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Freescale Semiconductor
Application Note

Interfacing a Hard Drive to an M5249C3 Board

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1   Introduction

In the embedded scenario it is popular to employ hard-disk drives (HDDs) for many applications such as media players, network-attached storage (NAS), TV content recorders, etc. Many HDD models are available in small footprint, high-density, and low-power suited for embedded applications. The MCF5249, MCF5250, and MCF5251 have an integrated IDE block that allows them to interface to standard HDDs with minimum external hardware.

This application note shows how to interface an HDD to an M5249C3 running uClinux IDE as the operational system. Installing uClinux, the appropriate toolchain, and how to use uClinux support for HDDs, and how to configure the VFAT file system are also explained.

After reading this application note, you should be able to install the uClinux package and toolchain and configure the kernel for a M5249C3 board; enable IDE support in uClinux for the M5249C3; build an uClinux image and download it to a M5249C3 board; and access the hard disk content from the M5249C3 board.

Contents

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1.1 Processor Description

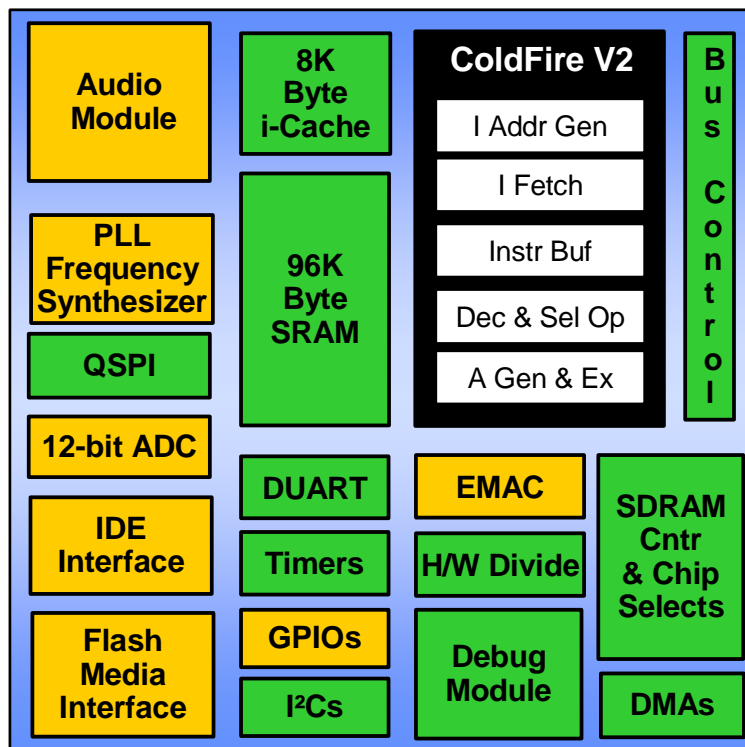The MCF5249 is used in this application note.

Figure 1. MCF5249 Block Diagram

Processor description and key features:

- The MCF5249 comes in two packages:
  - 144-pin QFP — Runs up to 120 MHz
  - 160-pin BGA — Runs up to 140 MHz
- Enhanced multiply and accumulate (eMAC) unit — Allows the MCF5249 to perform digital signal processing algorithms such as vocoders used in VoIP applications (G.729, G.723), MP3, WMA, decoder, and encoding
- Large amount of internal SRAM (96 KB on the MCF5249) — Necessary for real-time intensive tasks such as an MP3 decoder because critical time data and programs can be placed in internal SRAM, which has a faster access time than external SDRAM
- Low-power consumption — Suitable for portable devices (1.3 mW/MHz)
- IDE interface — Allows hard-disk-drive interface with minimum use of external devices.
- Background-debug module (BDM) — Flexible debug interface allows external flash programming
- Serial audio interfaces — Support I2S and EIAJ standards and SPDIF(IEC958) digital audio interfaces.
- SD and MMC interfaces

1.2   Evaluation Board

The M5249C3 is the evaluation board for the MCF5249 and is the hardware referred to throughout this document.

Figure 2. M5249C3 Board

M5249C3 main features:

- 8 MB of SDRAM, 2 MB of flash
- External 10/100 ethernet controller
- Two serial ports — One for monitor firmware output, one for general purpose
- Debug module interface connector (BDM) — Used with source level debuggers running on PCs
- IDE connector — Or glueless hard-disk connection
- Stereo audio inputs and stereo audio input jacks
- Pre-flashed dBug monitor firmware — Allows access to CPU registers, memory content, and it downloads applications to the target from the serial port and over the ethernet

2   Building the Application

The following sections show how to set up the application's working environment for the application and how to build and download a uClinux image with IDE and telnet support to the M5249C3.

2.1   System Requirements

- M5249C3 board, a serial cable, and crossover cable
- Hard-disk drive with a 40-pin standard IDE cable formatted as FAT32
- Linux host computer. The distribution used in the tests was RedHat 9.0™, but you can run in different Linux distributions. In the Linux host, you must enable network-file system (NFS) and trivial file transfer protocol (TFTP) services. This varies among distributions but is beyond the scope of this document to teach. A terminal emulator such as minicon is necessary for communicating with the M5249C3 board.

2.2 uClinux Installation Process

Installing uClinux on the host machine:

Download the latest uClinux distribution: http://www.uclinux.org/pub/uClinux/dist/. This document was written when the latest version was uClinux-dist-20051110. The current version is uClinux-dist 20060803. The former is a full source package containing kernel 2.0, 2.4, and 2.6 libraries and application code.

1. Download the toolchain for ColdFire® products (http://www.uclinux.org/pub/uClinux/m68k-elf-tools/). m68k-elf-tools-20030314 is used in this application note. It contains the cross-compiler and assembler for ColdFire targets.
2. As root, install the toolchain in the Linux Host sh m68k-elf-tools-20030314.
3. Log in as a standard user.
4. Copy the uClinux source package file uClinux-dist-200511110.tar.gz into /home/user (in my case, my name follows: /home/fabio).
5. Go to /home/user directory and extract tar –xzvf uClinux-dist-200511110.tar.gz.

2.2.1 Generating an uClinux Image and Downloading It to the Target

After the toolchain and uClinux distribution are installed in the host computer, build an image for the M5249C3 then download it to the board.

1. First, configure the kernel and target options. Go to uClinux-dist directory and then:

    >> cd /home/user/uClinux-dist

    >> make menuconfig.
2. Go to Vendor/Product Selection, then <Select>. The following window should appear:

**Interfacing a Hard Drive to an M5249C3 Board, Rev. 0**
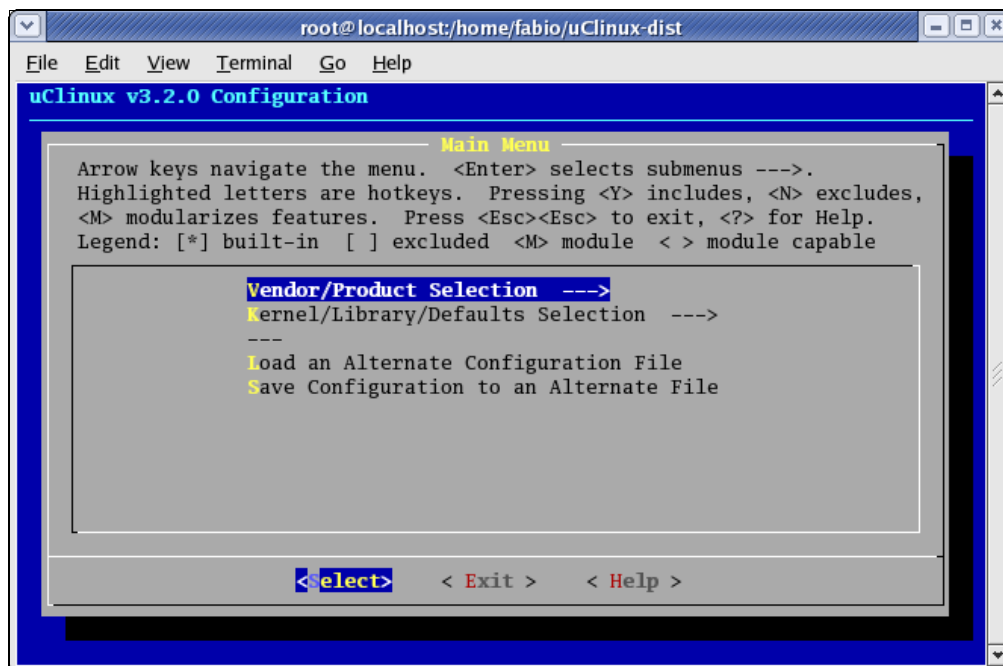
3. Select the vendor and M5249C3 as the target. Exit.
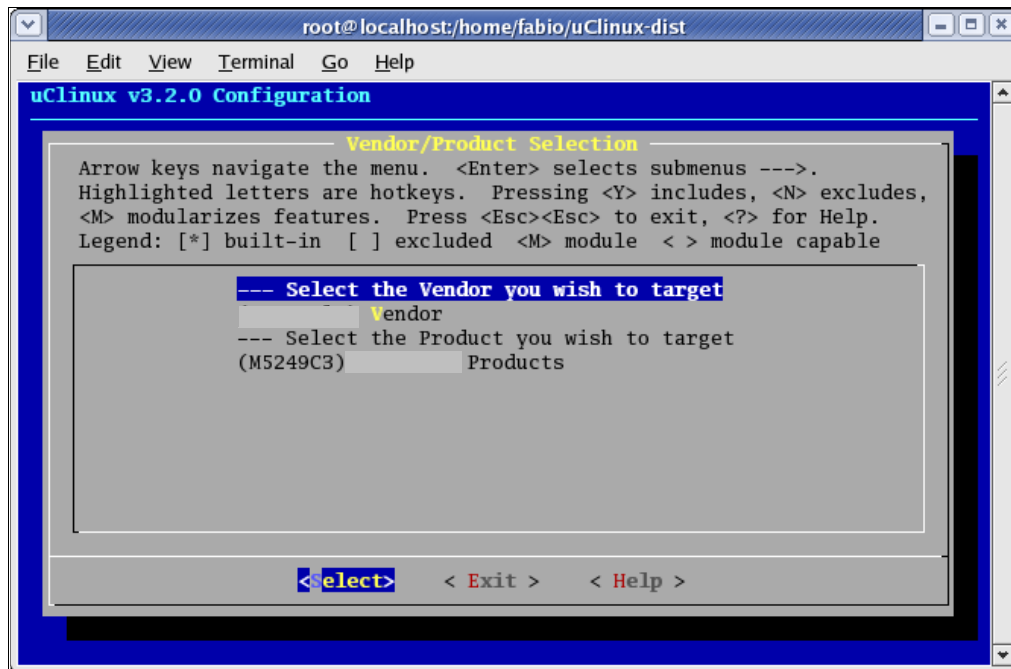
4. Go to Kernel/Library/Default Selection.
5. Select kernel linux-2.4.x as the kernel version and uC-lib as Libc version.
6. Mark customize kernel settings (by hitting the backspace key). Exit.
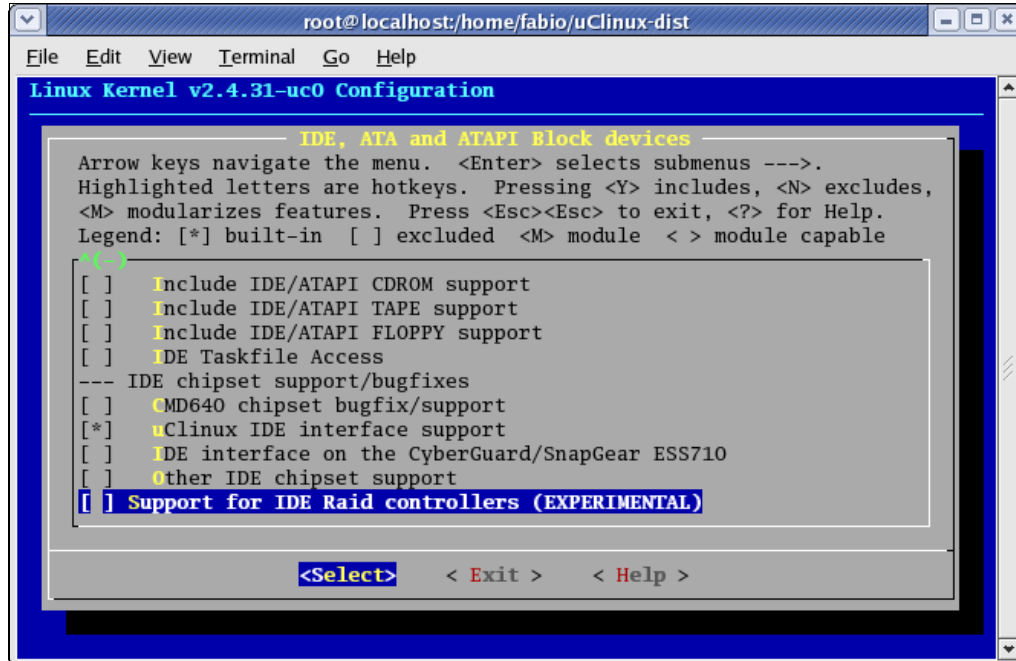7. Select Yes to save the kernel configuration.

Interfacing a Hard Drive to an M5249C3 Board, Rev. 0
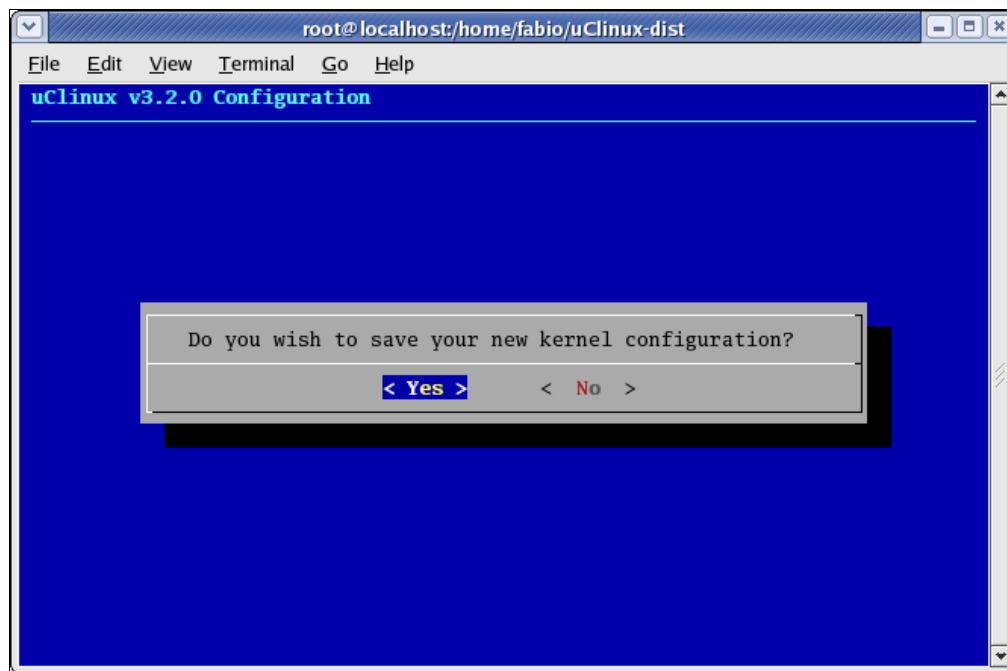
8. Go to ATA/IDE/MFM/RLL support.
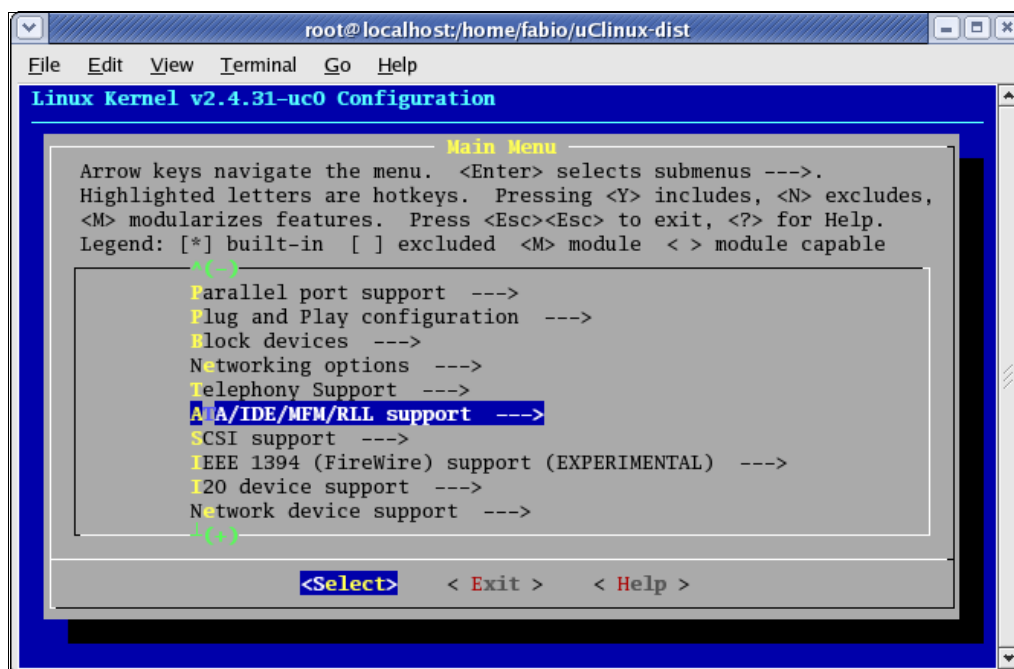
9. Select ATA/IDE/MFM/RLL. Go to IDE, ATA, and ATAPI block devices.
10. Select enhanced IDE/MFM/RLL disk/cdrom/tape/floppy support.
11. Select include IDE/ATA-2 DISK support.
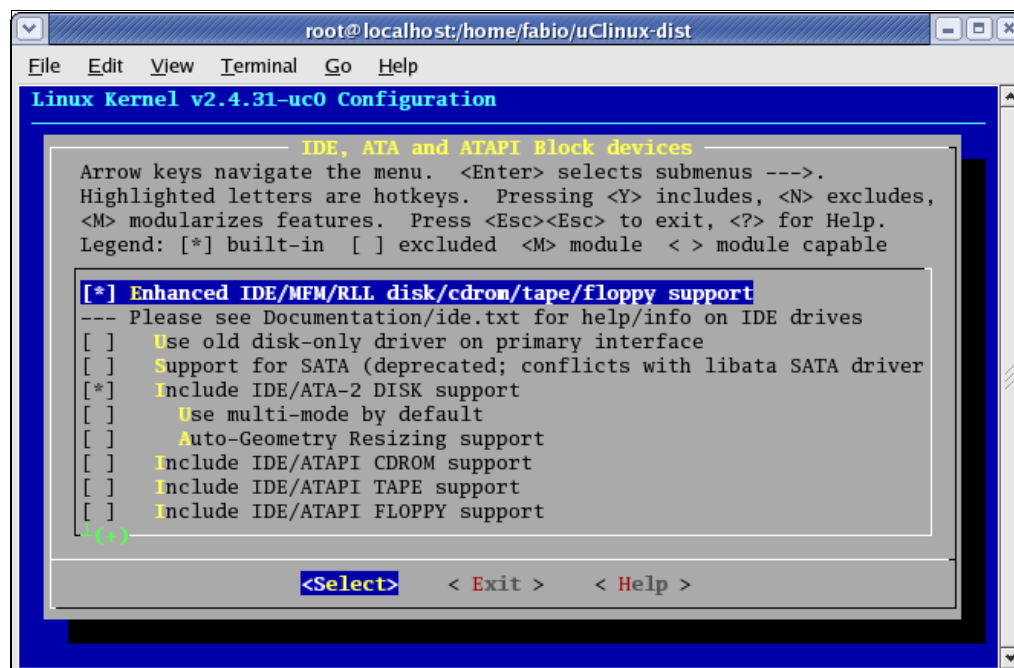
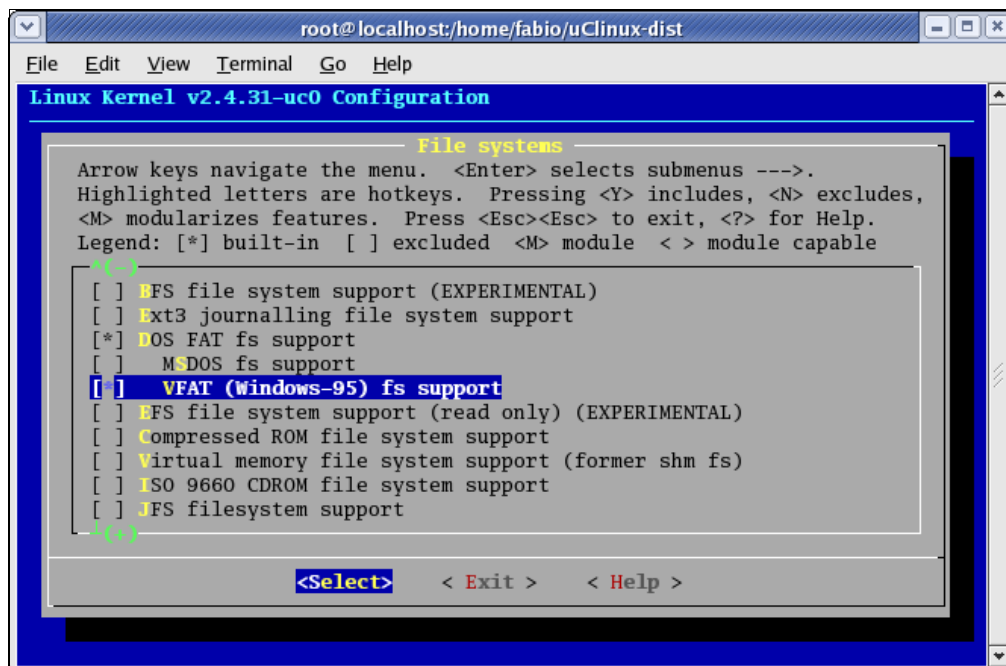12. Scroll down the menu. Select uClinux IDE interface support.
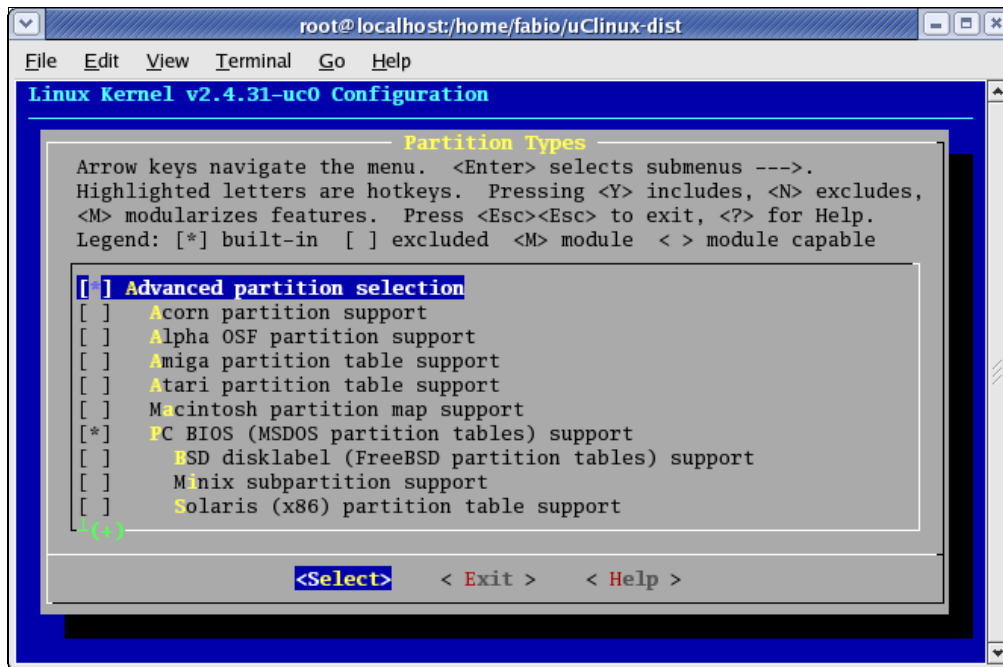

13. Exit.

14. Exit.

15. Go to file systems.

16. Under the file systems menu, select VFAT (Windows 95) fs support.

17. Scroll down the file systems menu. Go to partition types option.

18. Under the partition types menu, select advanced partition selection.

19. Exit.

20. Exit.

21. Exit.

22. Select Yes for saving new kernel configuration.

23. Create a folder called /tftboot that contains the generated image.bin file. As root (the "su" command enters in root mode):

    >>mkdir /tftpboot

    >>chmod 777/tftpboot

    Returning to user mode (command is "su user")

    >> make dep; make

After a successful build process, an image.bin file must have been placed in the/tftpboot folder. The image.bin file combines the kernel and root-file systems.

Downloading the image to the M5249C3:

1. Connect the serial cable between the host PC and the M5249C3.

2. In the host, run a terminal emulator such as minicon. Set it to a baud rate of 19200 bps, 8 bits, no parity, no software, and no hardware flow control.

3. Attach the hard disk drive formatted as FAT32 to the J8 IDE connector of the M5249C3.

4. Power up the M5249C3.

5. The following messages should appear:

```
Hard Reset
DRAM Size: 8M

ColdFire MCF5249 EVS Firmware v3a. 1b. 1c
(Build 4 on Mar 04 2003 15:38:14)

Enter "help" for help.

dBuG>
```

Refer to the *M5249C3 User Manual* for a detailed list of commands the dBug monitor supports.

Ensure the tftp service is enabled and that the /tftpboot folder can be exported. The tftp package is not installed by default in RedHat 9.0™ and other Linux distributions. In RedHat 9.0™, the configuration file for the tftp server is /etc/xinetd.d/tftp (listed below):

```
service tftp
{
     disable= no
     socket_type = dgram
     protocol    = udp
     wait             = yes
     user             = root
     server           = /usr/sbin/in.tftpd
     server_args = -s /tftpboot
     per_source  = 11
     cps              = 100 2
     flags            = IPv4
   }
```

Insert a crossover cable between the host PC and the M5249C3 board.

NOTE

You can use a normal cable to connect the PC and the M5249C3 in a network. By default, the DHCP application is enabled for the M5249C3, and the board can retrieve an IP address if the network has DHCP server capabilities.

In dBug prompt, type "show"

dBug>set server 192.168.0.1

dBug>set client 192.168.0.2

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In the host: ifconfig eth0 192.168.0.1

dBug>dn –i image.bin

This command requests a TFTP transfer and sends the image.bin file located at /tftpboot folder from the host.

The image transferred through TFTP is now placed in the external SDRAM of the M5249C3. To execute the uClinux kernel, jump to its initial location 0x20000. The command in dBug is:

dBug> go 20000

The kernel boot message should start:

```
Linux version 2.4.31-uc0 (root@localhost) (gcc version 2.95.3 20010315 (release)(ColdFire patches -
20010318 from http://fi6
uClinux/COLDFIRE(m5249)
COLDFIRE port done by Greg Ungerer, gerg@snapgear.com
Flat model support (C) 1998,1999 Kenneth Albanowski, D. Jeff Dionne
On node 0 totalpages: 2048
zone(0): 0 pages.
zone(1): 2048 pages.
zone(2): 0 pages.
Kernel command line:
Calibrating delay loop... 92.56 BogoMIPS
Memory available: 5992k/8192k RAM, 0k/0k ROM (850k kernel code, 229k data)
kmem_create: Forcing size word alignment - mm_struct
kmem_create: Forcing size word alignment - filp
Dentry cache hash table entries: 1024 (order: 1, 8192 bytes)
Inode cache hash table entries: 512 (order: 0, 4096 bytes)
kmem_create: Forcing size word alignment - inode_cache
Mount cache hash table entries: 512 (order: 0, 4096 bytes)
kmem_create: Forcing size word alignment - bdev_cache
kmem_create: Forcing size word alignment - cdev_cache
kmem_create: Forcing size word alignment - kiobuf
Buffer cache hash table entries: 1024 (order: 0, 4096 bytes)
Page-cache hash table entries: 2048 (order: 1, 8192 bytes)
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
kmem_create: Forcing size word alignment - file_lock_cache
kmem_create: Forcing size word alignment - nfs_read_data
kmem_create: Forcing size word alignment - nfs_write_data
ColdFire internal UART serial driver version 1.00
ttyS0 at 0x100001c0 (irq = 73) is a builtin ColdFire UART
ttyS1 at 0x10000200 (irq = 74) is a builtin ColdFire UART
M5249AUDIO: (C) Copyright 2002, Greg Ungerer (gerg@snapgear.com)
M5249AUDIO: DMA channel=0, irq=120
Bad boy: audio(DMA) (at 0x0007fe4c) called request_irq without a dev_id!
kmem_create: Forcing size word alignment - blkdev_requests
SMSC LAN91C111 Driver (v2.0), (Linux Kernel 2.4 + Support for Odd Byte) 09/24/01 -     by Pramod Bhardwaj
(pramod.bhardwaj@)eth0: SMC91C11xFD(rev:1) at 0xe0000300 IRQ:166 MEMSIZE:8192b NOWAIT:0 ADDR:
00:cf:52:49:c3:04
SLIP: version 0.8.4-NET3.019-NEWTTY (dynamic channels, max=256).
CSLIP: code copyright 1989 Regents of the University of California.
```

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```
Blkmem copyright 1998,1999 D. Jeff Dionne
Blkmem copyright 1998 Kenneth Albanowski
Blkmem 1 disk images:
0: 12E084-20BC83 [VIRTUAL 12E084-20BC83] (RO) <ROMFS>
RAMDISK driver initialized: 16 RAM disks of 4096K size 1024 blocksize
PPP generic driver version 2.4.2
PPP MPPE compression module registered
Uniform Multi-Platform E-IDE driver Revision: 7.00beta4-2.4
ide: Assuming 50MHz system bus speed for PIO modes; override with idebus=xx
hda: probing with STATUS(0x50) instead of ALTSTATUS(0x7f)
hda: QUANTUM FIREBALL ST2.5A, ATA DISK drive
hdb: probing with STATUS(0x00) instead of ALTSTATUS(0x7f)
hdb: probing with STATUS(0x00) instead of ALTSTATUS(0x7f)
ide0 at 0x50000020 on irq 165
hda: attached ide-disk driver.
hda: 5008752 sectors (2564 MB) w/81KiB Cache, CHS=4969/16/63
Partition check:
 hda: [PTBL] [621/128/63] hda1
NET4: Linux TCP/IP 1.0 for NET4.0
IP Protocols: ICMP, UDP, TCP
kmem_create: Forcing size word alignment - ip_dst_cache
IP: routing cache hash table of 512 buckets, 4Kbytes
TCP: Hash tables configured (established 512 bind 512)
NET4: Unix domain sockets 1.0/SMP for Linux NET4.0.
FAT: bogus logical sector size 49376
VFS: Mounted root (romfs filesystem) readonly.
Freeing unused kernel memory: 28k freed (0x112000 - 0x118000)
Shell invoked to run file: /etc/rc
Command: hostname uClinux
Command: /bin/expand /etc/ramfs.img /dev/ram1
Command: mount -t proc proc /proc
mount: bb_xasprintf: Unknown error 0
pid 9: failed 256
Command: mount -t ext2 /dev/ram1 /var
Command: mkdir /var/tmp
Command: mkdir /var/log
Command: mkdir /var/run
Command: mkdir /var/lock
Command: mkdir /var/empty
Command: ifconfig lo 127.0.0.1
Command: route add -net 127.0.0.0 netmask 255.0.0.0 lo
Command: dhcpcd -p -a eth0 &
[13]
Command: cat /etc/motd
Welcome to
              ____ _   _
           / __| | |_|
      _   _| |  | |  _ ___   _   _   _   _
     | | | | |  | || |  _ \| | | | |\ \/ /
     | |_| | |__| || | | | | |_| |/    \
     |  _____|_||_|_| |_|\____|\_/\_/
     | |
     |_|

For further information check:
http://www.uclinux.org/
```

```
Command:
Execution Finished, Exiting

Sash command shell (version 1.1.1)
    />
```

Highlighted above are the messages related to the IDE detection. The IDE vendor and model are shown as well as the number of sectors and disk size.

You can now manually set up the board's IP address by "> ifconfig eth0 192.168.0.2".

NOTE

If a cross cable connects the M5249C3 to a network, you can retrieve an IP address through DHCP. The uClinux default setting enables the DHCP daemon.

You can try to ping the host: "ping 192.168.0.1". Press CTRL-C to stop the ping process.

```
/> ifconfig eth0 192.168.0.2
/< ping 192.168.0.1
PING 192.168.0.1 (192.168.0.1): 59 data bytes
64 bytes from 192.168.0.1: icmp_seq=0 ttl=64 time=5.9 ms
64 bytes from 192.168.0.1: icmp_seq=1 ttl=64 time=2.9 ms
64 bytes from 192.168.0.1: icmp_seq=2 ttl=64 time=2.9 ms
64 bytes from 192.168.0.1: icmp_seq=3 ttl=64 time=2.9 ms
64 bytes from 192.168.0.1: icmp_seq=4 ttl=64 time=2.9 ms

--- 192.168.0.1 ping statistics ---
5 packets transmitted, 5 packets received, 0% packet loss
round-trip min/avg/max = 2.9/3.5/5.89 ms
```

3   IDE Interface

3.1   IDE Hardware

J9 is a standard 2X20 IDE connector. These signals are involved in IDE connection:
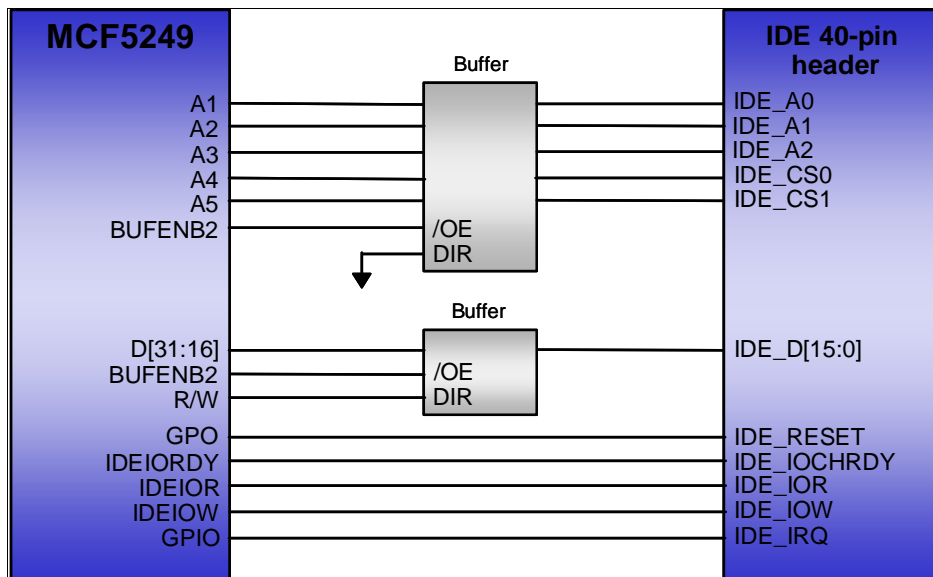
Figure 3. IDE Connection to M5249C3

3.2   IDE Signals Description

- BufEn2_b — Active-low external buffer enable. This enable is inactive when CS0 is active and should enable a buffer for peripheral devices except boot ROM.

- IDE-Iordy — Active-high ready indication from IDE device to MCF5249.

- CS2/IDE-DIOR/gpio13 and IDE-DIOW/gpio14 —These signals go active during CS2 cycles. IDE-DIOR can be programmed to go active on read and write cycles or to go active on read cycles only, and IDE-DIOW on write cycles only. IDE-DIOR has features identical to the normal CS2 and can be programmed for an address location and for masking, port size, and burst capability indication, wait state generation, and internal/external termination. You can also enable IDE-DIOR and IDE-DIOW to access an IDE drive or another AT-bus peripheral. This allows you to insert more than 16 wait states on IDE-DIOR and IDE-DIOW and have dynamic-cycle termination using the IORDY signal.

Detailed schematics shown below (from *M5249C3 User Manual*):
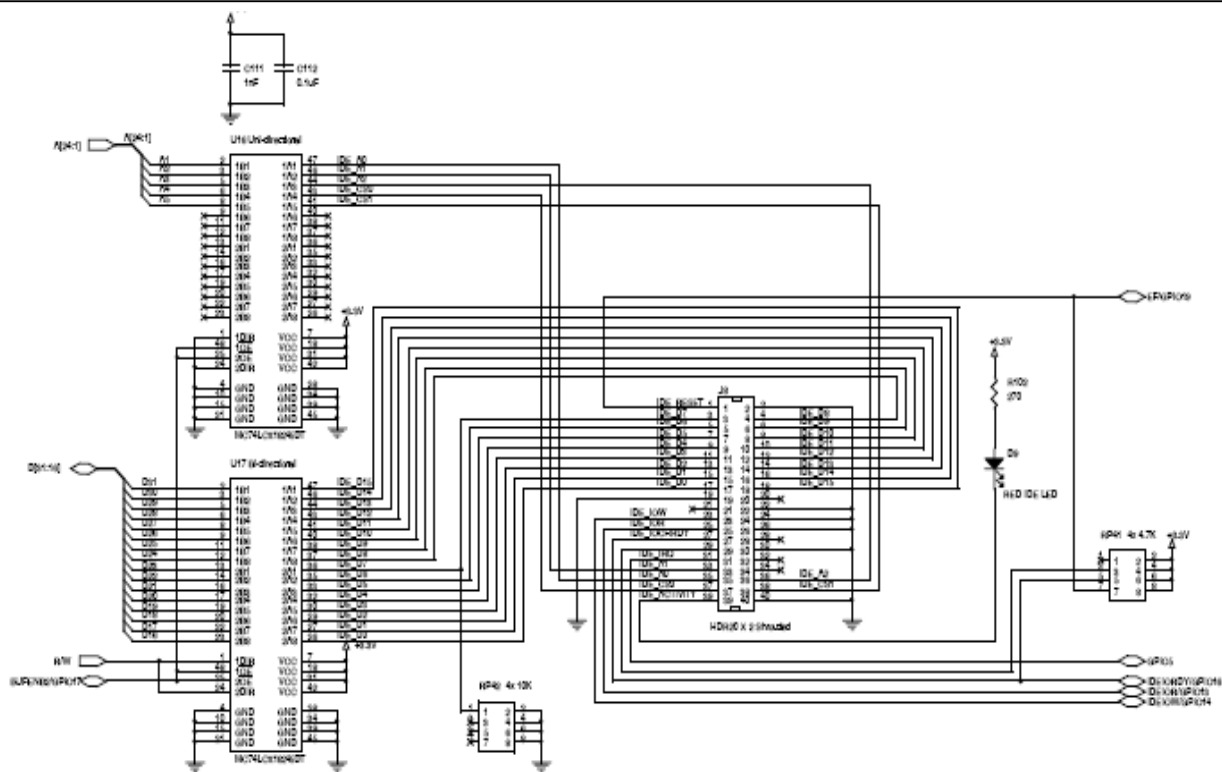
Figure 4. Schematics from M5249C3

3.3 IDE Register Programming

To set up the IDE interface:

1. Program chip-select-2 registers inside the chip-select modules (CSAR2, CSMR2, and CSCR2).

   — CSAR2, CSMR2 must be programmed to map the IDE interface in the correct part of the ColdFire address map. For example: in the M5249C3 we have CS2 mapped at address 0x50000000.

   — CSCR2 bit fields must be programmed as follows:

   — AA: 0 (TA signal generated by IDEconfig2 register logic)

   — WS[3:0]: not relevant

   — PS[1:0]: 10 (16 bit port size)

   — BSTR, BSTW: 00 (no burst read/write cycles)

   — BEM: not relevant

2. Program the IDE config1 register. Relevant fields are cs2pre, cs2post, bufen1cs2en, bufen2cs2en. The values required for the buffer enable signals (bufen1cs2en, and bufen2cs2en) depend on the hardware configuration. If two buffers are used in cascade, both bits must be 1. Fields cs2pre and cs2post are relevant and explained in Table 1.
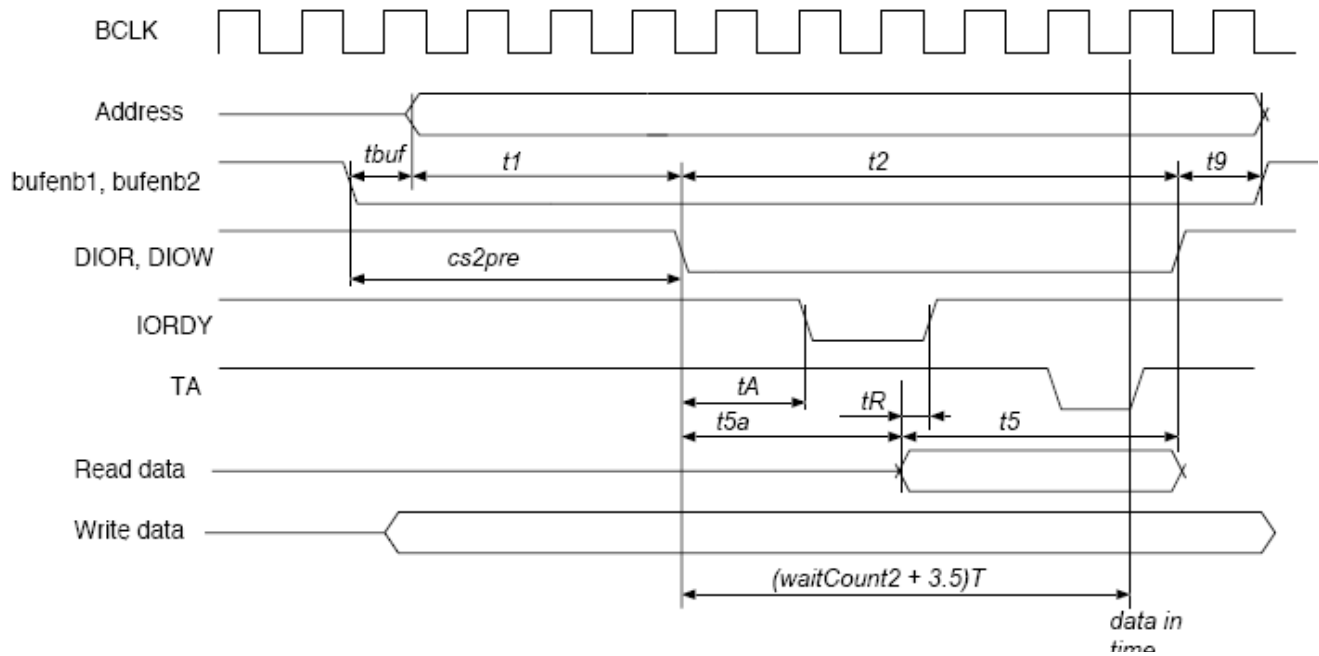
Figure 5. IDE Timing Diagram

Table 1. IDE-Related Timing Signals

ATA Timing Symbol	ATA4 Value	Controlled by Setting	Equation (Approximately)	Comments
t1	25	cs2pre	cs2pre > t1 − tbuf	tbus is external buffer enable time. cs2pre must be set high enough to provide sufficient address-to-DIOR, DIOW setup time. Typical cs2pre values range from 3 to 5 SCLK clocks.
t2	70	waitCount2	(waitCount2 + 4)T > t2	t2 is the DIOR, DIOW low period. To meet 70 ns t2 period, waitCcount2 must be set to 3.

Table 1. IDE-Related Timing Signals (continued)

ATA Timing Symbol	ATA4 Value	Controlled by Setting	Equation (Approximately)	Comments
t5a	50	waitCount2	(waitCount2 + 1.5)T > tA +tio	To meet this timing, waitCount2 must be set to 4–5.
tA	35	waitCount2	(waitCount2 + 1.5)T > tA +tio	To meet this timing, waitCount2 must be set to 3–4.
tR	0	—	3T > tbuf + tdel – tR	tdel: time difference between path from IORDY and from read data. Read data in device must be valid 3 clocks after IORDY going high.
t9	10	cs2post	cs2post >t9	To meet this timing, typical value for cs2post is 10 nS.

3.4 IDE-Related Files in uClinux

As shown below, the CS2, which acts as the IDE chip select, is initially set up at ../uClinux-dist/linux-2.4.x/arch/m68knommu/platform/5249/FREESCALE/crt0_ram.S file as shown below:

```
      /*
       *    Setup CS2 for IDE interface.
       */
      move.l    #0x50000000, %d0          /* CS2 mapped at
0x50000000 */
      move.l    %d0, 0x98(%a0)
      move.l    #0x001f0001, %d0          /* CS2 size of 1MB
*/
      move.l    %d0, 0x9c(%a0)
      move.w    #0x0080, %d0        /* CS2 = 16bit, TA */
      move.w    %d0, 0xa2(%a0)

      move.l    #0x00107020, %d0          /* IDEconfig1 */
      move.l    %d0, 0x18c(%a1)
      move.l    #0x000c0400, %d0          /* IDEconfig2 */
      move.l    %d0, 0x190(%a1)
```

Find the IDE driver at ../uClinux-dist/linux-2.4.x/drivers/ide/

3.5 Mount Process

Before the M5249C3 board can access the hard-disk-file system, send the following command in uClinux:

> mount –t vfat /dev/hda1 /mnt

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After this command, HDD content is mounted at the /mnt folder.

> cd /mnt

If you want the IDE mount process to be executed automatically at startup, append the following line:

 "mount –t vfat /dev/hda1 /mnt" to the end of this file: .../uClinux-dist/vendors/Generic/big/rc.

4 Conclusion

This application note showed how to interface an HDD with an M5249C3 evaluation board running uClinux. The hardware interface is straightforward due to a built-in MCF5249 IDE controller, the IDE driver, and file-system support. The file-system support is available in uClinux for the M5249C3 board; therefore, you can add your own application that needs an HDD interface.

5 References

1. *MCF5249 ColdFire Integrated Microprocessor User Manual*
2. *M5249C3 Reference Board User Manual*
3. *MP3 Decoder on uClinux Demo User Manual*

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