Embended systems
Microcontrollers
Fall 2016
Laboratory Work 2

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Introduction

Topic: General Purpose Input/Output registers on AVR.

Objectives: Understanding GPIO, . LED connection. Button connection. LCD Display device Task integration

Tasks: Write a C program and schematics for Micro Controller Unit (MCU) using led which will be turned on by pushing on button and turned off when button is released. Additionally use LCD Display which will display current state of led.

General-purpose input/output (GPIO)

Definition General-purpose input/output (GPIO) is a generic pin on an integrated circuit or computer board whose behavior including whether it is an input or output pin is controllable by the user at run time. GPIO pins have no predefined purpose, and go unused by default. The idea is that sometimes a system integrator who is building a full system might need a handful of additional digital control lines and having these available from a chip avoids having to arrange additional circuitry to provide them. For example, the Realtek ALC260 chips (audio codec) have 8 GPIO pins, which go unused by default.

Atmega32 GPIO Atmega32 has 8-bit port, i.e. it has 8 pins in a single port. Each bit represents a pin i.e. bit 0 represents pin 0 on that port and so on. As you can see in the diagram given below, Atmega32 has 4 ports named as A, B, C and D. Each of these ports has 8-pins (micro-controller pins).

GPIO REGISTERS

Every GPIO has three registers associated with it in order to control a particular pin. For AVR micro-controllers these registers are:

- DDRn – Data Direction Register
- PORTn – Port Output data Register
- PINn – Port Input Register

n - Indicates the port name i.e. A, B, C and D

DDRn Register Data Direction Register configures data direction of a port or a port pin. I mean a port will used for input or output. Writing a value 0 configure that port pin as INPUT and writing a value 1 configures a port pin as OUTPUT.

PORTn Register PORTn register is used for two purposes :

- To output data when port is configured as output
- To activate/deactivate internal pull-up registers when port is configures as input

PIN Register The PINn register keeps the status of all the pins in that port. By reading this register we can get the current logic level (0 or 1) on the pin. When the pin is configured as input, this register tells what logic level is being given on that pin, whether it's 0 or 1. When the pin is configured as output, this register tells what logic level is being driven out.111

Light-emitting diode

Definition A light-emitting diode (LED) is a two-lead semiconductor light source. It is a p–n junction diode, which emits light when activated.[4] When a suitable voltage is applied to the leads, electrons are able to recombine with electron holes within the device, releasing energy in the form of photons. This effect is called electroluminescence, and the color of the light (corresponding to the energy of the photon) is determined by the energy band gap of the semiconductor.

Usage Early LEDs were often used as indicator lamps for electronic devices, replacing small incandescent bulbs. They were soon packaged into numeric readouts in the form of seven-segment displays, and were commonly seen in digital clocks.

UART

Definition A universal asynchronous receiver/transmitter , is a computer hardware device for asynchronous serial communication in which the data format and transmission speeds are configurable. The electric signaling levels and methods (such as differential signaling, etc.) are handled by a driver circuit external to the UART.

Resourses

Short Theory: Proteus developed by Labcenter Electronics, is a software with which you can easily generate schematic captures, develop PCB and simulate microprocessor. It has such a simple yet effective interface that it simplifies the task required to be performed. This one aspect has attracted many users to select this tool amongst many others offering the same services. Atmel® Studio 6 is the integrated development platform (IDP) for developing and debugging Atmel ARM® Cortex®-M and Atmel AVR® microcontroller (MCU) based applications. The Atmel Studio 6 IDP gives you a seamless and easy-to-use environment to write, build and debug your applications written in C/C++ or assembly code. A microcontroller (sometimes abbreviated μC, uC or MCU) is a small computer on a single integrated circuit containing a processor core, memory, and programmable input/output peripherals. Microcontrollers are designed for embedded applications, in contrast to the microprocessors used in personal computers or other general purpose applications. In computing, a device driver (commonly referred to as a driver) is a computer program that operates or controls a particular type of device that is attached to a computer. A driver provides a software interface to hardware devices, enabling operating systems and other computer programs to access hardware functions without needing to know precise details of the hardware being used.

About stdio library: Input and Output operations can be performed using theCStandardInput andOutput Library (cstdio, known asstdio.hin the C language). This library uses what are calledstreamsto operate with physical devices such as keyboards, printers, terminals or with any other type of files supported by the system. Streams are an abstraction to interact with these in an uniform way. All streams have similar properties independently of the individual characteristics of the
physical media they are associated with. Streams are handled in thecstdiolibrary as pointers toFILEobjects. A pointer to aFILEobject uniquely identifies a stream, and is used as a parameter in the operations involving that stream.

Atmel® microcontrollers: Atmel® microcontrollers (MCUs) deliver a rich blend of efficient integrated designs, proven technology, and groundbreaking innovation that is ideal for today's smart, connected products. In this era of the Internet of Things (IoT), microcontrollers comprise a key technology that fuels machine-to-machine (M2M) communications. Building on decades of experience and industry leadership, Atmel offers proven architectures that are optimized for low power, high-speed connectivity, optimal data bandwidth, and rich interface support. By using our wide variety of configuration options, developers can devise complete system solutions for all kinds of applications. Atmel microcontrollers can also support seamless integration of capacitive touch technology to implement buttons, sliders, and wheels (BSW). In addition, Atmel MCUs deliver wireless and security support. No matter what your market or device, Atmel offers a compelling solution that is tailored to your needs—today and tomorrow. Atmel is a global industry leader in the design and manufacture of microcontrollers and related system solutions, including capacitive touch solutions, advanced logic, mixed-signal, nonvolatile memory, and radio frequency (RF) components. Leveraging one of the industry's broadest intellectual property technology portfolios and backed by a comprehensive ecosystem, Atmel MCU products enable designers to develop complete solutions for industrial, consumer, security, communications, computing, and automotive markets. Developers have the option of combining Atmel microcontrollers with industry-leading Atmel touch technology. Atmel technology for touchscreens and fixed-function buttons, sliders and wheels provides a rich user experience with unparalleled performance, while minimizing power consumption.

ATmega328

The high-performance Atmel 8-bit AVR RISC-based microcontroller combines 32KB ISP flash memory with read-while-write capabilities, 1KB EEPROM, 2KB SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible timer/counters with compare modes, internal and external interrupts,serial programmable USART, a byte-oriented 2-wire serial interface, SPI serial port, 6-channel 10-bit A/D converter (8-channels in TQFP and QFN/MLF packages), programmable watchdog timer with internal oscillator, and five software selectable power saving modes. The device operates between 1.8-5.5 volts. By executing

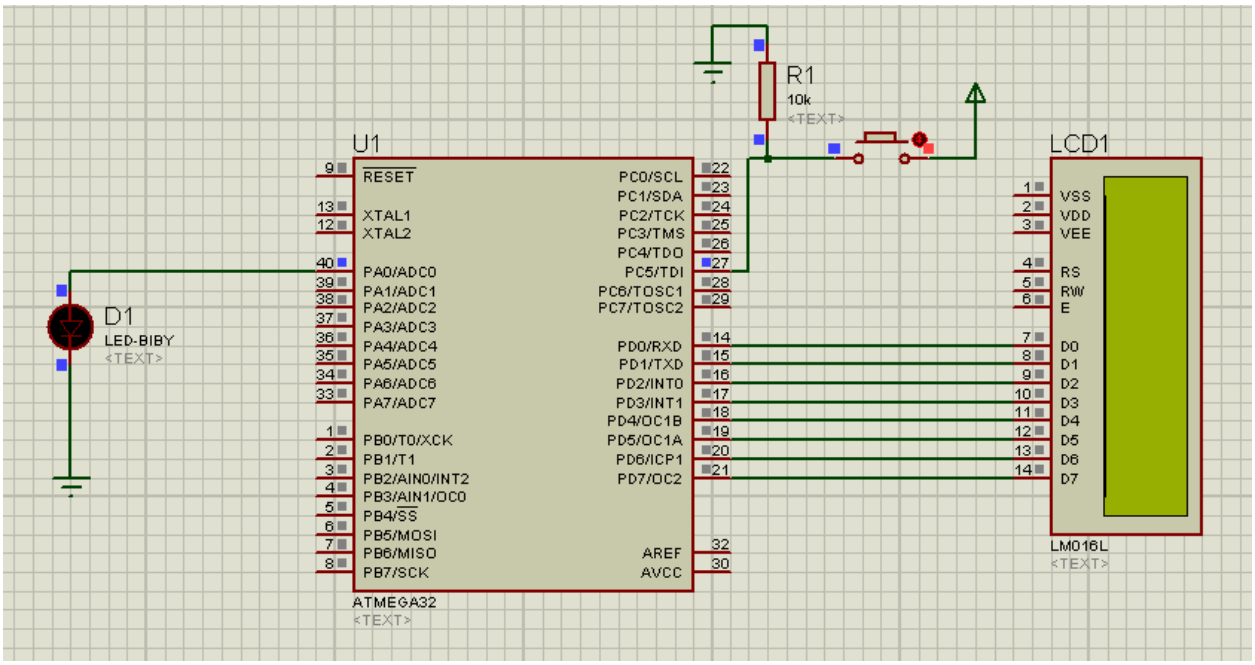
powerful instructions in a single clock cycle, the device achieves throughputs approaching 1 MIPS per MHz, balancing power consumption and processing speed.

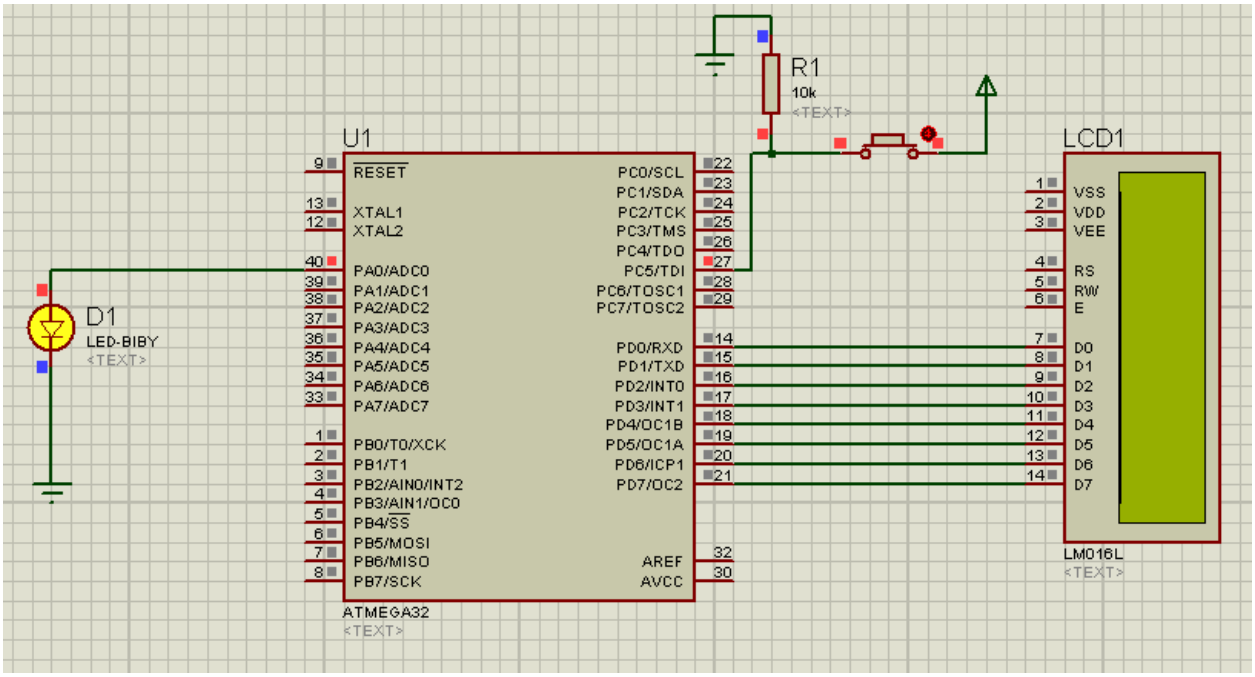
Atmel Studio: Atmel Studio 7 is the integrated development platform (IDP) for developing and debugging Atmel® SMART ARM®-based and Atmel AVR® microcontroller (MCU) applications. Studio 7 supports all AVR and Atmel SMART MCUs. The Atmel Studio 7 IDP gives you a seamless and easy-to-use environment to write, build and debug your applications written in C/C++ or assembly code. It also connects seamlessly to Atmel debuggers and development kits. Additionally, Atmel Studio includes Atmel Gallery, an online apps store that allows you to extend your development environment with plug-ins developed by Atmel as well as by third-party tool and embedded software vendors. Atmel Studio 7 can also able seamlessly import your Arduino sketches as C++ projects, providing a simple transition path from Makerspace to Marketplace.

Solution

Proteus Scheme Let's take a look on this scheme. So we have Microcontroler **ATMEGA32** This microcontroler is composed from 4 ports each of thie have 8 pins.

1. First we connect LED. In the code sourse I set PORT A pin 1 for LED output.We set up PORT A for led
2. Create function for LedON and LedOff
3. Set PORT C pin 5 for button
4. Create functions for button pushed and not pushed





<cstdio>(stdio.h) refference

C library to perform Input/Output operations Input and Output operations can also be performed in C++ using the C Standard Input and Output Library (cstdio, known as stdio.h in the C language). This library uses what are called streams to operate with physical devices such as keyboards, printers, terminals or with any other type of files supported by the system. Streams are an abstraction to interact with these in

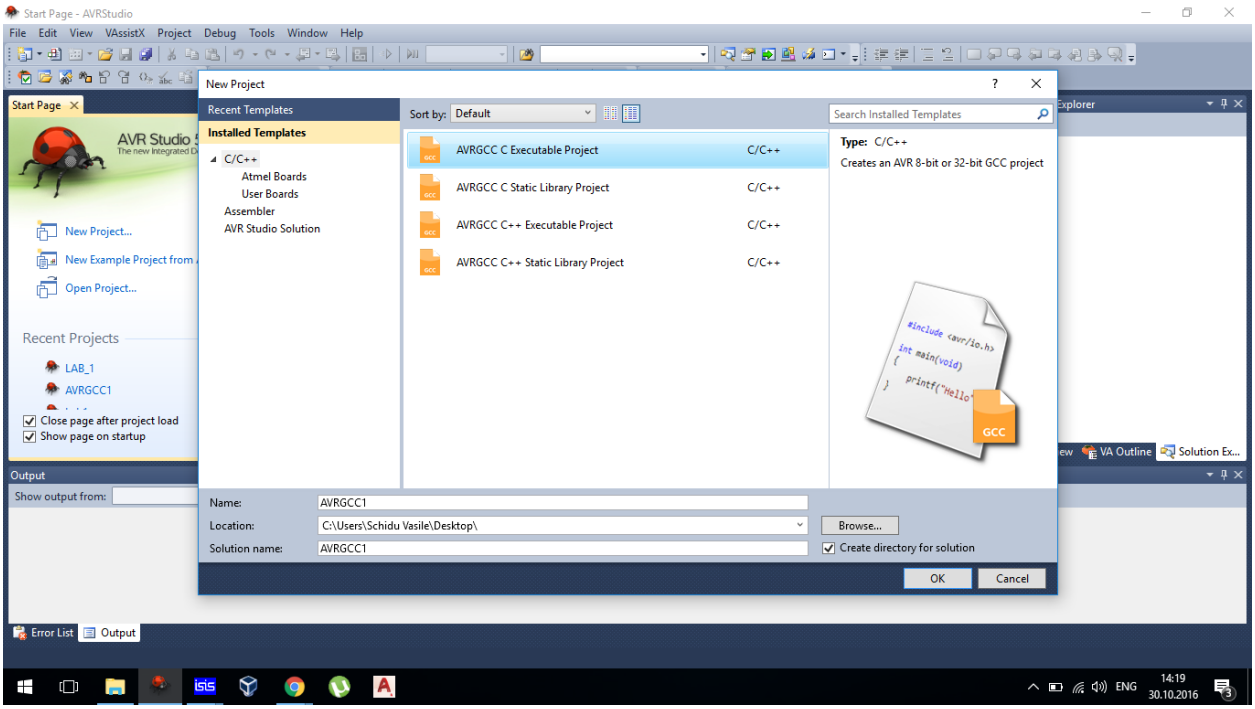
an uniform way; All streams have similar properties independently of the individual characteristics of the physical media they are associated with.

Streams are handled in the cstdio library as pointers to FILE objects. A pointer to a FILE object uniquely identifies a stream, and is used as a parameter in the operations involving that stream.

There also exist three standard streams: stdin, stdout and stderr, which are automatically created and opened for all programs using the library.

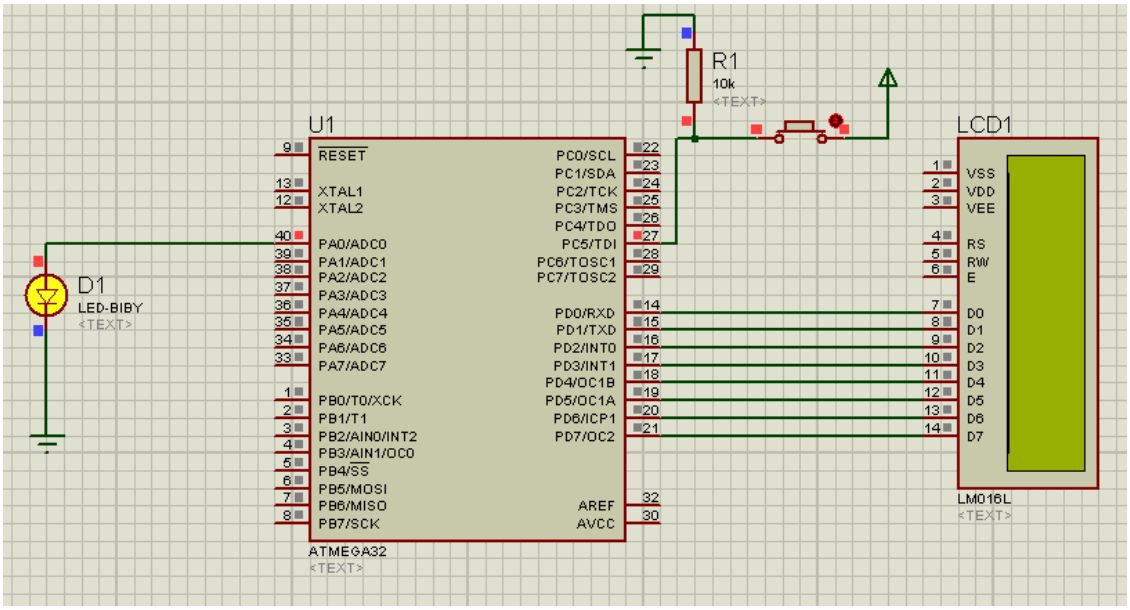
Create your very first project in Atmel Studio

- The First screen shown up after the AS5 has started is the Start Page. The start page helps you quickly create a new project or load your previous project without wasting much time.
  File → New Project → GCC C executable → ATMega32 microcontroller



We want just to display a count variable in the terminal

- Create a main.c file compile it and see if everything works proprelly
- Next create uartstdio.c and uart _stdio.h file, where we created functions uart_stdio_Init(), uart_stdio_PutChar().



Conclusion

By completing this project, I have gained a basic understanding ofabout microcontrolles. I undersand how it work, also I got familiar with AVR Studio and Proteus ISIS. I created a driver for communication with the terminal, and made a couple of basic functions for theterminal such as initialisation and putChar;