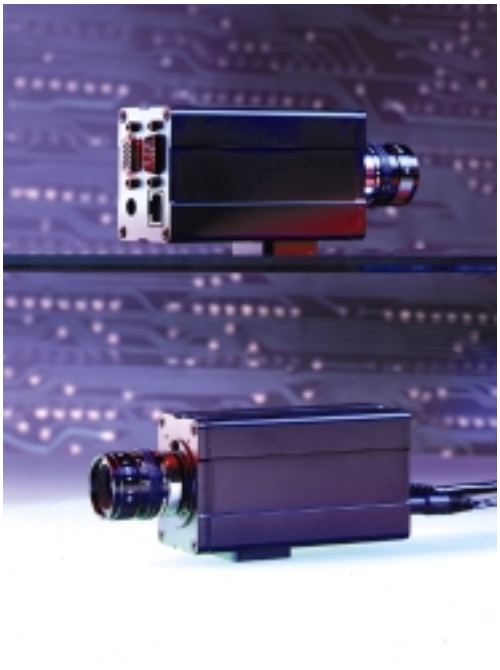
miniHiPerCam



Hardware Manual

Revision 1B

ELTEC
elektronik mainz

Revision History

Revision	Changes	Date
1A	First Edition, valid for Hardware revision 0A, 0B, 0C, 1A	07.09.99 GM
1B	Valid for Hardware 2A, 3A	26.10.99 GM/UW

WARNING ! This equipment generates and can radiate radio frequencies. If not installed in accordance with the instruction manual, it may cause interference to radio communications. The equipment has not been tested for compliance with the limits for class A computing devices, pursuant to subpart J of part 15 of FCC rules, which are designed to provide reasonable protection against such interference, but temporary usage is permitted as per regulations. Operation of this equipment in a residential area is likely to cause interference, in which case the user, at his own expense is required to take whatever measures may be required to shield the interference.

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ELTEC points out that there is no legal obligation to document internal relationships between any functional modules, realized in either hardware or software, of a delivered entity.

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1 Specification

1.1 Main Features

- Smart imaging system with camera module, local CPU, and connectivity.
- Operating system: Windows CE.
- CMOS imaging sensor.
- Intelligent camera with integrated camera sensor.
- Built-in hand-held PC.
- Real-time acquisition of images directly into memory for optimum CPU access.
- On-board frame grabber and graphics interface for video input/output.
- Video library 'el_Interface'.
- Standard camera size.

1.2 General Description

The miniHiPerCam is one of a growing number of intelligent cameras from ELTEC. It is a complete CMOS-based color matrix camera with an intelligent frame grabber together in a small housing.

The miniHiPerCam contains everything that is needed for image processing. A PowerPC CPU, peripherals optimized for embedded control applications, fast image and program memory, Flash EPROM, nonvolatile memory, video

output, connectivity via Ethernet or RS-232, and our proven professional frame grabber logic.

On-board I/O is intended to communicate with an external computer through the serial connection or two digital inputs and two digital outputs. The Ethernet interface can transfer images or image processing results for remote display or is used for software download. The on-board video interface drives an analog video output, supplied for adjustment purposes.

Video input data is stored in main memory (RAM) via an on-board DMA controller. It can store video data at video rates in several formats.

Video line pitch is the same as video line length to conserve memory - lines are tightly packed.

1.3 Mechanical Specification

The miniHiPerCam case has a small cross-section of 43,5 mm x 60 mm and a length of 96,5 mm, making it possible to stack several HiPerCams in space-constrained applications. The camera has a C-mount thread for lenses; all electrical connections are routed to the miniHiPerCam's back panel.

1.3.1 I/O

The PowerPC 823 handles all I/Os: serial, parallel (internal only for OS debug), real-time clock (without battery-backup), video output, and Ethernet.

Type	Number of I/Os	Format (electrical)	Data rate
I/O	2 in + 2 out	TTL opto-coupled (24V)	1us/IO
Ethernet	1	10BaseT	10 Mb/s
Video	RGB	VGA	25 MHz
Serial	1 line	RS 232	300 bps .. 115 kbps

Table 1-1: Video out with VGA Standard (8 bit/pixel color).

1.3.2 I/O Mechanical

Connector	conn. type	Signals
serial I/O	9-pin D female	RS232 serial
Power	Power	+12V in
Video out, digital I/O	15-pin 3-row D (VGA)	Video out, Hsync out, Vsync out, 2 in , 2 out
Ethernet	RJ45	10BaseT

Table 1-2: Connectors

1.4 Technical Details

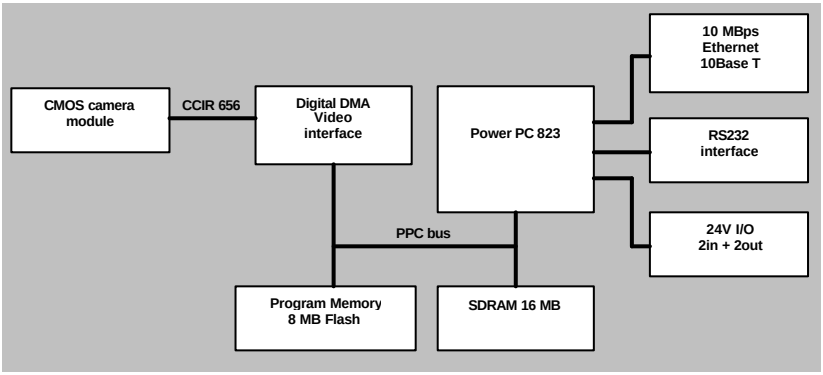

Figure 1-1: Block Diagram

1.4.1 CPU

The miniHiPerCam CPU chip is a member of the PowerPC family of RISC processors. It is a full PowerPC with on-chip peripherals optimized for embedded control.

The CPU on the miniHiPerCam is the Motorola PowerPC 823 controller.

CPU	PPC 823
Compatibility	Windows CE, PowerPC
Clock	50 MHz
Power consumption	0,7 W
Bus	32-bit, 50 MHz
On-chip I/O	Serial, parallel, Ethernet
On-chip cache	1k + 2k

Table 1-3: CPU

The MPC823 is a 32-bit RISC embedded controller with a specific implementation of the PowerPC architecture. The MPC823 consists of a highly pipelined processor core and several peripheral interface units as DMA controller, serial interface, asynchronous interrupt controller and programmable interval and watchdog timers.

1.4.2 Power Supply

The power supply for the miniHiPerCam must deliver 8V to 24V with a minimum output power of 5W. The plug must have a diameter of 5.0mm to 5.5mm and a hole for a 2.1mm pin. The inner contact must be connected the negative pole.

To avoid shortcuts it is strongly recommended that the power supply has no internal connection to ground.

The miniHiPerCam is protected by a diode against reverse polarity of the power supply. Reversed polarity will neither damage the miniHiPerCam nor the power supply.

1.4.3 Video Output

The video output of the miniHiPerCam is 640x480 with 60Hz refresh rate. It can display 256 out of 4096 colors. The video timing is rather close to the VGA standard so that it can be displayed with all VGA monitors. The video interface has a 256x12bit LUT. The 6 least significant bits of the LUT are connected to the 6 least significant bits of the three DACs. The 2 most significant bits of the LUT are connected to the 2 MSBs of the blue DAC, the next 2 bits of the LUT with the 2 MSBs of the green DAC, and the next 2

with the 2 MSBs of the red DAC. This scheme allows to display 256 grey levels or 64 colors.

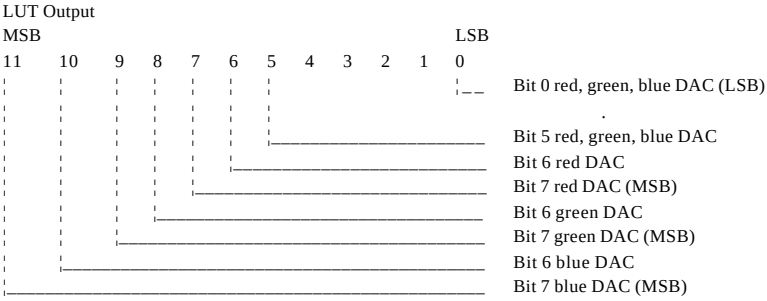

Table 1-4: Video LUT

Number	Output		
0	0/255 grey (black)		
1	1/255 grey		
'	'		
240	240/255 grey		
241	0% red	0% green	25% blue (dark blue)
242	0% red	25% green	0% blue (dark green)
243	0% red	25% green	25% blue (dark cyan)
244	25% red	0% green	0% blue (dark red)
245	25% red	0% green	25% blue (dark magenta)
246	25% red	25% green	0% blue (dark yellow)
247	75% red	75% green	75% blue (light grey)
248	50% red	50% green	50% blue (grey)
249	0% red	0% green	75% blue (blue)
250	0% red	75% green	0% blue (green)
251	0% red	75% green	75% blue (cyan)
252	75% red	0% green	0% blue (red)
253	75% red	0% green	75% blue (magenta)
254	75% red	75% green	0% blue (yellow)
255	100% red	100% green	100% blue (white)

Table 1-5: Default LUT Setup

Colors 241 to 255 are similar to the VGA colors.

To save power and bus bandwidth it is recommended to disable the video output when it is not used.

1.4.4 Digital I/O

The miniHiPerCam features two optoisolated inputs and two optoisolated outputs. The outputs are open collector type and can sink up to 120mA current.

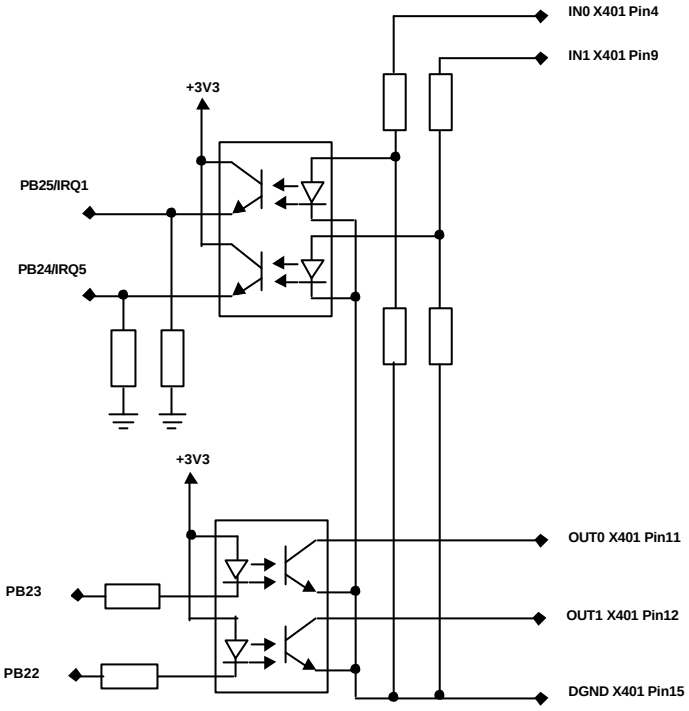

Figure 1-2: miniHiPerCam Digital I/O

Output:				
Characteristic	Min.	Typ.	Max.	Unit
Output Voltage	0		50	V
Output Current	-		120	mA

Input:				
Characteristic	Min.	Typ.	Max.	Unit
Input Voltage low	-27		+6	V
Input Voltage high	+16		+27	V
Input Current at +24V	-		11	mA

I/O:				
Characteristic	Min.	Typ.	Max.	Unit
Offset to Ground	-		50	V
Turn on Time		5		uS
Turn off Time		80		uS

Table 1-6: Digital I/O Characteristics

1.4.5 Memory / File system

The miniHiPerCam main memory consists of dynamic memory for programs, data and images. A boot EPROM contains the complete operating system Windows CE.

Memory	**Size**
Boot Flash PROM	8 MB Flash (16-bit)
RAM	16 MB 3.3V SDRAM, 32-bit.

Table 1-7: Main Memory

1.4.6 DRAM

The main memory of the miniHiPerCam has a size of 16 Mbytes consisting of two 64 Mbit SDRAM chips. The memory timing is 5,1,1,1+1 for read and 3,1,1,1 for write bursts. This results in a bandwidth of 88 Mbytes/s for read and 133 Mbytes/s for write.

1.4.7 Flash EPROM

There are 8 Mbytes Flash EPROM installed on the miniHiPerCam. It holds the basic firmware for system initialization, booting, and configuration. After reset the Flash EPROM is mapped to $0000.0000.

Since the Flash EPROM is only 16 bit wide, one burst read of the CPU lasts about 1.6 us. I.e. the CPU bus is blocked for 1.6 us for every burst read. It is strongly recommended not to execute code out of the EPROM when the acquisition and the video output are enabled.

1.4.8 Video Capturing Modes

Two capturing modes are supported by the miniHiPerCam.

1.4.8.1 Snap:

The next frame is stored in the memory at one of two selectable addresses.

1.4.8.2 Live:

The next frames are stored in the memory at one of two selectable addresses until acquisition is stopped.

1.4.9 Lens Adjustment

To adjust iris and focus of the lens it is recommended to connect a VGA monitor to the video output of the miniHiPerCam and to enable live acquisition in Y only mode. This results in a live b/w picture on the video output.

1.4.10 Address Map

The CPU has programmable address decoders for all devices of the miniHiPerCam. Therefore the addressmap completely depends on the operating system used.

1.5 Connectors

Pin	VGA connector DB15
1	Red video output
2	Green video output
3	Blue video output
4	Digital input 0
5	Ground
6	Ground
7	Ground
8	Ground
9	Digital input 1
10	Ground
11	Digital output 0
12	Digital output 1
13	Horizontal sync out
14	Vertical sync out
15	Digital Ground

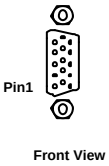

Table 1-8: VGA Connector (DB15 female)

Pin	Serial connector DB9
1	DCD
2	Receive data
3	Transmit data
4	DTR
5	Ground
6	DSR
7	RTS
8	CTS
9	RIC

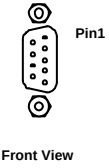

Table 1-9: Serial Connector (9-Pin D-Sub, male)

Pin	Ethernet connector RJ45
1	+Tx
2	-Tx
3	+Rx
4	-
5	-
6	-Rx
7	-
8	-

Table 1-10: Ethernet Connector (RJ45 Jack)

1.6 System Parameters

1.6.1 Environmental Conditions

- Storage Temperature:
  -25 ° C to +85 ° C
- Operating Temperature (case surface temperature):
  0 ° C to + 60 ° C (non condensing)
- Maximum Operating Humidity:
  85% relative

1.6.2 Power Requirements

- Input voltage range 8 V ... 24 V DC (stabilized, ripple <10%)
- Typ. 300 mA at 12 V, max. 450 mA
- Typ. 3,5 W, max. 5 W

1.6.3 Dimensions

- 43,5 mm x 60 mm x 96,5 mm (without lens, tripod attachment, protrusion of connectors at back panel)
- Weight:
  approx. 350 g

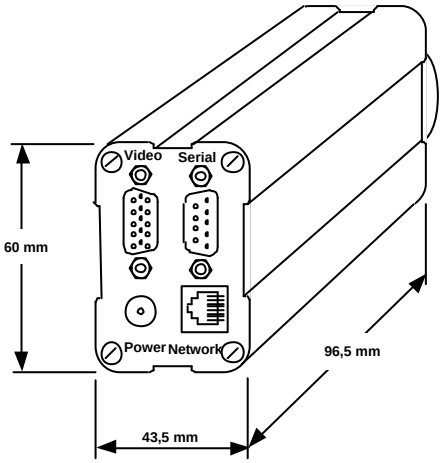

Figure 1-3: Dimensions

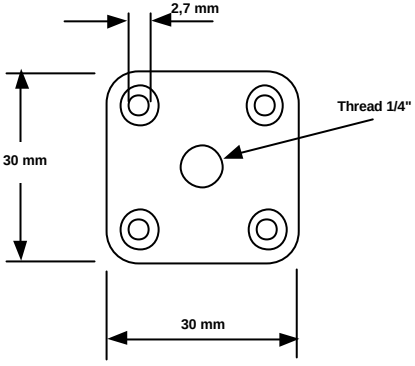

Figure 1-4:Tripod Attachment

1.6.4 Regulations/Compliance

CE: EN 50082-2

EN 55022

(unless otherwise noted)

1.7 Image Sensor

Currently one image sensor is supported by the miniHiPerCam: The OmniVision OV7610 color sensor. The device is a complete camera with digital interface supporting various data formats. It is controlled via a I2C interface.

The digital data are transferred via busmaster DMA into the main memory of the miniHiPerCam.

Resolution	**640 x 480**
Pixel Size	8.4um x 8.4um
Frame Rate	30 Hz
Scan Mode	Progressive Scan
Minimum Illumination	3 lux @ f1.4
S/N Ratio	36 dB
Data Format	YCrCb 4:2:2 GRB 4:2:2 RGB 565 Y only (b/w)

Table 1-11 OV7610 Sensor Characteristics

2 Operating System

The operating system running on this camera is Windows CE 2.12. The Windows CE image is stored in flash and is launched by the bootloader.

2.1 Flash File System

The flash memory is divided into two parts. The first part (typically 2 MB) is used as flat flash memory. This memory is only used for the bootloader and a emergency version on the kernel and not available for the user.

The rest of the flash memory is used for a flash file system. This file system is seen as FAT file system under Windows CE. So data can be stored into flash permanently by simply writing files with the Win32 file I/O functions.

As the WinCE kernel is stored in flash file system too, approximately 4,5 MB are free for user data.

2.2 Bootloader

The bootloader is the first piece of code started at power on. It does the basic hardware initialization and read some data from the eeprom. Then is sets up the serial port and looks for WinCE images in the flash file system. If there is more than one image, it shows a menu, so that the user can select one. After a timeout the first one found is started.

If there is no image in the flash file system the emergency version is started. If even this version is missing, the bootloader displays a message and runs into a endless loop.

2.3 Updates

Starting a kernel from the flash file system by the bootloader makes updating the kernel simple. When WinCE is running a new version can be copied to the flash file system from a host computer overriding the old one. After reboot the new kernel is started.

It is ensured that the emergency kernel can do this job too, even if it may be an older version.

2.4 Registry

Windows CE uses a registry like e.g. Windows 98. This registry is part of the kernel image. All changes to the registry by the Win32 routines are lost after reboot, if the registry is not stored permanently.

The registry can be stored to the flash file system with a single routine provided in the SDK. The bootloader copies it to RAM where it is loaded by the WinCE kernel.

For details concerning the bootloader and the SDK see the documentation provided on the SDK CD.

3 Installation

3.1 First Steps

- Carefully remove the camera from the shipping carton.
- Save the original shipping container and packing material for storing or reshipping the camera.
- Inspect the camera for any shipping damage. If undamaged, the camera can be prepared for system installation.
- Connect the miniHiPerCam as shown in Figure 3-2
  - Connect the serial 1 interface to your terminal/host.
  - Connect the miniHiPerCam via 10BaseT to your host.
- Configure the host and the miniHiPerCam as described in Section ‘3.3 Bootloader Configuration‘

3.2 Connect the miniHiPerCam to the Host

To setup the boot parameter or work with the serial shell the miniHiPerCam must be connected to a terminal via a serial null modem cable. To access the miniHiPerCam over a network, a network cable must be connected.

The miniHiPerCam can be directly connected to the host via a special crossed 10BaseT network cable. So, no hub is necessary for a point - to point connection.

It a connection orer a hub is used (Fig. 3-3) you have to use 10BaseT standard cable. The configuration of the PC network card to 10BaseT is necessary.

A video monitor should be connected to the miniHiPerCam. After power-on a live image can be seen on the monitor.

Before starting the miniHiPerCam make sure that the configuration of the host and the miniHiPerCam is correct. Therefore refer to Section ‘3.3 Bootloader Configuration‘.

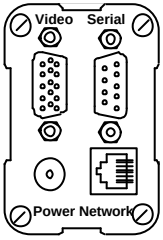

Figure 3-1: Location of Connectors on the Back Panel

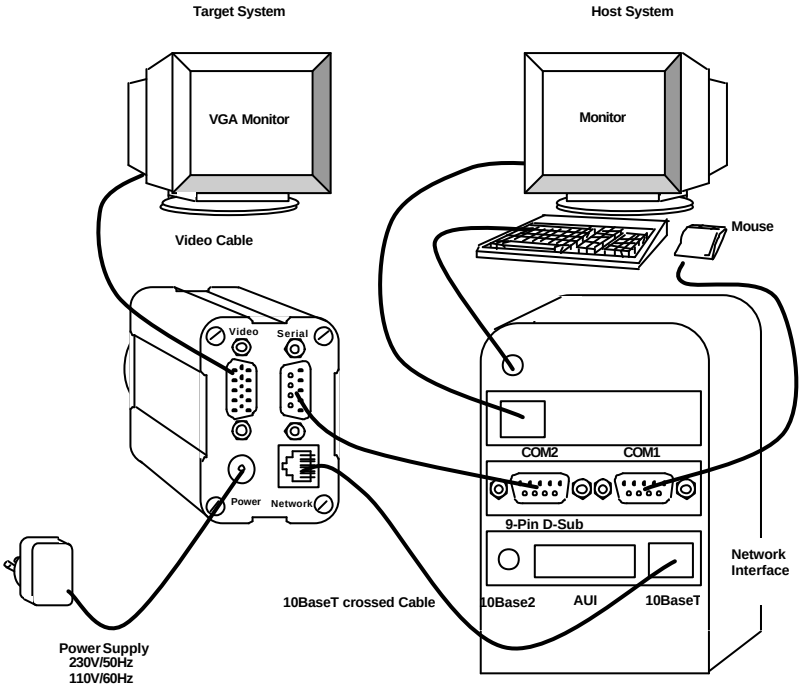

Figure 3-2 Connecting miniHiPerCam to Host (without Hub)

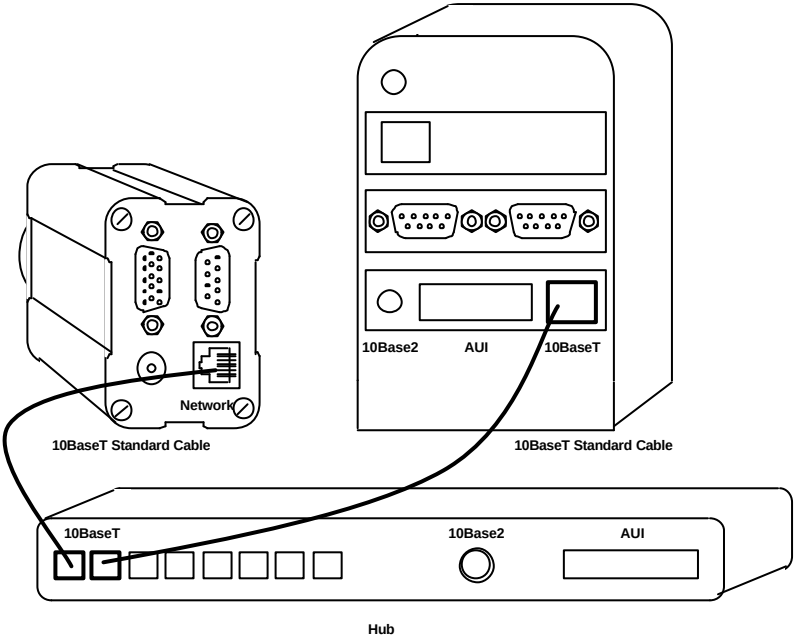

Figure 3-3 10BaseT Hub Network Connection

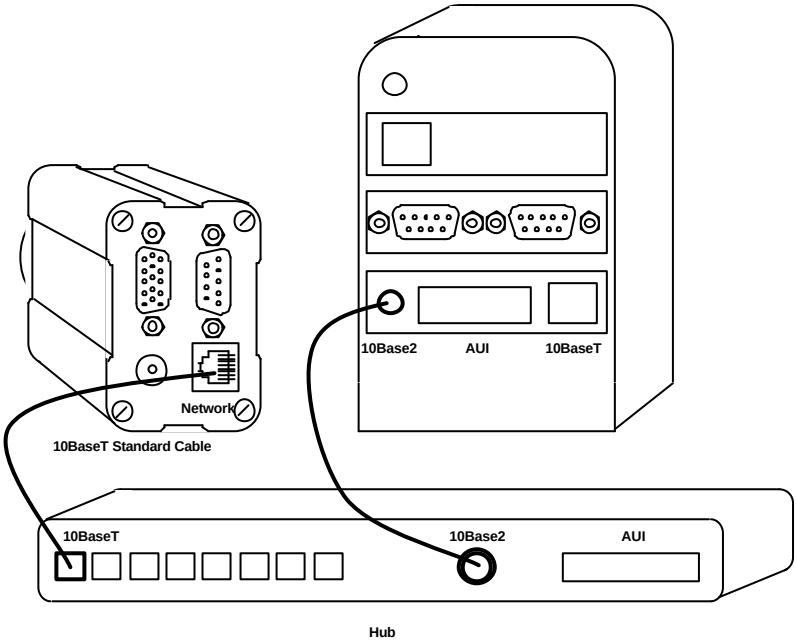

Figure 3-4 10BaseT/10Base2 Hub Network Connection

Take care that the 10Base2 network connection is correctly terminated at both ends.

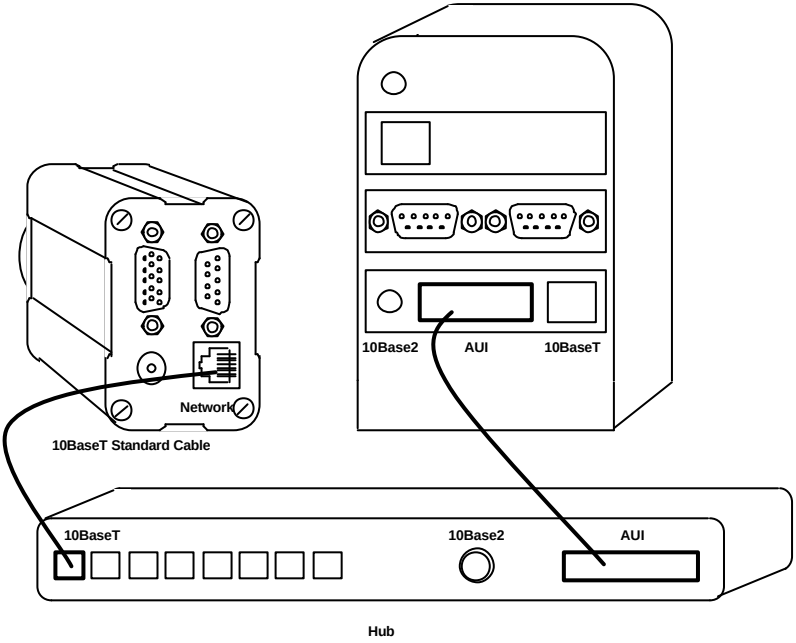

Figure 3-5 10BaseT/AUI Hub Network Connection

3.3 Bootloader Configuration

It is important to set up the miniHiPerCam properly before using it the first time. Setup your terminal to use a 38400 baud connection with 8 data bits, 1 stop bit, no parity and no flow control. Starting the miniHiPerCam your terminal output should look like this.

```
miniHiPerCam bootloader V1.3 ( Tue Aug 31 16:36:56 1999 )

Available kernels

0: packed WinCE kernel

Hit any key to enter setup .....
```

Stop the bootloader from launching WinCE by pressing the space bar. Now a prompt is shown and you can change some bootloader options. Type "help" to see them.

```
mHPC_Boot > help

quit                : quit the bootloader and start WinCE

Available commands

eeDump              : dump contents of the EEProm
revisionInfo        : show revision info
bootPara            : change boot parameter
cesh                : start serial download with cesh
launchFixed         : launch the image which is stored
                      directly in flash, not in flash file system

For further information see documentation.

mHPC_Boot >
```

revisionInfo

This command shows the serial number, network node id, revision information and the layout of the flash file system. The user is not able to change these settings.

mHPC_Boot > revisionInfo

Revision info	=	V-MHPC-100A
Serial number	=	195173
NodeID	=	00005B004B54
Sensor	=	0 (Omnivision Color)
Revision	=	0.B
WinCE image start	=	0x2900000
Flash file system start	=	0x2A00000
Flash file system length	=	0x600000
Registry buffer start	=	0x0
Registry buffer length	=	0x0

bootPara

This command is used to setup the network.

mHPC_Boot > bootPara

Device name	=	mHPC ?
IP address	=	0.0.0.0 ?
Subnet mask address	=	0.0.0.0 ?
Wins server	=	0.0.0.0 ?
DNS server	=	0.0.0.0 ?
Gateway	=	0.0.0.0 ?

Use DHCP server (Y/n) ?

Start serial shell (Y/n) ?

Baudrate 115200 instead of 38400 (y/N) ?

The settings above are default. To change them just enter new values. Entering no value and hitting "enter" will leave the values unchanged. "(Y/n)" means that current setting is "yes".

By default the miniHiPerCam uses a DHCP server to get an IP address. If you have no DHCP server, you can enter a ethernet address and a corresponding subnet mask.

If your network has a DNS or Wins server or a gateway you can enter their address too.

The default baud rate is 38400 baud. You can change it to 115200.

The "serial shell" is a program which is started automatically by WinCE. This shell is the only possibility to "talk" to the minHiPerCam as it has no keyboard or monitor. When your application is ready and started automatically too, you can avoid the serial shell to be loaded by changing the above option.

launchFixed

This command can be used to launch the WinCE *emergency* image. This may be necessary if the image in flash memory is corrupted. Nevertheless the *emergency* image is not guaranteed to be a current one.

The *emergency* image never uses a stored registry.

cesh

Using this command, an image can be downloaded over the serial port. This is the very last help, if the *emergency* image can not be started. As you need additional tools which are not provided on the SDK CD to do this download ask the ELTEC support for help.

eeDump

This command shows the contents of the eeprom. This is needed for support purposes only.

After doing all changes needed, type "quit" to leave the bootloader and start Windows CE.

quit

This command leaves the bootloader and starts WinCE.

3.4 Cmd Shell

If the serial command shell is not disabled in the bootloader, it is started automatically. The image below shows an example of a boot process.

miniHiPerCam bootloader V1.3 (Tue Aug 31 16:36:56 1999)

Available kernels

0: packed WinCE kernel

Hit any key to enter setup

Registry image found: 9427 bytes

Starting packed WinCE kernel from flash file system

Uncompressing ... 1636263 bytes

Going to launch WinCE image at 0x13868!

Windows CE Kernel for PowerPC Built on Apr 19 1999 at 21:18:00

ELTEC init V1.1 (Tue Aug 31 16:35:56 1999)

EL-Shell >

The serial shell is written by ELTEC. See the online help shipped on the SDK CD for details. Here we will only show some commands needed to verify proper network connection.

The command "gethostname" show the network address of the miniHiPerCam.

EL-Shell > gethostname

Hostname: mHPC IP: 194.0.0.158

This is an example of a proper network address. If the network address "127.0.0.1" is shown, the miniHiPerCam was configured to use a DHCP server, but no proper address was obtained.

The program "ping" can be used to test, if a remote computer can be found. You must use network addresses, not computer names.

EL-Shell > run -w ping 194.0.0.150

Pinging Host [194.0.0.150]

Reply from 194.0.0.150:Echo size=32 time=5ms TTL=128

Reply from 194.0.0.150:Echo size=32 time=2ms TTL=128

Reply from 194.0.0.150:Echo size=32 time=2ms TTL=128

Reply from 194.0.0.150:Echo size=32 time=2ms TTL=128

Of course the miniHiPerCam can be "pinged" from the outside.

The shell command "nc" can be used to connect a network drive on a remote computer.

EL-Shell > nc \\computer\remote_directory as_directory username password

In this example the shared directory "remote_directory" on the PC "computer" is mapped with the name "as_directory". The name "username" and the password "password" are used to authorize. The remote directory is mounted under the directory "\Network". Use the "dir" command to see files on the remote system.

EL-Shell > dir \network\as_directory*.*

3.5 Connect to the miniHiPerCam Webserver

By default a webserver is started on the miniHiPerCam. This server is described in detail in the online help.

With help of this webserver the miniHiPerCam sensor can be configured and images can be transfered over the network with a browser.

The start page of configuration program is

http://194.0.0.158/flashfx/confhtml/index.htm.

Of course the network (IP) address must be changed.

Connect to this site. On the third screen you see a configuration form. If everything is connected correctly, you must be able to see an image.

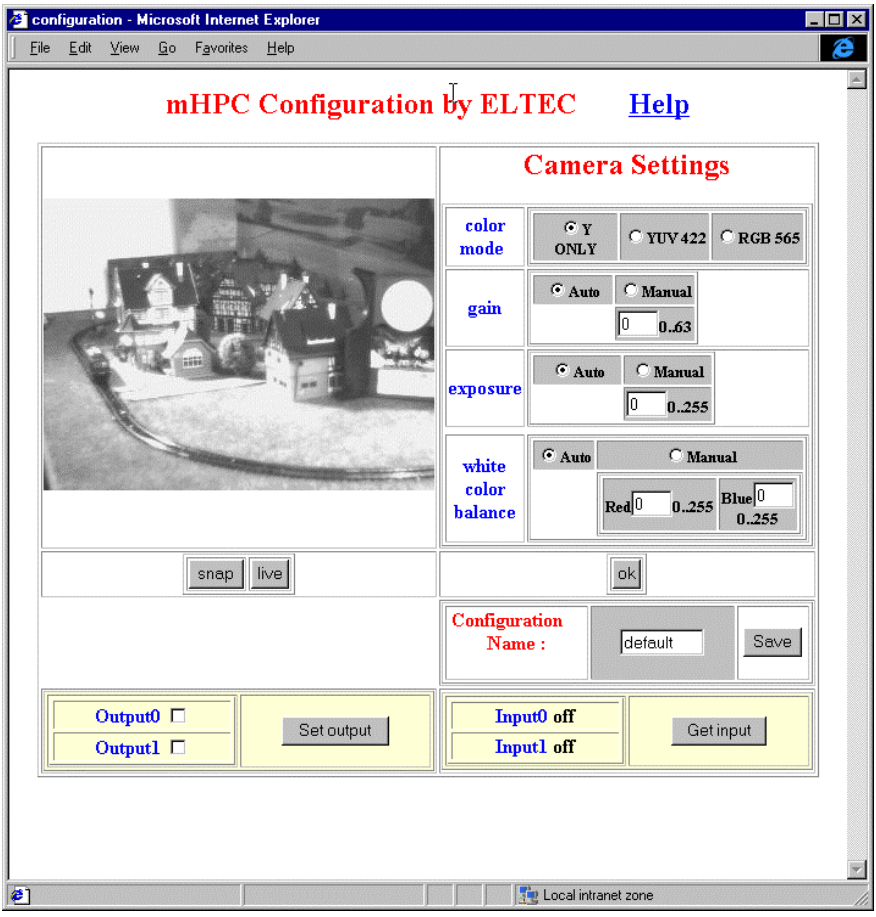

Figure 3-6: mHPC Configuration

3.6 Software Development

To develop applications for the miniHiPerCam you need a Visual C++ compiler and a toolkit for Windows CE.

A detailed description and sample programs come with the SDK CD.

3.7 Troubleshooting

If the miniHiPerCam does not work properly or you have questions about programming please contact the ELTEC support (support@eltec.com).

Before calling the support for help, please have a look at the documentation and prepare some information about the miniHiPerCam.

You can gather the following information in your terminal program, copy the output and send it as email or fax to the ELTEC support.

3.7.1 Bootloader Version

First boot the camera and enter the bootloader by hitting any key. If you do not see any output, you may not have connected the serial output properly to your modem. Try baud rates 115200 and 38400.

The bootloader version is the first output:

miniHiPerCam bootloader V1.4 (Thu Sep 9 20:25:42 1999)

3.7.2 Revision Information

When the bootshell is entered type "revisionInfo".

mHPC_Boot > revisionInfo

Revision info	= V-MINIHIPERCAM-100A
Serial number	= 195173
NodeID	= 00005B004B54
Sensor	= 0 (Omnivision Color)

Revision = 0.C

WinCE image start = 0x2900000

Flash file system start = 0x2A00000

Flash file system length = 0x600000

Registry buffer start = 0x0

Registry buffer length = 0x0

3.7.3 Boot Parameters

Type "bootPara" to show the boot parameters. Just hit "enter" for each entry to leave the values set.

miniHiPerCam_Boot > bootPara

Device name = mHPC ?

IP address = 194.0.0.158 ?

Subnet mask address = 255.255.255.0 ?

Wins server = 0.0.0.0 ?

DNS server = 0.0.0.0 ?

Gateway = 0.0.0.0 ?

Use DHCP server (y/N) ?

Start serial shell (Y/n) ?

Baudrate 115200 instead of 38400 (Y/n) ?

3.7.4 Kernel Version

Just enter "quit" to leave the bootloader and start WinCE.

A sample output is shown below.

mHPC_Boot > q

Really quit (Y/n) ?

Bye !

No registry image found

Starting packed WinCE kernel from flash file system

Uncompressing ... 1806011 bytes

Going to launch WinCE image at 0x13868!

Windows CE Kernel for PowerPC Built on Jun 14 1999 at 17:58:50

ELTEC init V1.2 (Fri Sep 10 11:14:30 1999)

3.7.5 Registry Contents

You can use the program "regdump" to dump the contents of the registry.

EL-Shell > run -w regdump.exe

Regdump (c) 1995 Microsoft - Registry dump utility

HKEY_CLASSES_ROOT

HKEY_CURRENT_USER

[ControlPanel]

...

3.7.6 Flash File System Contents

Use "dir" to display the contents of the "flashfx" directory

EL-Shell > dir \Flashfx\

09/10/1999 13:04:40 878660 nk.gz

Gathering this information will help to save time solving your problems.

Notes:

Notes:

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