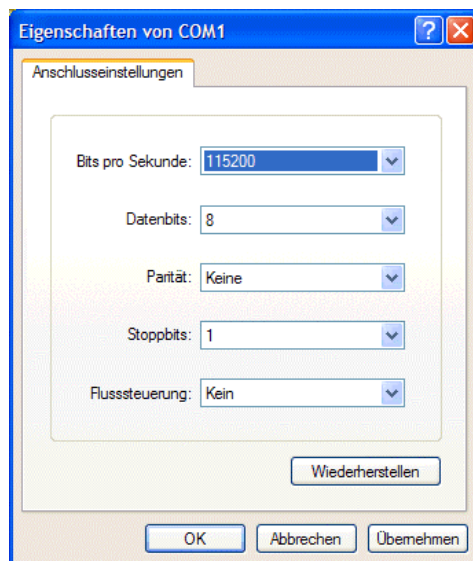
2.4 Using Serial Link with Terminal Program

Run *HyperTerminal* on your Windows-PC, *minicom* or a similar simple terminal emulation program on your Linux-based PC.

Figure 6:   Direct connection setup with HyperTerminal

Setup a direct connection with the parameters of table 1. Make sure, that the PC COM port supports 115.200 bps.

Figure 7:   Parameter setup with HyperTerminal

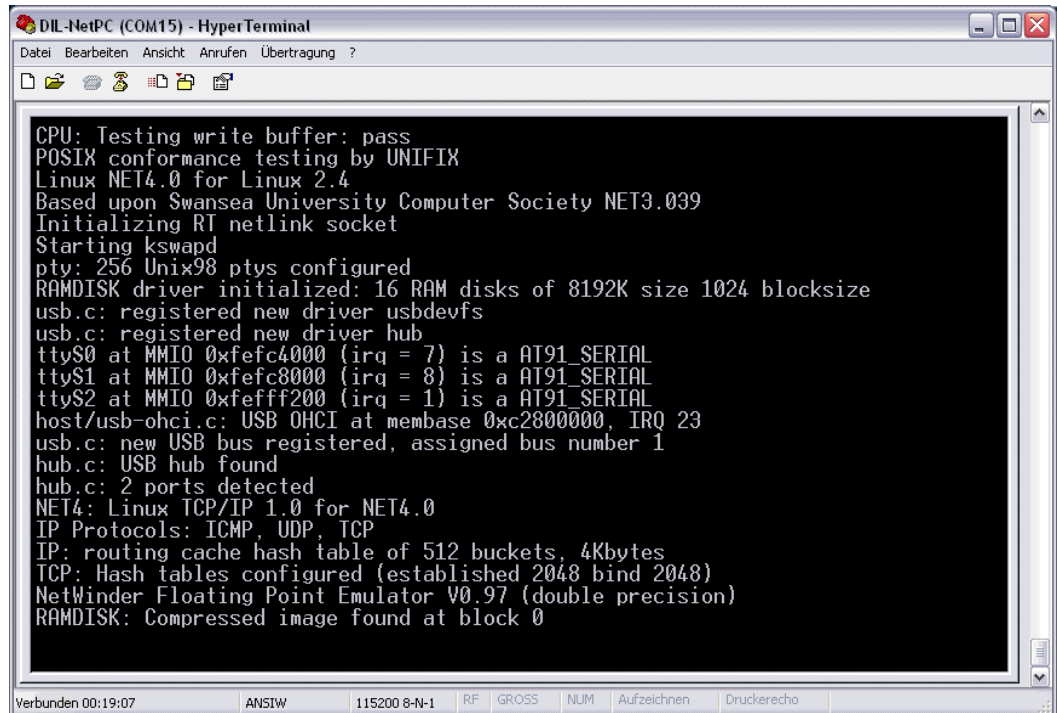| Parameter	Value
Speed	115.200 bps
Data Bits	8
Parity	None
Stop Bits	1
Protocol	No (Xon/Xoff, RTS/CTS or similar)

Table 1:   Setup parameters for the serial link

2.5 Power-up DNP/9200 without RCM Jumper (RCM disabled)

After power-up the DIL/NetPC DNP/9200 starts an automatic boot process from the on-board flash memory chip. This process consists of two steps:

1. Direct after power-up, the DNP/9200 runs the U-Boot boot loader program for some milliseconds. U-Boot initializes the hardware components (hardware init). **With RCM disabled** (please see the *DIL/NetPC DNP/9200 hardware reference manual* for details), there is no U-Boot text message output over the DNP/9200 COM1 serial interface and no **boot delay**-based[1] wait period. Direct after the hardware init, the U-Boot boot loader starts the Linux OS image.

2. Linux takes control over the DNP/9200 hardware and runs all necessary processes for coming up to live.

Figure 8: Linux booting process with HyperTerminal

Please note: The U-Boot environment variable **boot delay** doesn't influence the DNP/9200 boot process with RCM (Remote Console Mode) disabled.

The DNP/9200 Linux supports a serial console. It allows running a Linux-based system in a headless configuration without a monitor or keyboard. Wait until the Linux boot process finishes. Then enter the user name **root**. This user name needs no password. Just hit Enter if the DNP/9200 Linux asks for a password.

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[1] **"boot delay"** is a U-Boot environment variable. The value defines a wait time before U-Boot starts the Linux operating system.

2.6   Power-up DNP/9200 with RCM Jumper (RCM enabled)

The DIL/NetPC DNP/9200 boot sequence with RCM enabled is similar to the boot procedure with RCM disabled. Only the first step is different:

1. The DNP/9200 runs the U-Boot boot loader program. This software shows a wait message over the DNP/9200 COM1 serial interface if RCM is enabled (please see the *DIL/NetPC DNP/9200 hardware reference manual* for details). It is possible to interrupt the boot process and switch to the U-Boot command line interface. Just hit a key of your terminal emulation program.

2. Without interruption the U-Boot boot loader starts a Linux OS image after the wait period from the DNP/9200 Flash memory.
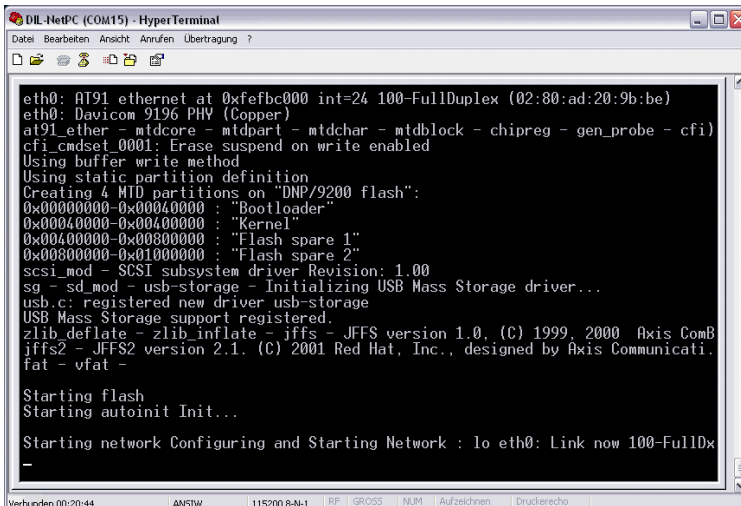

Figure 9: U-Boot wait message

Please note: The U-Boot command line interface allows you to change the wait time of the first step. Please see the U-Boot environment variable **boot delay** for details.

Figure 10: Linux booting process after the U-Boot boot delay

2.7 Checking IP Address of PC

Make sure that your PC is using the right IP address for the Ethernet-based TCP/IP communication with the DIL/NetPC. Use 192.168.0.1 or 192.168.0.254 for your PC and 192.168.0.126 for the DNP/9200.
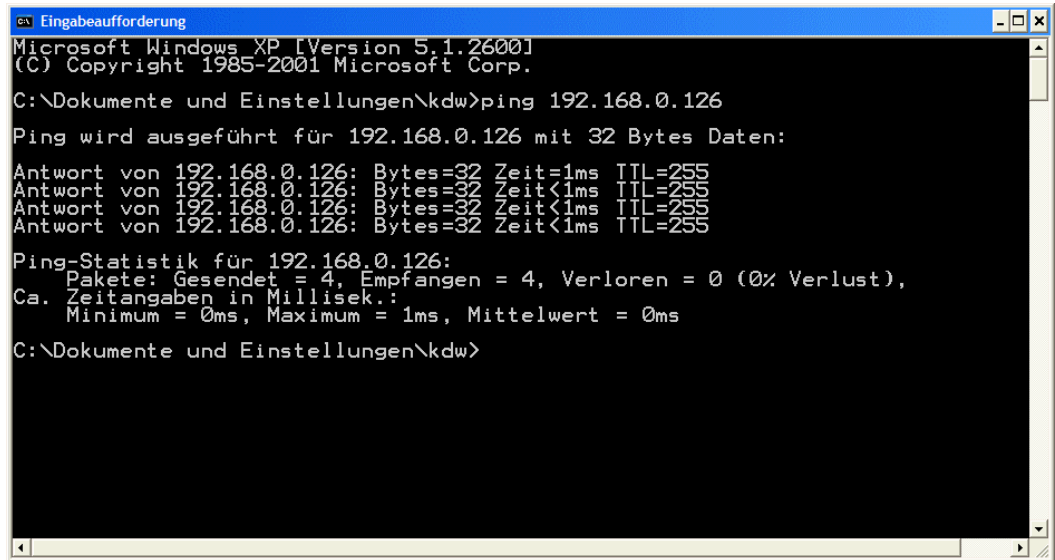
Figure 11: Windows-PC IP address check with *ipconfig*

Talk to your network administrator if you have problems with the IP address understanding.

2.8 Checking Ethernet-based TCP/IP Communication

Check the Ethernet-based TCP/IP communication between the DNP/9200 and the PC with a simple *ping* command.

Figure 12: Windows-PC TCP/IP communication check with *ping*

First check the cable connections and then the IP addresses if your ping doesn't work. Then check the TCP/IP setup of your PC.

2.9   Using a Telnet Connection

Run a Telnet client program on your PC with the IP address of the DNP/9200. You can use a Telnet session for remote entering Linux commands.
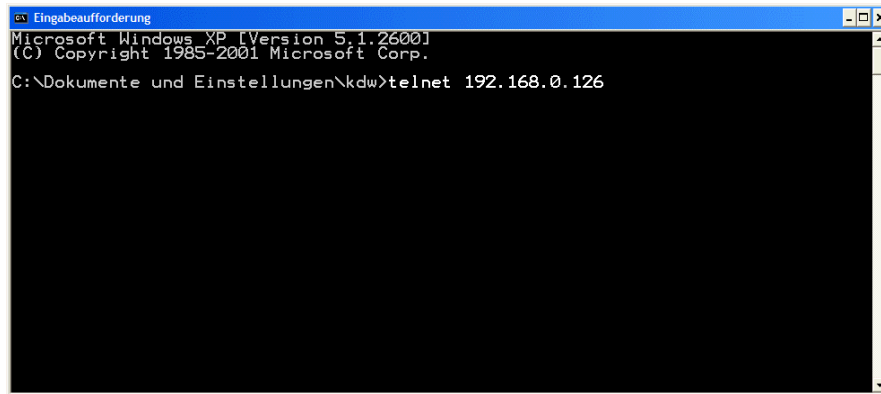
Figure 13: Run the Windows telnet client program

Wait until the DNP/9200 Linux ask you for a user name. Please enter the user name **root**. This user name needs no password. Just hit Enter if the DNP/9200 Linux asks for a password.

Please note: The DNP/9200 Linux comes with *BusyBox*. All Linux command line commands are implemented in *BusyBox*. *BusyBox* combines tiny versions of many common UNIX utilities into a single small executable. It provides replacements for most of the utilities you usually find in GNU *fileutils*, *shellutils*, etc. The utilities in *BusyBox* generally have fewer options than their full-featured GNU cousins; however, the options that are included provide the expected functionality and behave very much like their GNU counterparts. *BusyBox* provides a fairly complete environment for any small or embedded system.
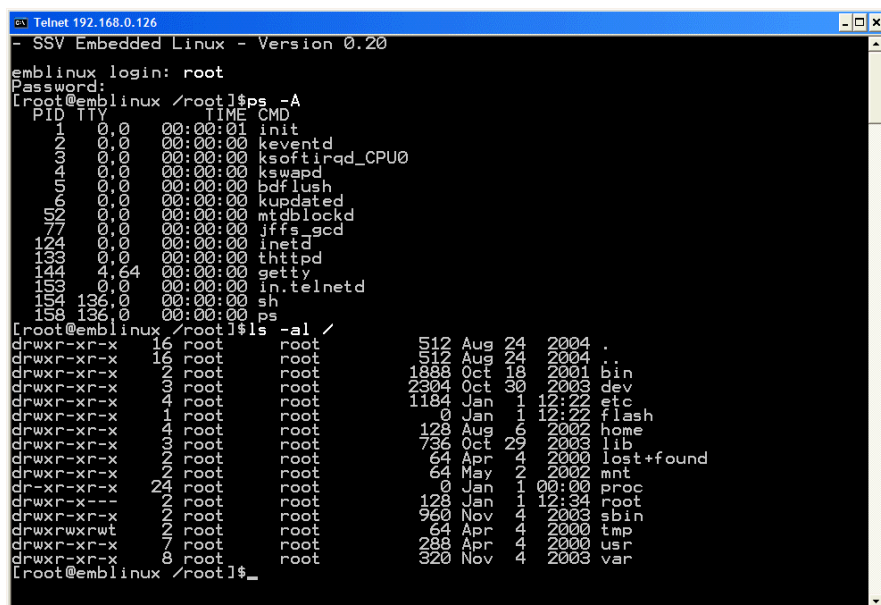
Figure 14: Using Linux commands within a Telnet client window

2.10 Checking DNP/9200 Embedded Web Server
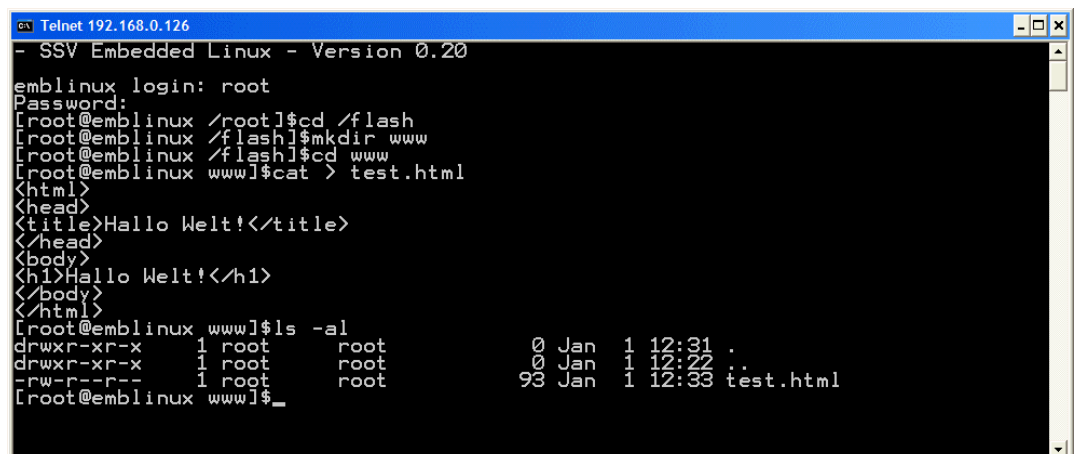
The DIL/NetPC DNP/9200 default Linux configuration comes with a pre-installed embedded web server. The object storage space (HTML pages, pictures, CGI programs, Java Applets, …) for this web server is located within the DNP/9200 Flash memory.

Setup a Telnet session with root user rights from your PC to the DNP/9200 (see chapter 2.9 if necessary). Enter the following command lines within this Telnet session:

```
cd /flash
mkdir www
cd www
cat > test.html
<html>
<head>
<title>Hallo Welt!</title>
</head>
<body>
<h1>Hallo Welt!</h1>
</body>
</html>
```
CTRL-D (CTRL-D stops the Linux cat command)

These command lines create an HTML file /flash/www/test.html within the DNP/9200 Flash memory with the German version of "Hello World" ("Hallo Welt!").

Reboot your DNP/9200. This reboot defines /flash/www/ as default directory for the web server.

Figure 15: Create a HTML file within a Telnet session

Run your PC web browser and access the HTML file test.html with your browser. Use the URL http://192.168.0.126/test.html. This URL assumes that your DNP/9200 is using the IP address 192.168.0.126 for the Ethernet LAN interface LAN1. Change this IP address if necessary.
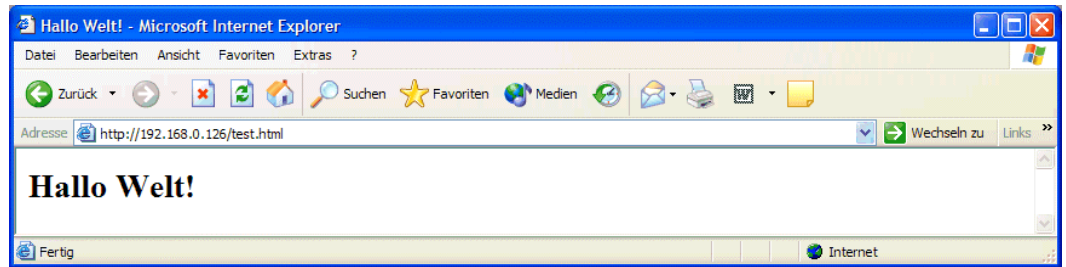
Figure 16: Check the Embedded web server with Internet Explorer

Please note: `/flash/www` is the default directory for the DNP/9200 embedded web server. Restart the DNP/9200 Linux after the creation of `/flash/www/test.html` and before the first access with a web browser. The DNP/9200 embedded web server looks out for `/flash/www` at boot time. If this the directory `/flash/www` at boot time does not exist, the DNP/9200 embedded web server works with the RAM disk-based directory `/usr/local/www`.

2.11 Checking DNP/9200 FTP Server

The DIL/NetPC DNP/9200 Linux comes with a pre-installed FTP server. This server allows the file transfer between a PC and the DNP/9200.

Run a FTP client program on your PC. Set the session parameters for your FTP client to IP address: **192.168.0.126**, user name: **guest**, password **guest**. The DNP/9200 default directory for the FTP user name guest is `/home/guest`. This directory is located within the DNP/9200 RAM disk.
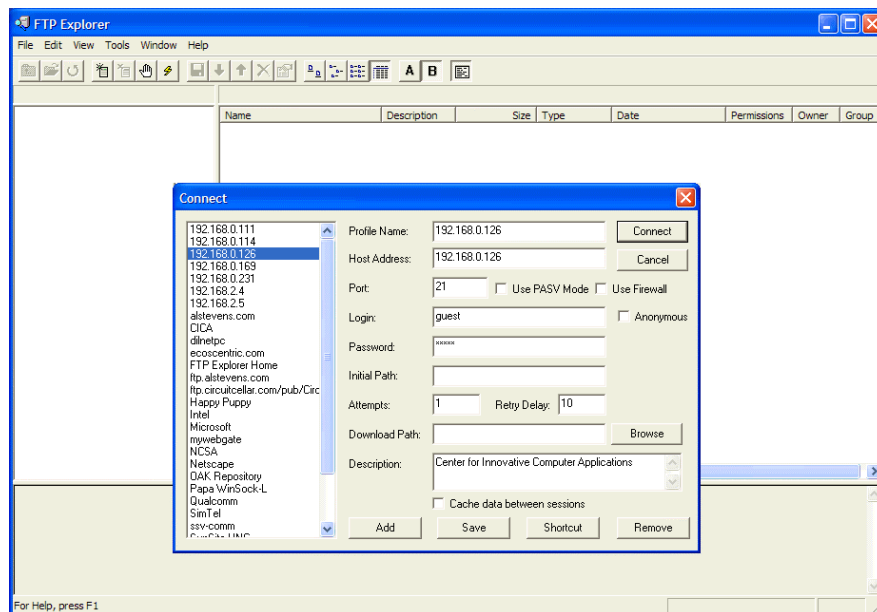
Figure 17: Set the session parameters for a FTP client program

Connect your FTP client with the DNP/9200 FTP server. Please watch the DNP/9200 default FTP directory. Transfer some files from your PC to the DNP/9200. The DNP/9200 stores this files in the DNP/9200 default FTP directory.
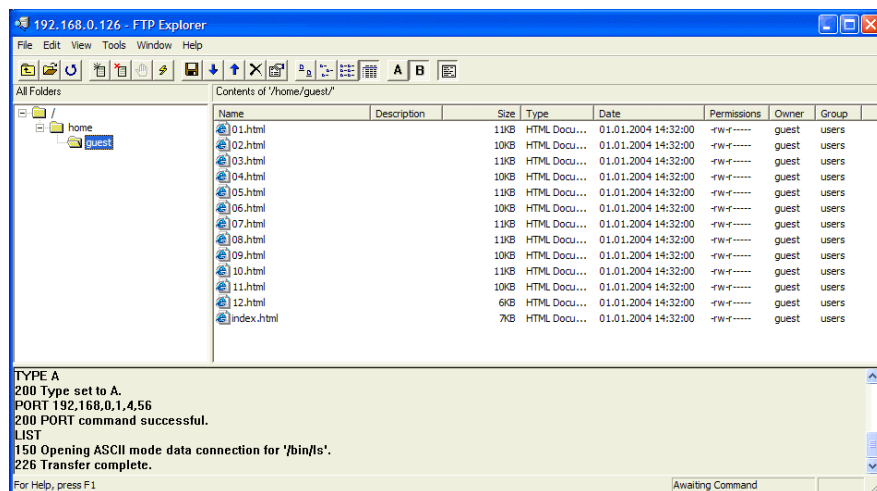
Figure 18: Transfer some files to the DNP/9200

Check the new files with a Telnet session. Change to the DNP/9200 default FTP directory `/home/guest` within your Telnet session.

Figure 19: The new files within /home/guest

2.12   Checking DNP/9200 TFTP Client

The DIL/NetPC DNP/9200 Linux offers also a pre-installed TFTP client. This program allows the TFTP-based file transfer between a PC and the DNP/9200.

First run a TFTP server program on your PC system. Linux-based PCs offer a TFTP server as part of the standard networking feature set. For Windows-based PCs please use the free Win32 TFTP server program from the Starter Kit CD-ROM (see directory /TFTP-Server-Win32 at the Starter Kit CD-ROM).
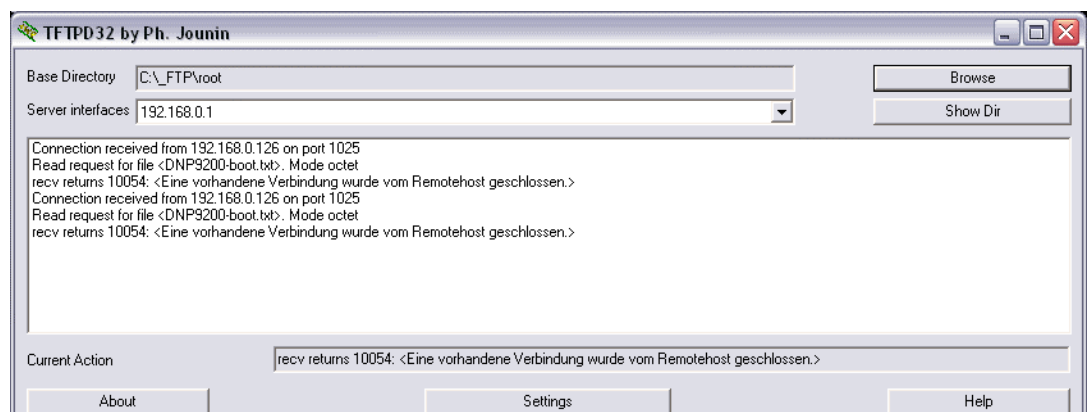
Figure 20: Running the Win32 TFTP server

Figure 19 shows the free Win32 TFTP server in action. This server allows file transfers to and from any DNP/9200 directory.
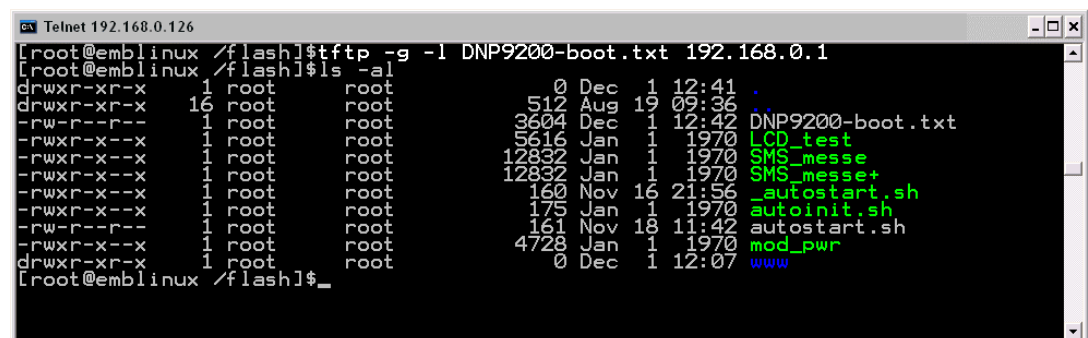
Figure 21: Download with TFTP *get* command

Enter your get and put commands within a Telnet session. Figure 20 shows a sample for a TFTP get (getting a file from the PC to the DNP/9200). Here we enter:

```
tftp –g –l DNP9200-boot.txt 192.168.0.1
```

DNP9200-boot.txt is the filename wich is requested from the TFTP server. **192.168.0.1** is the TFTP server IP address.

2.13   Changing DNP/9200 Ex Factory IP Address (ipaddree usage)

Every device connected to an IP network must have an unique IP address. This address is used to reference the specific unit.

The DIL/NetPC DNP/9200 is automatically assigned an IP address on DHCP-enabled networks as it is DHCP-enabled by default. If DHCP doesn't work (i.e. no DHCP server available), the DNP/9200 takes a default IP address.

The ex factory value for this default IP address is **192.168.0.126**. The network mask for this address is **255.255.255.0**. You can change this IP address over a RS232-based serial link with the help of program, called **ipaddree**.
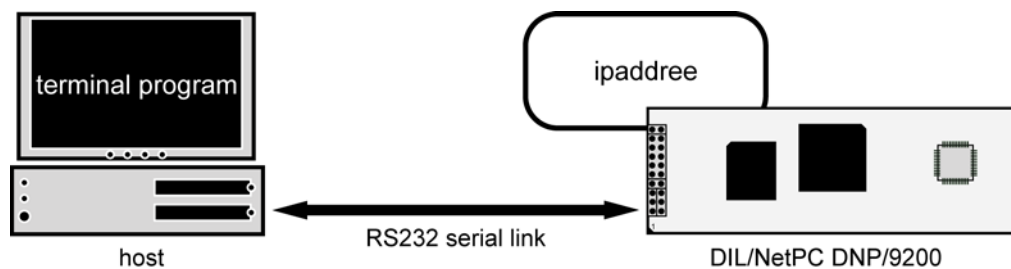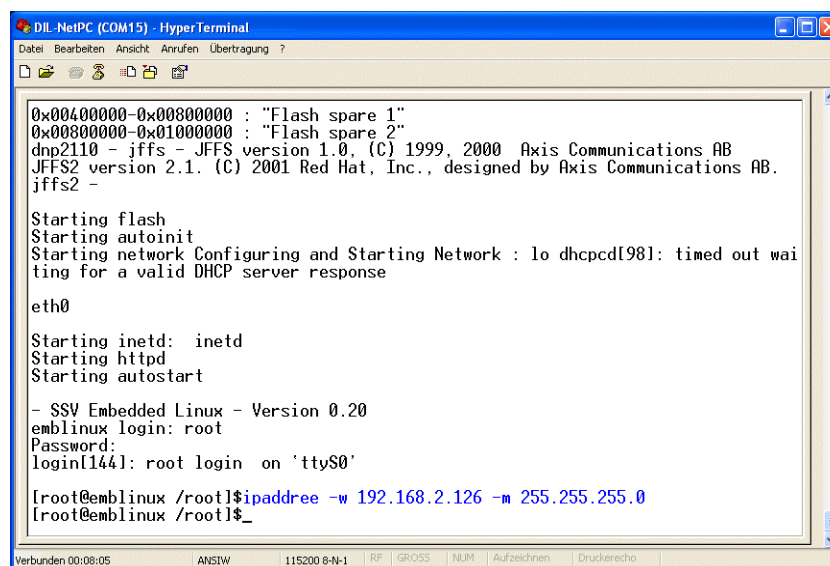
Figure 22: Environment for ipaddree usage

Use a serial console and enter the user name **root**. This user name needs no password. Just hit Enter if the DNP/9200 Linux asks for a password. Then execute the following command:

```
ipaddree -w 192.168.2.126 -m 255.255.255.0
```

"ipaddree" is the name of a command line IP setup tool. "192.168.2.126" is an IP address. Use the IP address of your choice for your setup on this position. "255.255.255.0" is a network mask. Use a valid network mask for your IP address.

Figure 23: Serial console with *ipaddree* command line

Reboot the DNP/9200. The new IP address and network mask is valid after the next boot process if no DHCP server available or if DHCP doesn't work. Check the new IP address with a *ping*.

Figure 24: Check the new IP address with *ping*

Please note: Don't forget to change the IP address of your PC to 192.168.2.1 or similar.

3   U-BOOT BOOT LOADER COMMAND OVERVIEW

The user interface to U-Boot consists of a command line interpreter (CLI), much like a Linux shell prompt. When connected via a serial line you can interactively enter commands and see the results. The following table shows the available U-Boot commands for the DIL/NetPC DNP/9200.

Command	Function
autoscr	run script from memory
base	print or set address offset
bdinfo	print Board Info structure
bootm	boot application image from memory
bootp	boot image via network using BootP/TFTP protocol
bootd	boot default, i.e., run 'bootcmd'
cmp	memory compare
cp	memory copy
crc32	checksum calculation
echo	echo args to console
erase	erase FLASH memory
flinfo	print FLASH memory information
go	start application at address 'addr'
help	print online help
iminfo	print header information for application image
loadb	load binary file over serial line (kermit mode)
loadc	load binary file over serial line (ymodem-c mode)
loadg	load binary file over serial line (ymodem-g mode)
loads	load S-Record file over serial line
loop	infinite loop on address range
md	memory display
mm	memory modify (auto-incrementing)
mtest	simple RAM test
mw	memory write (fill)
nm	memory modify (constant address)
printenv	print environment variables
protect	enable or disable FLASH write protection
rarpboot	boot image via network using RARP/TFTP protocol
reset	perform RESET of the CPU
run	run commands in an environment variable
saveenv	save environment variables to persistent storage
setenv	set environment variables
sleep	delay execution for some time
tftpboot	boot image via network using TFTP protocol and env variables ipaddr and serverip
version	print monitor version
?	alias for 'help'

Table 2:   U-Boot command overview

Command	Function
autoscr	run script from memory
base	print or set address offset
bdinfo	print Board Info structure
bootm	boot application image from memory
bootp	boot image via network using BootP/TFTP protocol
bootd	boot default, i.e., run 'bootcmd'
cmp	memory compare
cp	memory copy
crc32	checksum calculation
echo	echo args to console

Table 3:   U-Boot command overview

4   DNP/9200 LINUX BOOT MESSAGES OVERVIEW

```
Linux version 2.4.27-vrs1-ssv1 (mha@hareangle-debian) SSV20050818 <mha@ist1.de> ↵
<m.hasewinkel@web.de> (gcc version 2.95.2 19991024 (release)) #1 Do Aug 18 ↵
18:00:40 CEST 2005
CPU: Arm920Tid(wb) revision 0
Machine: ATMEL AT91RM9200
On node 0 totalpages: 8192
zone(0): 8192 pages.
zone(1): 0 pages.
zone(2): 0 pages.
Kernel command line: console=ttyS0,115200 root=/dev/ram
Calibrating delay loop... 89.70 BogoMIPS
Memory: 32MB = 32MB total
Memory: 29716KB available (906K code, 215K data, 44K init)
Dentry cache hash table entries: 4096 (order: 3, 32768 bytes)
Inode cache hash table entries: 2048 (order: 2, 16384 bytes)
Mount cache hash table entries: 512 (order: 0, 4096 bytes)
Buffer cache hash table entries: 1024 (order: 0, 4096 bytes)
Page-cache hash table entries: 8192 (order: 3, 32768 bytes)
CPU: Testing write buffer: pass
POSIX conformance testing by UNIFIX
Linux NET4.0 for Linux 2.4
Based upon Swansea University Computer Society NET3.039
Initializing RT netlink socket
Starting kswapd
pty: 256 Unix98 ptys configured
RAMDISK driver initialized: 16 RAM disks of 8192K size 1024 blocksize
usb.c: registered new driver usbdevfs
usb.c: registered new driver hub
ttyS0 at MMIO 0xfefc4000 (irq = 7) is a AT91_SERIAL
ttyS1 at MMIO 0xfefc8000 (irq = 8) is a AT91_SERIAL
ttyS2 at MMIO 0xfefff200 (irq = 1) is a AT91_SERIAL
host/usb-ohci.c: USB OHCI at membase 0xc2800000, IRQ 23
usb.c: new USB bus registered, assigned bus number 1
hub.c: USB hub found
hub.c: 2 ports detected
NET4: Linux TCP/IP 1.0 for NET4.0
IP Protocols: ICMP, UDP, TCP
IP: routing cache hash table of 512 buckets, 4Kbytes
TCP: Hash tables configured (established 2048 bind 2048)
NetWinder Floating Point Emulator V0.97 (double precision)
RAMDISK: Compressed image found at block 0
Freeing initrd memory: 1494K
VFS: Mounted root (minix filesystem).
Freeing init memory: 44K
INIT: version 2.74 booting
IP=
ipaddree info: No IP configuration in EEPROM
hub.c: new USB device at91-2, assigned address 2
usb.c: USB device not accepting new address=2 (error=-110)
INIT: Entering runlevel: 3
hub.c: new USB device at91-2, assigned address 3
usb.c: USB device not accepting new address=3 (error=-110)
Starting modutils Loading modules:
af_packet - mii - eth0: Link now 100-FullDuplex
eth0: AT91 ethernet at 0xfefbc000 int=24 100-FullDuplex (02:80:ad:20:9b:be)
eth0: Davicom 9196 PHY (Copper)
```

```
at91_ether - mtdcore - mtdpart - mtdchar - mtdblock - chipreg - gen_probe - ↵
cfi_cmdset_0001 - cfi_probe - dnp9200 - Probing DNP9200 flash at physical ↵
address 0x10000000 (16-bit buswidth)
cfi_cmdset_0001: Erase suspend on write enabled
Using buffer write method
Using static partition definition
Creating 4 MTD partitions on "DNP/9200 flash":
0x00000000-0x00040000 : "Bootloader"
0x00040000-0x00400000 : "Kernel"
0x00400000-0x00800000 : "Flash spare 1"
0x00800000-0x01000000 : "Flash spare 2"
scsi_mod - SCSI subsystem driver Revision: 1.00
sg - sd_mod - usb-storage - Initializing USB Mass Storage driver...
usb.c: registered new driver usb-storage
USB Mass Storage support registered.
zlib_deflate - zlib_inflate - jffs - JFFS version 1.0, (C) 1999, 2000 Axis ↵
Communications AB
jffs2 - JFFS2 version 2.1. (C) 2001 Red Hat, Inc., designed by Axis ↵
Communications AB.
fat - vfat -
Starting flash
Starting autoinit Init...
Starting network Configuring and Starting Network : lo eth0: Link now 100- ↵
FullDuplex
dhcpcd[123]: timed out waiting for a valid DHCP server response
eth0: Link now 100-FullDuplex
eth0
Starting inetd:  inetd
Starting httpd
Starting autostart Starting...

- SSV Embedded Linux - Version 0.50
emblinux login:
```

Please note: This symbol "↵" shows that the following line belongs to the previous line.

HELPFUL LITERATURE

Atmel AT91RM9200 data sheet summary
Atmel AT91RM9200 user guide
ARM ARM926EJ-S technical reference manual
ARM ARM9EJ-S technical reference manual
DIL/NetPC DNP/9200 hardware reference manual (SSV Starter Kit item)

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DOCUMENT HISTORY

Revision	Date	Remarks	Name
1.0	2005-12-09	first version	WBU

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