

An Introduction to Firmware

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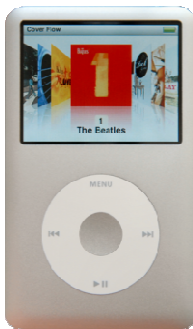
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Introduction

- What is firmware?
 - Implementations of firmware
 - Importance in embedded systems
 - Custom firmware source code projects
 - Example code structure of firmware
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What is firmware?

- Firmware is “bridge” between hardware and software
- Transforms hardware structure into software program
- Typically loaded in flash ROM
- Found in many commercial devices(MP3 players, network routers, cameras, etc.)



iPod Classic



Linksys WRT54G



Canon Powershot A720IS

Implementations of basic firmware

- Electronic watch example
 - Binary decision tree
 - M4 for the tens (0 or 1);
 - M3.M2.M1.M0 for the units (0000 ... 1001)
 - Simplify binary decision tree

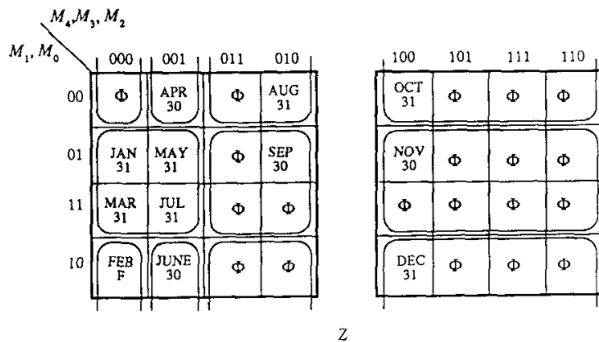


Fig. 1. Karnaugh map for the watch decoder: partition in 7 blocks.

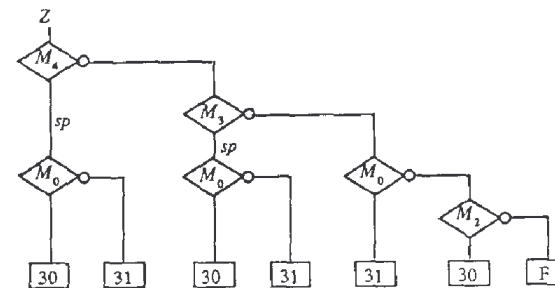


Fig. 2. Binary decision tree after simplification (7 branches).

Implementations of basic firmware, cont'd

- Simplify binary decision tree
- Software implementation below

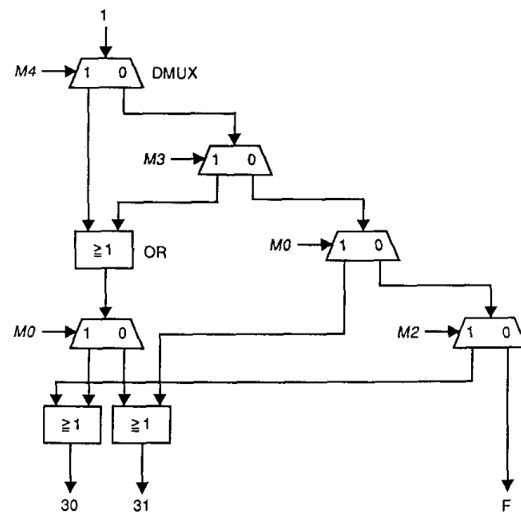


Fig. 6. Hardware implementation as a demultiplexer network.

```

program pp
if M4
  call sp
else
  if M3
    call sp
  else
    if M0
      do 31
    else
      if M2
        do 30
      else
        do F
      endif
    endif
  endif
endif

procedure sp
if M0
  do 30
else
  do 31
endif
end procedure
end program
  
```

Importance of firmware in embedded systems

- Additional features can be added without redesign of hardware
 - Products can be released to market quickly
 - Optimizations can be made to product line
-

Custom Firmware Source Code

- DD-WRT
 - Wireless routers Linksys WRT54G
 - <http://www.dd-wrt.com>
 - Rockbox
 - Portable MP3 players Apple iPod
 - <http://www.rockbox.org/>
 - CHDK
 - Canon Digic II or Digic III DSP based digital cameras
 - <http://chdk.wikia.com/wiki/CHDK>
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CHDK Firmware

- Download code via Subversion:
 - svn co <https://tools.assembla.com/svn/chdk/trunk>
 - Required tools to compile:
 - gcc – GNU C compiler
 - binutils – GNU binary utilities
 - Features available:
 - Live histogram
 - Raw image support
 - Run scripts in uBASIC
-

Example code structure of firmware

- sect.inc file
- Select camera platform in header for use in Makefile for gcc

```
VER=pre14
```

```
PLATFORM=a610
```

```
PLATFORMSUB=100e
```

```
...
```

```
include $(topdir)version.inc
```

```
include $(topdir)platform/$(PLATFORM)/sub/$(PLATFORMSUB)/makefile.inc
```

```
SILENT=SILENT
```

```
NOZERO100K=TRUE
```

Example code structure of firmware, cont'd

```
1   rem Interval shooting
2
...
10
11  t=b*60000+c*1000
12  if a<2 then let a=10
13  if t<1000 then let t=1000
14
15  print "Total time:", t*a/60000; "min", t*a%60000/1000; "sec"
16
17  sleep 1000
18
19  print "Shoot 1 of", a
20  shoot
21  for n=2 to a
22    sleep t
23    print "Shoot", n, "of", a
24    shoot
25  next n
26
27  end
```