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This article is a primer and general FAQ about microcontrollers.
Included is a collection of information sources on various
microcontrollers.

The following topics are addressed:

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0) Rantings and ravings

    Disclaimer: Just so it is understood, the "rantings and ravings" are
    my rantings and ravings. My readers are refined and sophisticated
    and would never rant or rave. I, on the other hand, sit in front of
    the TV in torn underwear and drink beer out of the bottle.

    Yeah, I know, this FAQ is getting a just a BIT long. I apologize to
    those who aren't able to retrieve the whole document. I'm now
    working on reformatting and splitting it up into multiple parts. I
    avoided this for as long as possible, since it is much more
    convenient when the entire article is only one piece, but - that's
    life :-).

    Tom Kellet's FAQ on the PIC line of microcontrollers has just been
    approved for posting to news.answers. If you're into the PIC, then
    his FAQ is a must. See section 8.4 for more information on his FAQ
    and others. Good job Tom!

    If you're interested in porting GCC to the processor you're using,
    check out the Cross GCC mailing list. See section 9.3 for details on
    how to subscribe.

    The other day I was watching my 8 year old daughter play with her
    Barbie Dolls. She has about 7 or so, including two that used to
    belong to my wife (Roz) when she was a girl. I noticed an
    interesting difference between the old dolls and the new dolls. The
    old Barbies could only move their heads sideways, while the new
    Barbies not only can move their heads sideways, but also up and down.
    AMAZING - the old Barbies were good girls - they could only say no.
    The new Barbies however can also say yes. Progress - isn't it
    wonderful!

    Dave Perry adds: "My Daughter got a gymnast Barbie for Christmas -
    wait'll you see what *she* can do ;-)"

    Which leads me to an amazing fact. Most everyone thinks of the PIC
    microcontroller line as being a recent introduction. However,
    they've been around for over 20 years. What's the difference? The
    new chips are fabricated in CMOS, some features have been added, new
    family lines have been introduced, and the company name is Microchip
    and not General Instrument. Microchip actually seems to care - they
    are aggressive and are providing a product that their customers want.
    Whatever the differences might be, these chips are really dynamite.

    PSST! Hey kid! Want a naked Barbie Doll?!

    Just a reminder to please be kind and send in your suggestions.
    Thanks.

    Take care of yourselves,

            Uncle Russ

1) ABOUT THIS FAQ

1.1) Who put this FAQ together?

    Me again! This FAQ is just a way to tie up loose ends. From time to
    time, general questions about microcontrollers (from beginners to
    experienced designers) pop up in the newsgroups. It seemed that a
    general primer/FAQ on microcontrollers might be useful.

    Much of this document could be considered as a sort of a primer on
    microcontrollers. For those of you with previous experience,
    sections 8 and 9 might be of special interest (especially for those
    of you looking for that elusive "free COBOL compiler for the 1802").

1.2) How can I contribute to this list?

    I please ask that if you have any suggestions or additions, or you
    would like to correct any of the information contained herein, please
    send me a note.
        My Email address is: sibit@datasrv.co.il
        My Smail address is:
                Russ Hersch
                HaVradim 11
                Ginot Shomron
                ISRAEL

    Thanks to the following who have contributed to this document:
            Robin L. Getz (National Semiconductor)
            Robert Boys
            Dave Dunfield (Dunfield Development Systems)
            Jeff Fox (Ultra Technology)
            Zack Lau

    Also, thanks to those who have posted questions and to those who have
    posted answers. Thanks to "my new friends" who send suggestions and
    encouragement, as well as the occasional question. Special thanks to
    my mother-in-law, who thankfully will probably never read this
    document ;-).

    I hope that those of you who have special knowledge on the subject of
    microcontroller use, or know of sources of information on
    microcontrollers, will share with everyone by contributing to
    document.

1.3) What newsgroups will this FAQ be posted to?

    This FAQ will be posted to the following newsgroups:
        comp.robotics
        comp.sys.intel
        comp.sys.m68k
        comp.sys.6809
        sci.electronics
        alt.comp.hardware.homebuilt

    I will post once a month - on or about the 26th of each month.

1.4) May I distribute this FAQ or post it somewhere else?

    I am putting no restrictions on the use of this FAQ except - It must

be distributed in its entirety with the copyright notice, and no
financial gain may be realized from it. After all, I have spent, and
continue to spend, a lot of time on this.

For this reason I have appended a copyright statement to the end of
this FAQ. I feel pretty silly doing this, but I just want to protect
myself. The copyright does not limit the use of this list for
noncommercial purposes. I hereby give my permission to one and all
to pass this list around and post it wherever you want - as long as
it is not for financial gain.

     Thank you.

2)   MICROCONTROLLERS

2.1) What is a Microcontroller?

A controller is used to control (makes sense!) some process or aspect
of the environment. A typical microcontroller application is the
monitoring of my house. As the temperature rises, the controller
causes the windows to open. If the temperature goes above a certain
threshold, the air conditioner is activated. If the system detects
my mother-in-law approaching, the doors are locked and the windows
barred. In addition, upon detecting that my computer is turned on,
the stereo turns on at deafening volume (for more on this, see the
section on development tools).

At one time, controllers were built exclusively from logic
components, and were usually large, heavy boxes (before this, they
were even bigger, more complex analog circuits). Later on,
microprocessors were used and the entire controller could fit on a
small circuit board. This is still common - you can find many [good]
controllers powered by one of the many common microprocessors
(including Zilog Z80, Intel 8088, Motorola 6809, and others).

As the process of miniaturization continued, all of the components
needed for a controller were built right onto one chip. A one chip
computer, or microcontroller was born. A microcontroller is a highly
integrated chip which includes, on one chip, all or most of the parts
needed for a controller. The microcontroller could be called a
"one-chip solution". It typically includes:
     CPU (central processing unit)
     RAM (Random Access Memory)
     EPROM/PROM/ROM (Erasable Programmable Read Only Memory)
     I/O (input/output) - serial and parallel
     timers
     interrupt controller

By only including the features specific to the task (control), cost
is relatively low. A typical microcontroller has bit manipulation
instructions, easy and direct access to I/O (input/output), and quick
and efficient interrupt processing. Microcontrollers are a "one-chip
solution" which drastically reduces parts count and design costs.

2.2) Applications

In addition to control applications such as the above home monitoring

system, microcontrollers are frequently found in embedded
applications. Among the many uses that you can find one or more
microcontrollers: appliances (microwave oven, refrigerators,
television and VCRs, stereos), automobiles (engine control,
diagnostics, climate control), environmental control (greenhouse,
factory, home), instrumentation, aerospace, and thousands of other
uses.

Microcontrollers are used extensively in robotics. In this
application, many specific tasks might be distributed among a large
number of microcontrollers in one system. Communications between
each microcontroller and a central, more powerful microcontroller (or
microcomputer, or even large computer) would enable information to be
processed by the central computer, or to be passed around to other
microcrontrollers in the system.

A special application that microcontrollers are well suited for is
data logging. Stick one of these chips out in the middle of a corn
field or up in a ballon, and monitor and record environmental
parameters (temperature, humidity, rain, etc). Small size, low power
consumption, and flexibility make these devices ideal for unattended
data monitoring and recording.

2.3) Flavors

Microcontrollers come in many flavors and varieties. Depending on
the power and features that are needed, you might choose a 4 bit, 8
bit, 16 bit, or 32 bit microcontroller. In addition, some
specialized versions are available which include features specific
for communications, keyboard handling, signal processing, video
processing, and other tasks.

3) MICROCONTROLLER FEATURES

3.1) Fabrication techniques

CMOS - Complementary Metal Oxide Semiconductor

This is the name of a common technique used to fabricate most (if
not all) of the newer microcontrollers. CMOS requires much less
power than older fabrication techniques, which permits battery
operation. CMOS chips also can be fully or near fully static,
which means that the clock can be slowed up (or even stopped)
putting the chip in sleep mode. CMOS has a much higher immunity
to noise (power fluctuations or spikes) than the older fabrication
techniques.

PMP - Post Metal Programming (National Semiconductor)

PMP is a high-energy implantation process that allows
microcontroller ROM to be programmed AFTER final metalization.
Usually ROM is implemented in the second layer die, with nine or
ten other layers then added on top. That means the ROM pattern
must be specified early in the production process, and completed
prototypes devices won't be available typically for six to eight
weeks. With PMP, however, dies can be fully manufactured through

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