Setup and Use of the LPM Instruction

Features

- **Use of the LPM (Load Program Memory) Instruction with the AVR® Assembler**
- **Load Constants from Program Memory**
- **Use of Look-up Tables**

Introduction

This application note describes how to access the constants saved in the Flash program memory of the microcontroller embedded in FPSLIC devices. The AVR microcontroller is based on a Harward architecture, this means that Address and Data memory use separate busses. This is necessary to achieve single cycle instructions execution speed. To be able to save constants in Flash memory the Load Program Memory, (LPM) instruction is included in the instruction set. The Assembly code with an example of the LPM instruction can be found in the FPSLIC Software section of the Atmel web site (http://www.atmel.com), under the **3049.asm** archive.

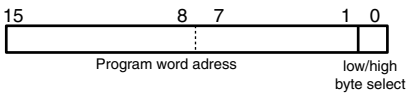
Use of the LPM

The LPM instruction is included in the AVR instruction set to load a data byte from the FLASH program memory into the register file.

The flash program memory of the AVR microcontroller is organized as 16-bit words. The register file and SRAM data memory are organized as 8 bits bytes. Special consideration must therefore be taken when loading data from program memory to data memory.

The Z-register in the register file is used to access the program memory. This 16-bit register pair is used as a 16-bit pointer to the program memory. The 15 most significant bits select the word address in program memory. Because of this, the word address is multiplied by 2 before it is put in the Z register.

Figure 1. Z Address Register



The least-significant bit of the Z address register selects either low byte (0) or high byte(1) of the program memory word. To calculate the low (ZL) an high (ZH) part of the address, use the LOW() and HIGH() functions.

To load data from random places in program memory, the Z register must be set up with the proper address each time a new address is accessed.

In program memory the data is organized with one byte in the low part of a program word and the next byte in the high part. Because of this, the message string will

FPSLIC™

Programmable SLI

AT94K

AT94S

Application Note

Rev. 3049A–FPSLI–04/02

appear as if every pair of characters has been swapped, when viewed in the memory view in AVR Studio®.

The program in this application note loads a string of bytes from the program memory and writes it to Port D. The program first initializes Port D so that all the pins are output. It loads the starting address of the string “Hello World” into Z register, as described above. Then a byte is loaded from program memory. The program checks whether or not the end of the string is reached (byte was zero). If the end is not reached yet the last read byte is put on Port D, a short delay is made, and the Z register is increased. The program then jumps back to load another byte.

```
;**** A P P L I C A T I O N   N O T E ************************
;*
;* Title:        Load Program Memory
;* Version:      1.0
;* Last updated: 98.12.17
;* Target:       AT94K
;*
;* DESCRIPTION
;* This Application note shows how to use the Load Program Memory (LPM)
;* instruction. The application note loads the string “Hello World” from
;* program memory byte by byte, and puts it onto port D.
;*
;***************************************************************************


  .include “at94kdef.inc”
  .device   AT94K                   ; Specify device
  .def      temp=r16                ; Define temporary variable


  start:
    ldi     temp,low(RAMEND)
    out     SPL,temp                ; Set stack pointer to last internal RAM
location
    ldi     temp,high(RAMEND)
    out     SPH,temp

    ldi     temp,$ff
    out     PORTD,temp              ; Set all pins at port D high
    out     DDRD,temp               ; Set port D as output

  ; Load the address of ‘message’ into the Z register. Multiplies
  ; word address with 2 to achieve the byte address, and uses the
  ; functions high() and low() to calculate high and low address byte.

    ldi     ZH,high(2*message)      ; Load high part of byte address into ZH
    ldi     ZL,low(2*message)       ; Load low part of byte address into ZL

  loadbyte:
    lpm                             ; Load byte from program memory into r0
```

```
    tst     r0                      ; Check if we've reached the end of the
message
    breq    quit                    ; If so, quit

    out     PORTD,r0                ; Put the character onto Port B
    rcall   one_sec_delay           ; A short delay

    adiw    ZL,1                    ; Increase Z registers
    rjmp    loadbyte

    quit:   rjmp quit

  one_sec_delay:
    ldi     r20, 20
    ldi     r21, 255
    ldi     r22, 255
  delay:
    dec     r22
    brne    delay
    dec     r21
    brne    delay
    dec     r20
    brne    delay
    ret

  message:
  .db "Hello World"
  .db 0
```

Atmel Headquarters

Corporate Headquarters
2325 Orchard Parkway
San Jose, CA 95131
TEL 1(408) 441-0311
FAX 1(408) 487-2600

Europe
Atmel Sarl
Route des Arsenaux 41
Casa Postale 80
CH-1705 Fribourg
Switzerland
TEL (41) 26-426-5555
FAX (41) 26-426-5500

Asia
Atmel Asia, Ltd.
Room 1219
Chinachem Golden Plaza
77 Mody Road Tsimhatsui
East Kowloon
Hong Kong
TEL (852) 2721-9778
FAX (852) 2722-1369

Japan
Atmel Japan K.K.
9F, Tonetsu Shinkawa Bldg.
1-24-8 Shinkawa
Chuo-ku, Tokyo 104-0033
Japan
TEL (81) 3-3523-3551
FAX (81) 3-3523-7581

Atmel Operations

Memory
Atmel Corporate
2325 Orchard Parkway
San Jose, CA 95131
TEL 1(408) 436-4270
FAX 1(408) 436-4314

Microcontrollers
Atmel Corporate
2325 Orchard Parkway
San Jose, CA 95131
TEL 1(408) 436-4270
FAX 1(408) 436-4314

Atmel Nantes
La Chantrerie
BP 70602
44306 Nantes Cedex 3, France
TEL (33) 2-40-18-18-18
FAX (33) 2-40-18-19-60

ASIC/ASSP/Smart Cards
Atmel Rousset
Zone Industrielle
13106 Rousset Cedex, France
TEL (33) 4-42-53-60-00
FAX (33) 4-42-53-60-01

Atmel Colorado Springs
1150 East Cheyenne Mtn. Blvd.
Colorado Springs, CO 80906
TEL 1(719) 576-3300
FAX 1(719) 540-1759

Atmel Smart Card ICs
Scottish Enterprise Technology Park
Maxwell Building
East Kilbride G75 0QR, Scotland
TEL (44) 1355-803-000
FAX (44) 1355-242-743

RF/Automotive
Atmel Heilbronn
Theresienstrasse 2
Postfach 3535
74025 Heilbronn, Germany
TEL (49) 71-31-67-0
FAX (49) 71-31-67-2340

Atmel Colorado Springs
1150 East Cheyenne Mtn. Blvd.
Colorado Springs, CO 80906
TEL 1(719) 576-3300
FAX 1(719) 540-1759

Biometrics/Imaging/Hi-Rel MPU/
High Speed Converters/RF Datacom
Atmel Grenoble
Avenue de Rochepleine
BP 123
38521 Saint-Egreve Cedex, France
TEL (33) 4-76-58-30-00
FAX (33) 4-76-58-34-80

Atmel Programmable SLI Hotline
(408) 436-4119

Atmel Programmable SLI e-mail
fpslic@atmel.com

FAQ
Available on web site

e-mail
literature@atmel.com

Web Site
http://www.atmel.com

3049A–FPSLI–04/02 0M