Mini2440 Hardware Essentials

Industrial ARMWorks www.friendlyarm.us

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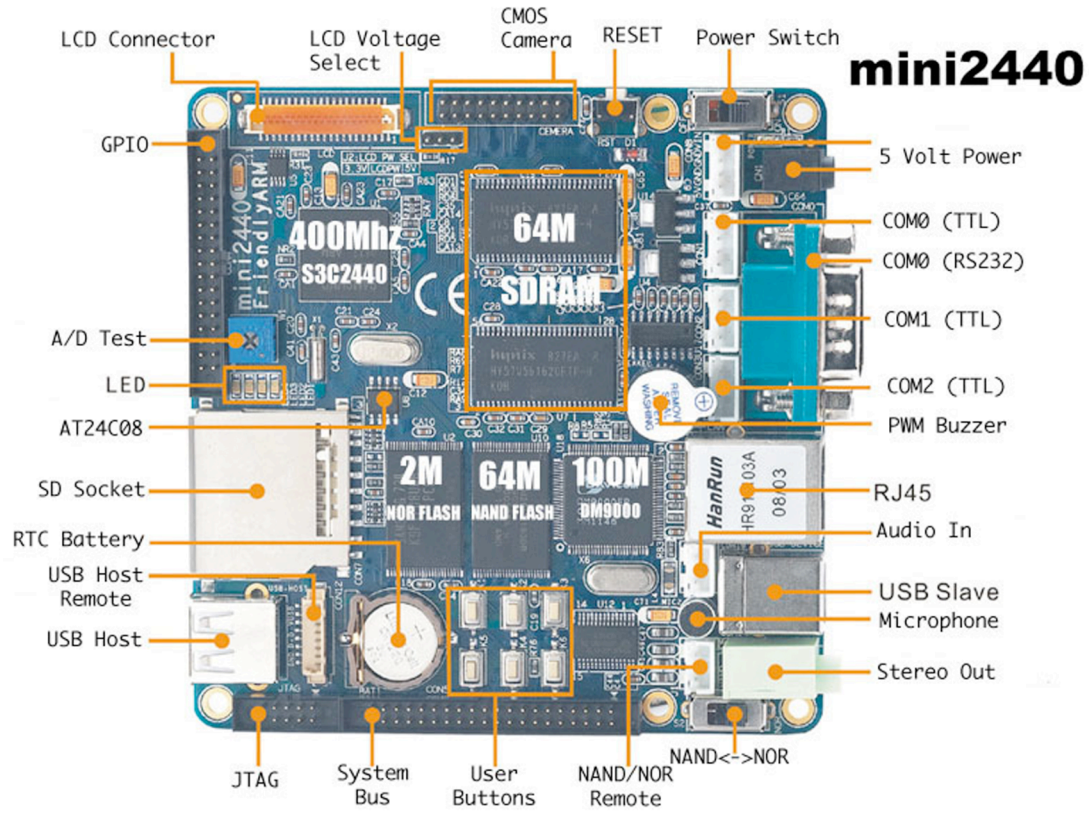
MINI2440 Introduction

The mini2440 is a practical low-cost ARM9 Single Board Computer (SBC) with a very high performance/cost ratio. With the Samsung S3C2440 microprocessor and the use of professional layout and quality peripheral chips, it is very robust. The Mini2440 uses a four-layer board design with gold immersion processing, and has high quality equal-length bus routing in timing critical areas. The production environment and quality control are the same as those of modern high-speed motherboards.

MINI2440 Component Side



MINI2440 features and hardware resources

Processor - Samsung S3C2440A, 405MHz (Max 533Mhz)

RAM On-board 64M SDRAM
32bit data bus
clock frequency up to 100MHz

FLASH storage
128Mbytes (64Mbytes) Nand Flash
2MBytes Nor Flash with installed BIOS

LCD Interface
4-wire Resistive Touch Panel interface -- 10 bit A/D
Supports 4 and 16 level gray-scale, 256 color, 4096 color STN LCD
screen size from 3.5 inch to 12.1 inch
screen resolution up to 1024x768
Support 4 and 16 level gray-scale, 256 color, 64K color, True Color TFT LCD
screen size from 3.5-inch to 12.1-inch
screen resolution to 1024x768 pixels
Standard configuration for the NEC 240x320/3.5-inch TFT true color LCD with Touch Panel
Leads to a 12V power supply on-board interface, for the large-size TFT LCD 12V CCFL backlight module (Inverting) Power supply.

Interface and resources
1 10/100M Ethernet RJ-45 interface (DM9000 network chip)
3 serial ports - one configured for RS-232, COM0
1 USB Host
1 USB Slave B-type interface
1 SD card storage interface, no size limit
1 Channel Stereo audio output interface,
1 Built in microphone
1 Microphone input.
1 2.0mm pitch 10-pin JTAG interface
4 USER LEDs
6 USER buttons (with connection to GPIO connector and 8 pin user connector)
1 buzzer PWM control
1 adjustable resistor for A/D test
1 IIC bus AT24C08 chip for IIC Bus Test or configuration data, holds 256 bytes.
2.0 mm pitch 20PIN camera interface
Power Interface (5V), with power switch and indicator light

System Clock Source
Passive crystal
Internal real-time clock (with back-up lithium battery)

Expansion Interface
1 34 pin 2.0mm GPIO interface

1 40 pin 2.0mm system bus interface

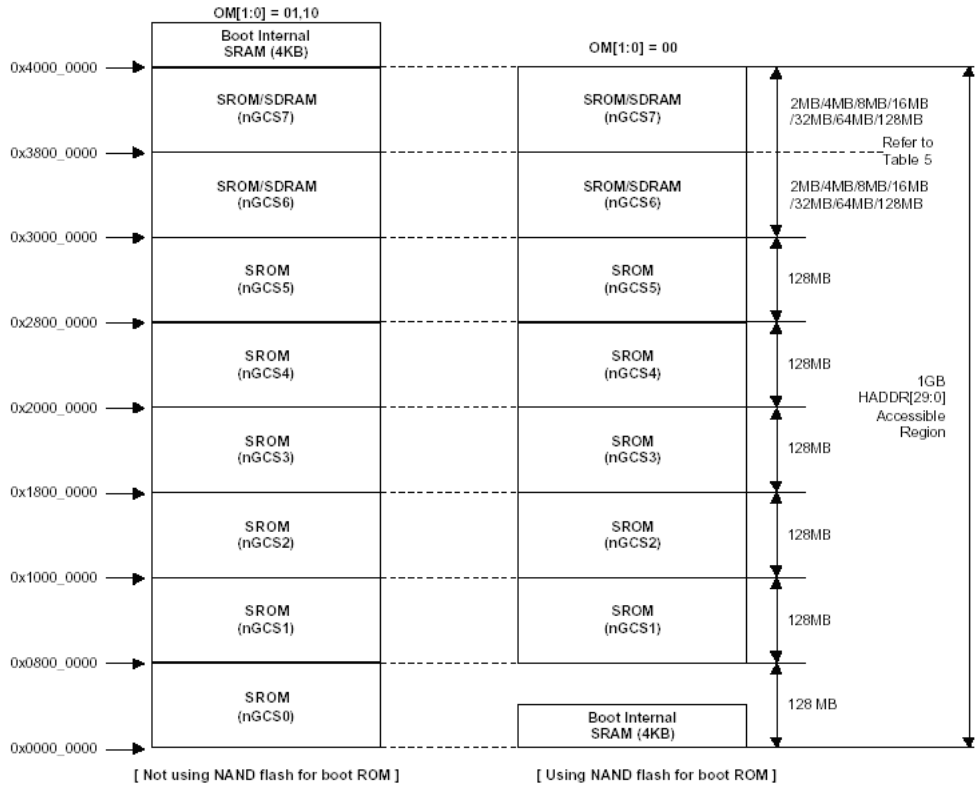
Size 100 x 100 (mm)

LCD Power Jumper

There is only one on-board jumper, J2. It is used to select the LCD driver board input voltage.
For NEC and Toppoly 3.5-inch LCD and 7" Innolux, set voltage selector for 5V.

Address space allocation and the definition of chip select signals

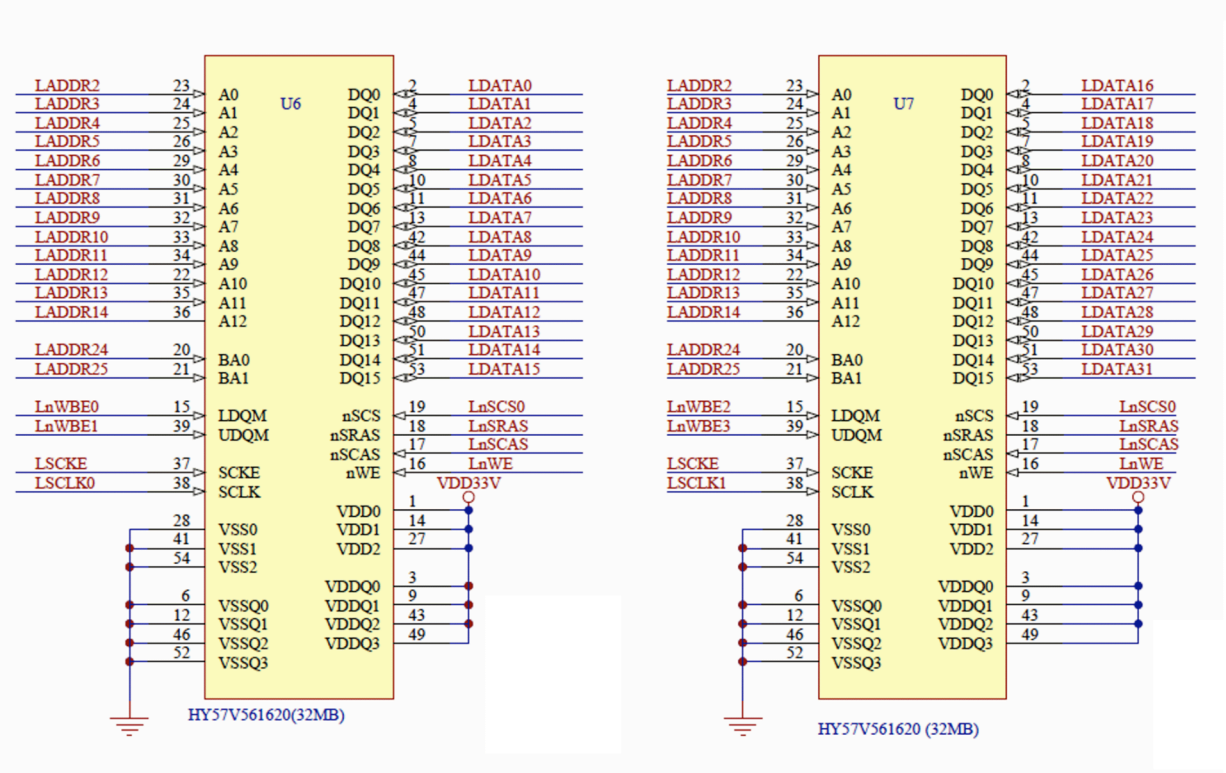
The S3C2440 supports two modes: Boot from NAND Flash or boot from NOR Flash.
The boot mode determines the configuration of the memory map as shown in this table.



When the NOR/NAND switch is in the NOR position, the system conforms to the memory map on the left. In the NAND position, the memory map on the right represents the start configuration.
Description: The SFR area is for special control register addresses.
In NAND Flash boot mode, the internal 4K Byte BootSram section is mapped to the nGCS0 space.
In Nor Flash start mode nGCS0 is connected to external memory. Nor Flash has been mapped to the chip select space nGCS0. SDRAM address space: 0x30000000 ~ 0x34000000

SDRAM storage systems

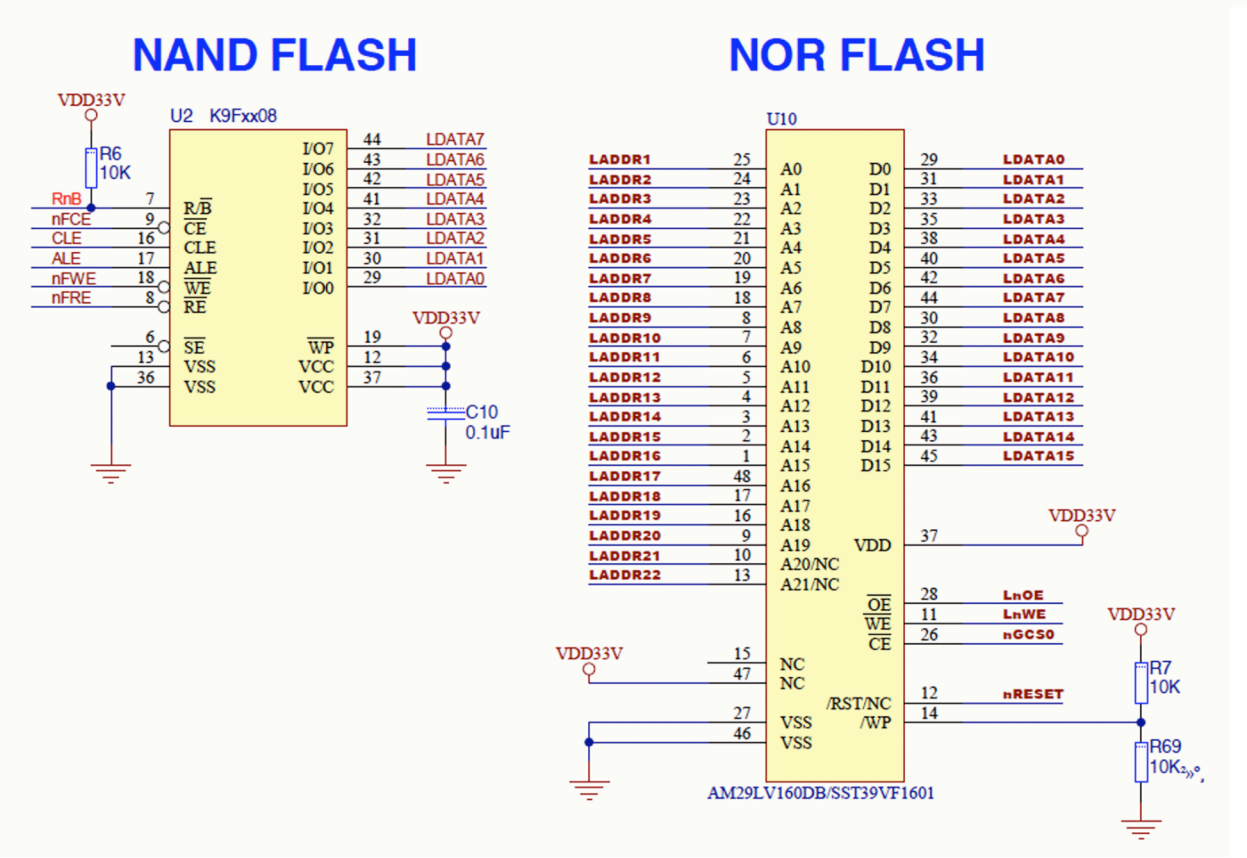
The Mini2440 two external SDRAM chips with a total of 32M bytes each or 64M bytes of with a full 32-bit data bus width for maximum speed. CPU chip select nGCS6 is used for the SDRAM which places it at address 0x3000 0000 (8 zeroes).



FLASH storage systems

The Mini2440 has two kinds of Flash, one is the 2MByte Nor Flash, model SST39VF1601 (For programming with JTAG you must check the Flash on your board. Manufactureres and model numbers cab vary). The other is the 64 (128, 256) MByte Nand Flash model K9F1208 (again, check before Flashinf with JTAG). The S3C2440 supports starting from either Flash. The slide switch, S2, chooses Nand or Nor. The Nor Flash uses A1-A22 for a total of 22 address lines. Why not A0? Because the memory is 1 word or two bytes (16 bits) wide and all access is on even numbered addresses. The smallest unit read is two bytes.

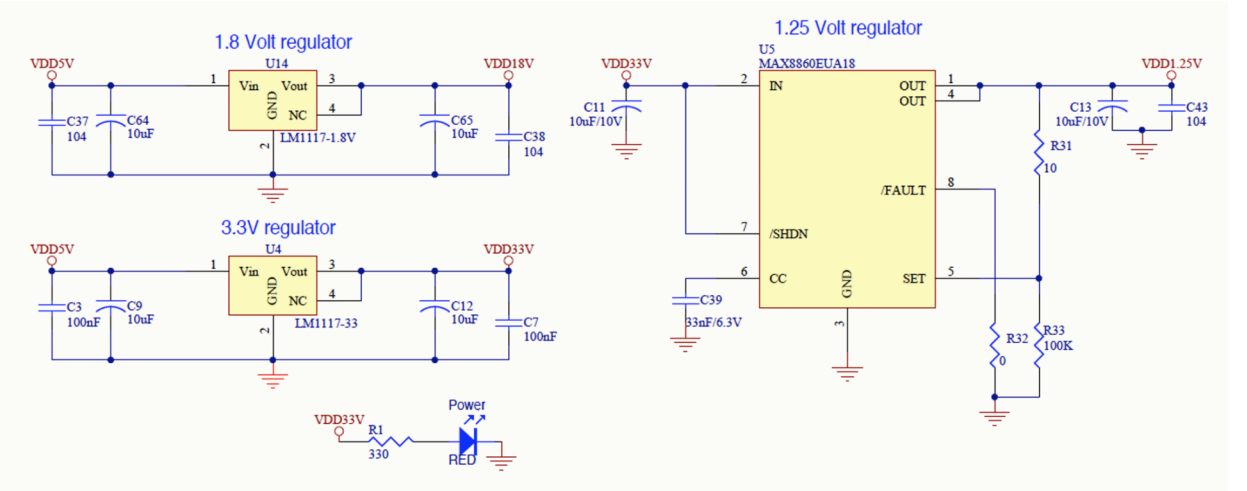
According to the schematic, the design could use a total of 8 Mbyte of Nor Flash. On the SST39V1601 chips, A20 and A21 have no connection, allowing 2 Mbytes of Nor flash. The NAND circuit allows up to 256 MByte chips without a design change.



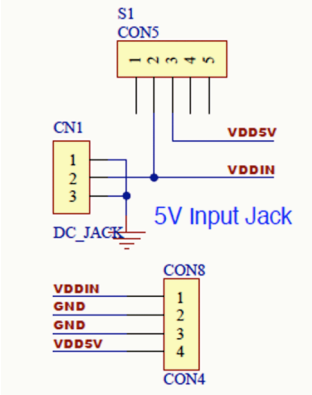
Power Supplies

The Mini2440's power supply system is rather simple and requires an external 5V power supply. Three regulators are used to generate: 3.3V, 1.8V, 1.25V.

Please note: The Mini2440 is not designed for handheld mobile devices, so it does not have full power management circuitry. The S1 DIP switch controls the system power and there is no provision for power control through software.

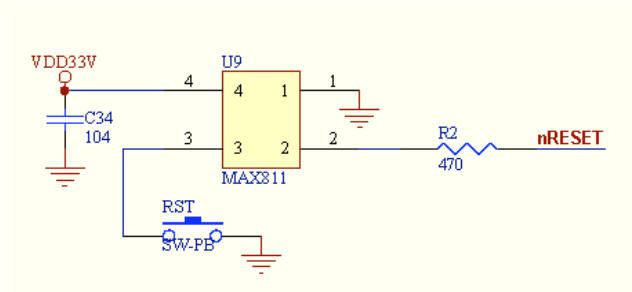


Most installations eventually need a power connection more permanent than a simple barrel jack. CON8 should be used to supply the 5V power. This 2.0mm pitch single row socket needs 5V on each outside pin and both inner pins are GND. Note that the two input voltages are not connected. VDDIN powers the on-board parts through the regulators. VDD5V goes to CON5, the system bus expansion connector.



System Reset

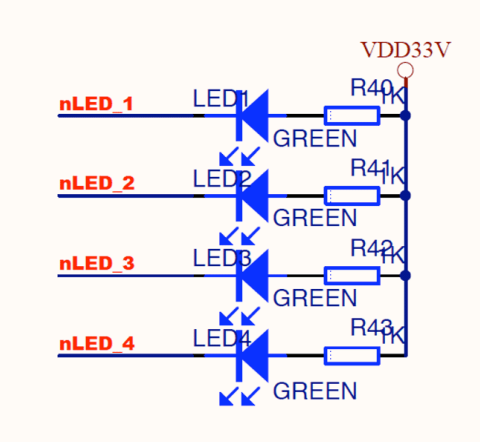
The Mini2440 conditions reset with the MAX811 reset chip to provide a clean low level reset to the CPU.



User LED

LEDs are commonly used for status indication. The Mini2440 has four user-programmable LEDs. They are connected to the S3C2440 GPIO lines and are active-low (light on when signal is low).

LED1	LED2	LED3	LED4
GPB5	GPB6	GPB7	GPB8



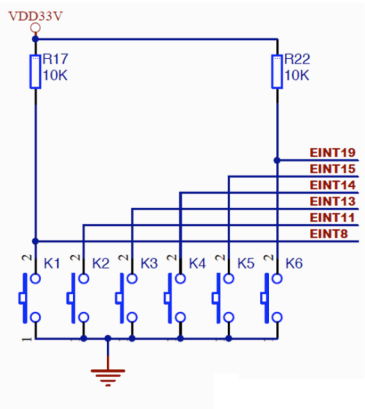
User buttons or keys

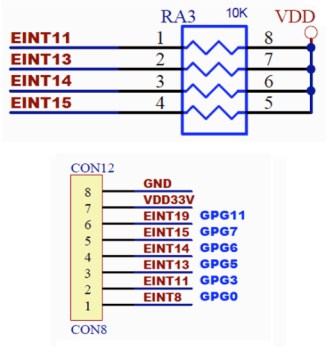
The user buttons are controlled by Port G, which can be used to assign several functions to the pins. The Mini2440 has a total of 6 user test buttons connected directly to the CPU interrupt pins. The active-low signals are held high by 10K resistors R17 - R22. Connector 12 has the same 6 user button signals with ground and VDD (3.3V). No external pull-up is needed. Pins 1 - 6 on Connector 12 are defined as K1 through K6 to match the on-board buttons. You can use more than one switch on each line.

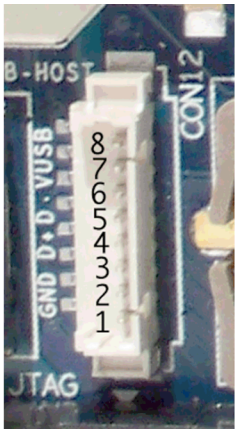
The 6 user buttons correspond to external interrupts EINT8 EINT11 EINT13 EINT14 EINT15 EINT19 and depending on resister settings, can also be set to GPIO GPG0 GPG3 GPG5 GPG6 GPG7 GPG11, or nSS1 SPIMISO1 SPIMOSI1 SPICLK1 TCLK1

The Connector-12 functions are determined by Port G. See S3C2440 Data sheet for Port G details.

Port G Control Register →	10xx 101010xx 10xxxx10	11xx 111111xx 11xxxx11	00xx 000000xx 00xxxx00 in 01xx 010101xx 01xxxx01 out
Con12.1	EINT8		GPG0
Con12.2	EINT11	nSS1	GPG3
Con12.3	EINT13	SPI MISO1	GPG5
Con12.4	EINT14	SPI MOSI1	GPG6
Con12.5	EINT15	SPI CLK1	GPG7
Con12.6	EINT19	TCLK1	GPG11
Con12.7	Vdd 3.3V		
Con12.8	GND		

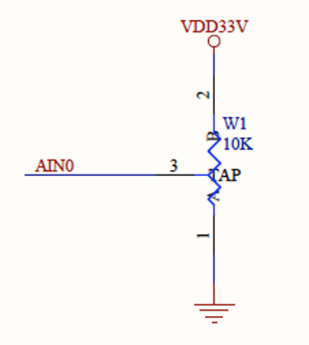






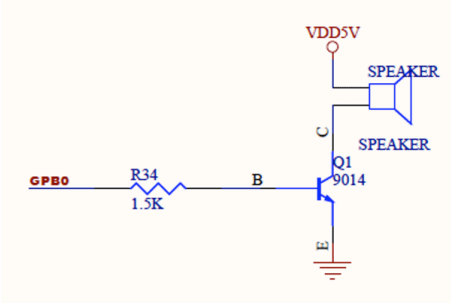
A/D input test

The Mini2440 has an 8-channel 10 bit A/D converter with sample and hold. When a touchpad is used, 4 channels are dedicated to touch pad conversion. The other 4 are general purpose and are on connector 4, GPIO. Pins 5, 6, 7, 8 are AIN0, AIN1, AIN2, AIN3. AIN0 is connected to a pot on the PCB for testing. If you need AIN0, remove the pot or cut the trace from the pot center pin to pin5 of CON4. The trace is on the bottom of the PCB with quite a bit of free space around it.



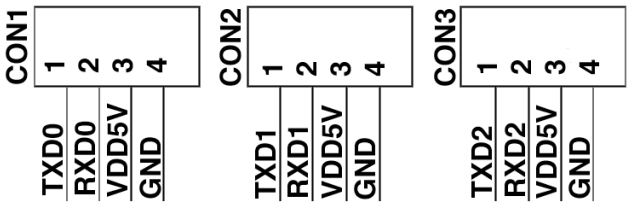
PWM Control buzzer

The Mini2440 has a small buzzer, which can be controlled (somewhat) through PWM. The signal is from GPIO pin 31 (GPB0).



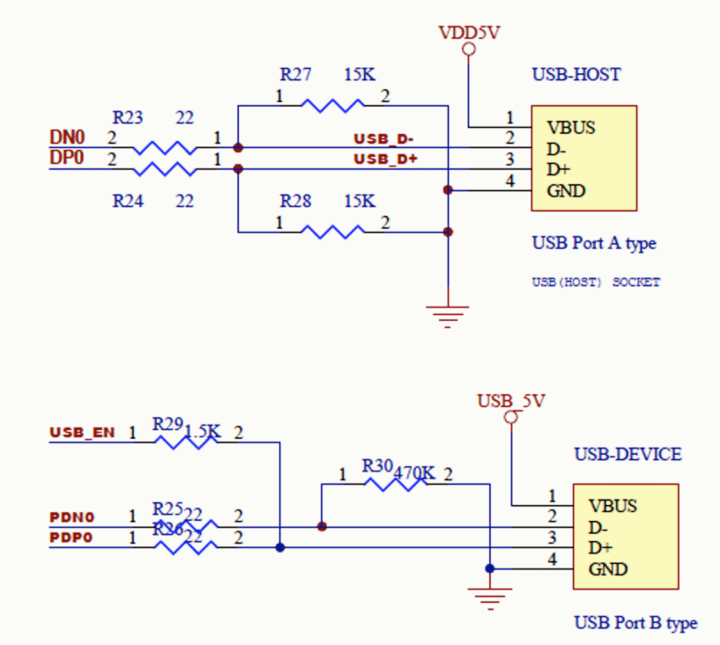
Serial

The Samsung S3C2440 chip supports three serial ports UART0, UART1, UART2. Each has a connector with TTL level signals and also connects to CON4, the GPIO connector. UART0 also has TTL to RS-232 conversion and uses the COM0 DB9 connector to work with any RS232 device. COM0 boots at 115,000 BAUD, N 0 1 and is fully supported by Linux and WinCE.



USB interface

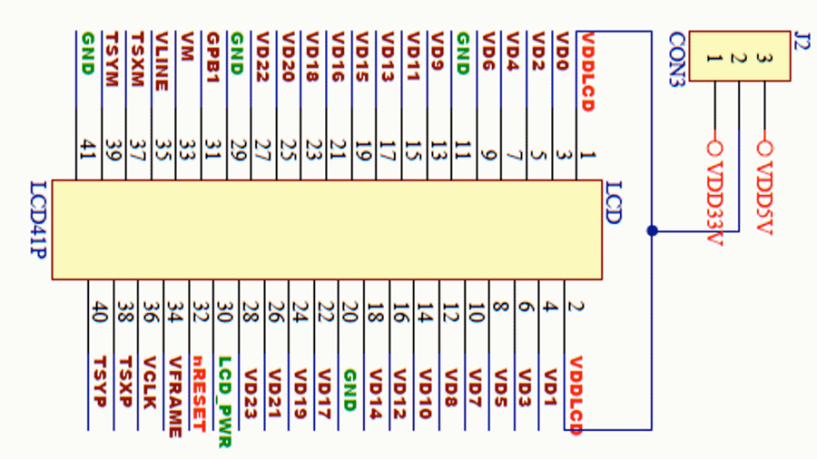
The Mini2440 has two USB interfaces. A USB Host, like an ordinary PC's USB interface, can be used with a USB camera, keyboard, mouse, wifi dongle, etc. The USB Slave is the smaller squarish connector (like you find on printers) and is generally used to download to the target board. When the Mini2440 is running WinCE, it can ActiveSync software with Windows. When the Mini2440 is running a Linux system, there is no corresponding driver and application. Ethernet is usually preferred for data transfer in Linux. The USB Slave can be controlled with a GPC5 register bit to set USB_EN or disable. It can be disabled to conserve CPU resources.



LCD interface

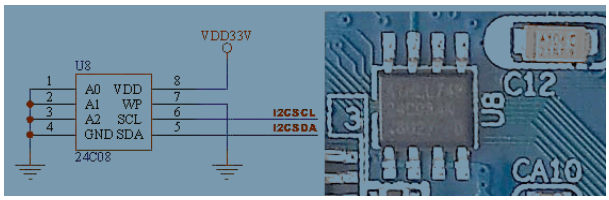
The Mini2440 LCD interface has a 41 Pin 0.5mm pitch white connector, which contains common LCD control signals (line-field scanning, the clock, enable, etc.) and complete RGB output of 8:8:8, supporting a maximum of 16 million colors. The LED backlight can be turned on or off or modulated with GPB1. The backlight signal is called LCD_PWR PWM output (GPB1 be sent through Depositors configuration for PWM), and reset signals (nRESET), one of backlight control signals are LCD_PWR.

In addition, pins 37, 38, 39, 40 are for the four-wire touch screen interface. They can be directly connected to a Touch Panel. See figure J2 for the LCD driver board power supply select signal. All the currently used LCD controllers use a 5V power supply.



EEPROM

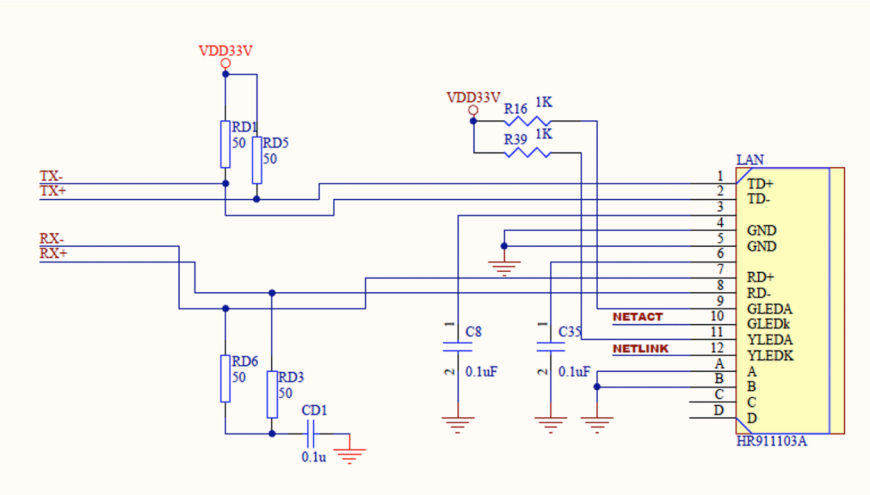
The Mini2440 has a direct connection from the S3C2440 I^{2}C signal pin to an AT24C08 EEPROM with a capacity of 256 bytes. This is mainly used to test the I^{2}C bus and I^{2}C code.



Network Interface

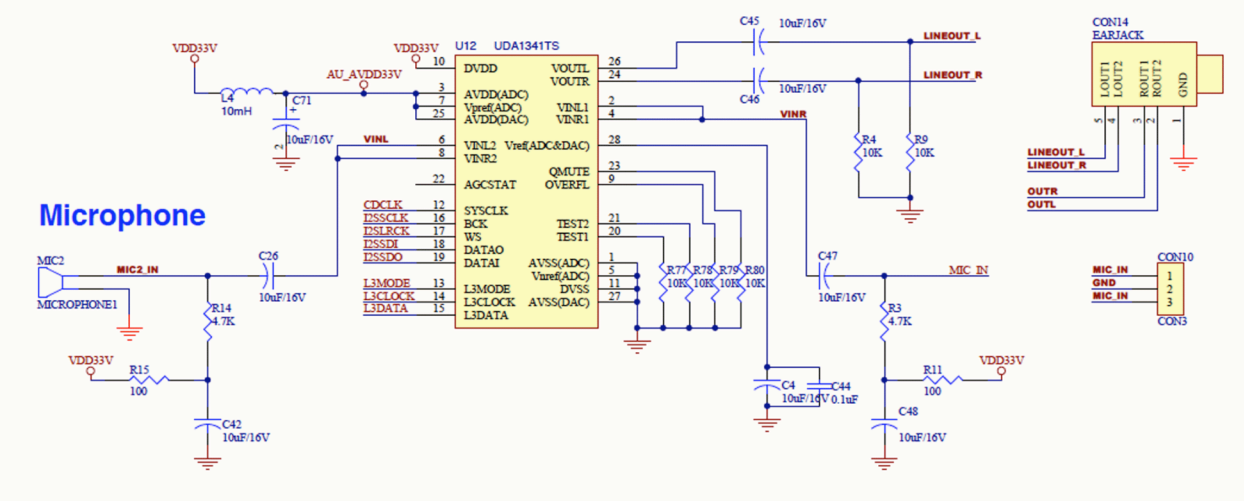
The Mini2440 uses a DM9000 10/100M LAN chip with network transformers and an RJ-45 connector. Ordinary Cat5e cable can connect from the Mini2440 to your routers or switches.

Note: Each Mini2440's network MAC address is the same and can be configured by software. See section 2.4 for Linux, and for WinCE users, refer to the BSP for the DM9000 driver code and the registry file (platform.reg).



Audio Interface

The S3C2440's built in I2S bus interface is directly connected to an external 8/16 bit stereo CODEC. The circuit with the UDA1341 audio decoder chip is taken directly from a Samsung reference design using the CPU's GPB2, GPB3, GPB4 port analog implementation of the L3-Bus specification L3MODE, L3DATA, L3CLOCK, their initialization



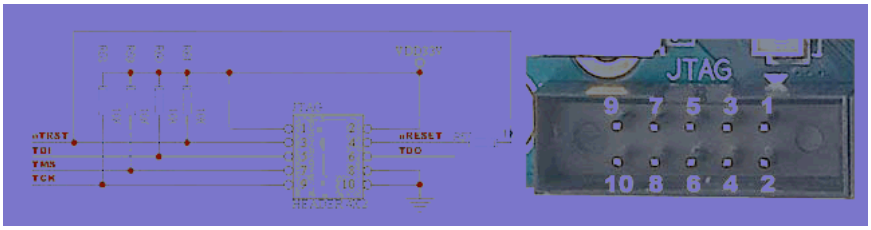
JTAG Interface

When the Mini2440 is fresh from the circuit board SMT (Surface Mount Technology) manufacturing line, the Fash EPROMs are blank. We use the JTAG interface to program the NOR Flash with the Supervivi BIOS. With Supervivi in place, we can use the USB port to download more complex systems. In case you wipe out the BIOS, you will need to be able to use JTAG to bootstrap your board. This is covered in "JTAGingTheNOR". The JTAG interface is also used for debugging with features like single-steping, examining memory, debugging software, etc.

The standard JTAG interface has four wires: TMS, TCK, TDI, TDO, or mode selection, clock, data input and data output lines. This is coupled with power and a total of six lines in general suffice; in order to facilitate debugging, the majority of simulators also provide a reset signal.
So, the standard JTAG interface is just these signals. The 20 pin and 10 pin and other connectors are convenient but not necessary.

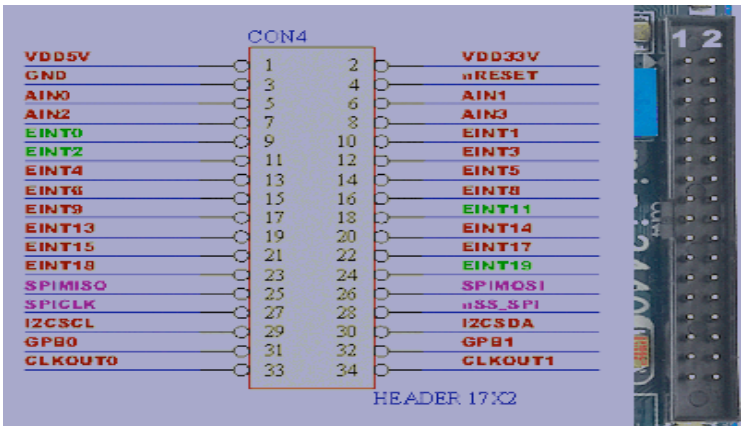
The Mini2440 provides a complete JTAG set of standard signals in a 10 Pin JTAG interface, the pin definition of figure.

JTAG is generally needed only for loading a "bricked" (NAND and NOR bios erased) Mini2440 or for the debugging of very basic code that requires single-stepping through instructions while observing registers or external signals.


nTRST
TDI
TMS
TCK
nRESET
TDO
JTAG
9 7 5 3 1
10 8 6 4 2

GPIO

Mini2440 with a 34 Pin 2.0mm pitch GPIO interface on CON4. CON4 contains the GPIO pins and a number of other CPU-pins, such as AIN0-AIN3, CLKOUT, SPI interface, I^2C interface, GPB0 and GPB1.



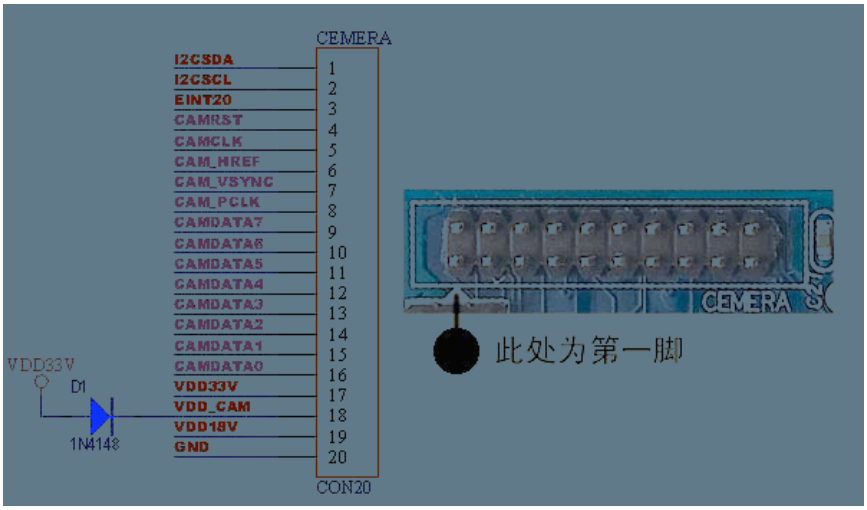
CON4 network name description (some ports reusable)

Pin#	Signal	Alt 1	Alt 2	Pin#	Signal	Alt 1	Alt 2
1	VDD5V 5V			18	EINT11	GPG3	nSS1
2	VDD33V			19	EINT13	GPG5	SPIMISO1
3	GND			20	EINT14	GPG6	SPIMOSI1
4	nRESET			21	EINT15	GPG7	SPICLK1
5	AIN0 A/D			22	EINT17	GPG9	nRST1
6	AIN1 A/D			23	EINT18	GPG10	nCTS1
7	AIN2			24	EINT19	GPG11	
8	AIN3			25	SPIMISO	GPE11	
9	EINT0	GPF0		26	SPIMOSI	GPG6	EINT14
10	EINT1	GPF1		27	SPICLK	GPE13	
11	EINT2	GPF2		28	nSS_SPI	GPG2	EINT10
12	EINT3	GPF3		29	I2CSCL	GPE14	
13	EINT4	GPF4		30	I2CSDA	GPE15	
14	EINT5	GPF5		31	GPB0	TOUT0	

15	EINT6	GPF6		32	GPB1	TOUT1	
16	EINT8	GPG0		33	CLKOUT0	GPH9	
17	EINT9	GPG1		34	CLKOUT1	GPH10	

CMOS CAMERA Interface

The Mini2440 S3C2440 CMOS camera interface uses a 20 pin 2.0mm pitch pin header that directly accepts our CAM130 camera module. The CAM130 PCB has no electronic parts. It simply relays the signal to a ZT130G2 camera module.

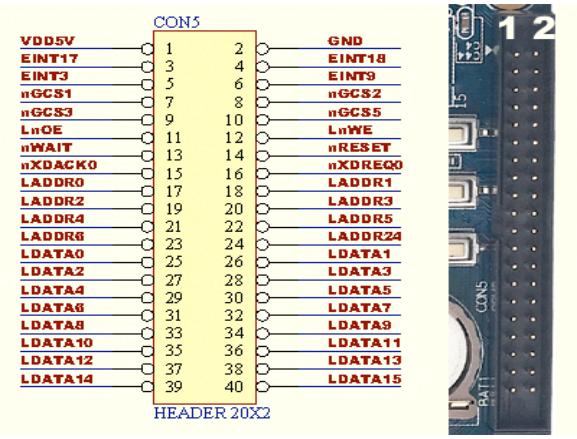


The CAMERA interface is a multiplexed port and is set by the appropriate GPIO registers.
The following table is a list of the corresponding GPIO pins.

Pin#	CAMERA	Alternate	Pin#	CAMERA	Alternate
1	I2CSDA	GPE15	2	I2CSCL	GPE14
3	EINT20	GPG12	4	CAMRST	GPJ12
5	CAMCLK	GPJ11	6	CAM_HREF	GPJ10
7	CAM_VSYNC	GPJ9	8	CAM_PCLK	GPJ8
9	CAMDATA7	GPJ7	10	CAMDATA6	GPJ6
11	CAMDATA5	GPJ5	12	CAMDATA4	GPJ4
13	CAMDATA3	GPJ3	14	CAMDATA2	GPJ2
15	CAMDATA1	GPJ1	16	CAMDATA0	GPJ0
17	VDD33V 3.3V		18	VDD_CAM	
19	VDD18V 1.8V		20	GND	

System Interface Expansion Buss

The CON5 interface expansion contains a total of 16 data lines (D0-D15), 8 Address Lines (A0-A6, A24) and some control signal lines (chip select, read and write, reset, etc.). CON5 can supply 5V directly from one of the power supply input pins.



Pin#	Net Name	Pin#	Net Name
1	VDD5V 5V power -- source or sink.	2	GND
3	EINT17 Interrupt 17 -- input	4	ENINT18 Interrupt 18 -- input
5	EINT3 Interrupt 3 -- Input	6	EINT9 Interrupt 9 -- input
7	nGCS1 Chip Select 1 (physical addr 0x08 00 00 00)	8	nGCS2 Chip select 2 (physical addr 0x10 00 00 00)
9	nGCS3 Chip select 3 (physical addr 0x18 00 00 00)	10	nGSC5 Chip select 5 (physical addr 0x28 00 00 00)
11	LnOE read enable	12	LnWE write enable
13	nWAIT	14	nRESET reset
15	nXDACK0	16	nXDREQ0
17	LADDR0 address 0	18	LADDR1 address 1
19	LADDR2 address 2	20	LADDR3 address 3
21	LADDR4 address 4	22	LADDR5 address 5
23	LADDR6 address 5	24	LADDR7 address 7
25	LDATAT0 data 0	26	LDATA1 data 1
27	LDATA2 data 2	28	LDATA3 data 3
29	LDATA4 data 4	30	LDATA5 data 5
31	LDATA6 data 6	32	LDATA7 data 7
33	LDATA8 data 8	34	LDATA9 data 9

35	LDATA10 data 10	36	LDATA11 data 11
37	LDATA12 data 12	38	LDATA13 data 13
39	LDATA14 data 14	40	LDATA15 data 15

LINUX

At the time of writing boards are shipping with 2.6.29-rc6. Older systems have 2.6.13. Mini2440 is now in the main Linux source beginning with 2.6.31.

Supported file systems:

- Yaffs (read-write file system recommended)
- Cramfs (compressed read-only file system, not recommend for most applications)
- Ext2
- Fat32
- NFS (network file system, driver development and application ease of use)

Drivers (Source code included for the following):

- 3 serial ports standard drive
- DM9000 driver for Ethernet
- Sound driver
- RTC driver (battery backed RTC)
- User-driven LED lights
- USB Host Driver
- Common LCD driver
- Touch Panel driver
- USB camera, support for mesh, SMIC microchip camera
- USB mouse, USB keyboard, USB mobile hard disk
- SD card driver SDHC no size limit.

LINUX applications and services:

- Busybox1.2.0 (Linux tool set, including the commonly used Linux commands, etc.)
- Telnet, FTP, inetd (telnet network tools and services)
- Boa (web server)
- Madplay (console-based mp3 player)
- Snapshot (screen capture app)
- Ishow (console-based image viewer software)
- Ifconfig, ping, route, etc. (commonly used web-based tools command)

Embedded graphics system (source code include):

- Qt / Embedded

Mini2440 Software

Before shipping, if unspecified by customers, the default system software is LINUX + Qtopia. The binaries for the default are supervivi, zImage_t35 (or 7" kernel), root_qtopia_tp.img.

Please note the following: Make is based on the Windows environment.

Startup mode selection

The Mini2440 startup mode is selected by the DIP switch S2. Select NOR or NAND. For NOR, the switch is slid towards the edge of the PCB. The Mini2440 is shipped default with the supervivi BIOS burned to both NAND and NOR flash memory.

Making the Connection

Use the included DB9 serial cable to connect the Mini2440 COM 0 (DB9 on the PCB) and serial on a PC. If the PC has no serial connector, use a USB to Serial converter.
(For LINUX, use the included Cat5e Ethernet crossover cable to the network interface with the PC.)
Use the included 5V power adapter to connect to the board's 5V input socket.
Connect speakers or headphones to the audio output jack (green - optional)
Use the included USB device-to-host cable and connect to the PC (The one like a printer USB).

Desktop versions of Linux usually come with serial terminal software like minicom, which is used with command lines in a console window. The use is fairly complex compared to the Windows method.

In Windows, run the DNW utility. It can be run from the DVD or moved to your PC. It is an executable program that needs no extra files. Set the COM port you are using to 115,000 N 1 0.

Set the Mini2440 memory mode to NOR. Turn on the Mini2440 power switch. The status bar at the top of the DNW window should say OK and display the BAUD rate. If not, under the serial menu, enable the connection. The USB status should also say OK.

Push the reset button on the mini2440. You should get the supervivi menu.
See other documents for more details on using supervivi, JTAG, writing your first app, etc.

Mini2440/Micro2440 Linux Driver Locations and Corresponding Device Names: The hardware and software of the Mini2440 and Micro2440 are identical.

1	Device or Resource	Driver Code Location	Device Name
	Yaff2 File system	Linux-2.6.29/fs/yaffs2	The root file system uses yaffs2 and the tool, mkyaffs2image. At the time of writing there are 64M and 128M versions.
2	LCD FrameBuffer	Linux-2.6.29/drivers/video/s3c2410fb.c	/dev/fb0
3	CMOS Camera CAM130	Linux-2.6.29/drivers/media//video/s3c2440camif.c	/dev/camera
4	USB Camera	Linux-2.6.29/drivers/media/video/gspca	/dev/video0
5	USB to Serial	Linux-2.6.29/drivers.usb/serial/p12302.c	/dev/ttyUSB0
6	USB Mouse and KB	Linux-2.6.29/drivers/usb/hid	USB Mouse: /dev/input/mice USB KB : /dev/input/
7	LED	Linux-2.6.29/drivers/char/mini2440_leds.c	/dev/leds
8	Push Buttons	Linux-2.6.29/drivers/char/mini2440_buttons.c	/dev/buttons
9	I2C EEPROM	Linux-2.6.29/drivers/i2c.c	/dev/i2c/0
10	Buzzer PWM	Linux-2.6.29/drivers/char/mini2440_pwm.c	/dev/pwm
11	A/D Conversion	Linux-2.6.29/drivers/char/mini2440_ad.c	/dev/adc
12	LCD Backlight	Linux-2.6.29/drivers/char/mini2440_backlight.c	/dev/backlight
13	Watchdog	Linux-2.6.29/watchdog/s3c2410_wdt.c	/dev/watchdog
14	Touch Screen	Linux-2.6.29/drivers/input/touchscreen/s3c2410_ts.c	/dev/event0
15	USB Flash Drives	Linux-2.6.29/drivers.usb/storage.c	/dev/udisk
16	MMC / SD	Linux-2.6.29/drivers/mmc (directory)	/dev/sdcard
17	NAND Flash	Linux-2.6.29/drivers/mtd/nand	/dev/mtdblock2
18	UDA1341 Audio	Linux-2.6.29/sound/soc/s3c24xx	/dev/dsp (playback or recording) /dev/mixer (Volume control)
19	RTC Clock	Linux-2.6.29/drivers/rtc/rtc-s3c.c	/dev/rtc
20	Serial Ports	Linux-2.6.29/drivers/serial/sc32440.c	/dev/ttySAC0, 1, 2
21	USB Wifi	Linux-2.6.29/drivers/net/wireless/rt2x00	No device name for network equipment. Type TL-WN321G+
22	DM9000 Ethernet	Linux-2.6.29/drivers/drivers/net/dm9000.c	No device name for network equipment.