
Software Examples Manual

FRONTLINE
ELECTRONICS

Copyright © 2002 Frontline Electronics Pvt Ltd. All Rights Reserved.

Information in this document is subject to change without notice. No part of this document may be reproduced or transmitted in any form or by any means, electronic or mechanical, for any purpose without the express written permission of Frontline Electronics Pvt Ltd.

FRONTLINE
ELECTRONICS

Software Examples Manual

Contents

Chapter 1 - Introduction

1.1 Introduction	1
1.2 Interrupts	5

Chapter 2 - Example Programs

Example 1: Flashing the LED connected to port line P1.4 using CPL instruction.....	7
Example 2: Flashing the LED connected to port line P1.4 using SETB and CLR instructions.	8
Example 3: Read the status of the switch SW1 (connected to portline P1.2) and display it on LED connected to Port line P1.5.	9
Example 4: AND operation using ANL instruction.	10
Example 5: NAND operation using ORL instruction.	11
Example 6: OR operation using ORL instruction.	12
Example 7: NOR operation using ORL instruction.	13
Example 8: Up/Down Counter	14
Example 9: Study of INT1 interrupt (using Level triggering)	16
Example 10: Study of INT1 interrupt (Using Edge triggering)	19
Example 11: Study of Timer 0 - External Event Counter	22
Example 12: Study of Serial Port	23
Example 13: Addition of two 8 bit numbers	26
Example 14: Subtraction of two 8 bit numbers	28
Example 15: Multiplication of two 8 bit numbers	30
Example 16: Division of two 8 bit numbers	32
Example 17: Display message "HELLO"	33
Example 18: Flash message "HELP"	35
Example 19: 32 Bit Addition.....	36
Example 20: 32 Bit Subtraction.....	38

Example 21: 5 Digit BCD to binary conversion	40
Example 22: 16 bit binary to BCD conversion	43

Chapter 3 - Routines

Routine 1: Clears the seven segment display.	47
Routine 2: Displays a message.	48
Routine 3: Displays Carry and Accumulator contents in the seven segment display	49
Routine 4: Displays B register and Accumulator contents in first 4 digits of seven segment display.	50
Routine 5: Displays the lower nibble of Acc(hex) in the seven segment display.	51
Routine 6: Displays a character in the seven segment display.	52
Routine 7: Delay Routine (approximately one second).	53
Routine 8: Displays the contents of DPTR in first four digits of the display	54
Routine 9: Displays the contents of accumulator	55
Routine 10: Checks the keyboard status and waits until a key is pressed Note that the key value is not read from Keyboard display controller.	57
Routine 11: Checks the keyboard status waits until a key is pressed. The key value is read and returned in Acc.	58
Routine 12: Reads a four digit data from keyboard and displays them in the first 4 digits of the display.	59
Routine 13: Reads 2 digit data from keyboard and displays it in the display	60
Routine 14: Reads a byte from keyboard/display controller.	61
Routine 15: Writes a byte to keyboard/display controller.	62
Routine 16: Serial Port initialization routine.	64
Routine 17: Waits until a byte of data is received on serial port.	66
Routine 18: Sends the Accumulator data to Serial port.	67

Routine 19: Hexadecimal to Decimal conversion routine (Both Input and output values are in internal memory)	68
Routine 20: Hexadecimal to Decimal conversion routine (Both Input and output values are stored in external memory)	70
Routine 21: Decrements DPTR by one (16 bit decrement)	72
Routine 22: Writes a byte to RTC	73
Routine 23: Reads a byte from RTC	74

1.1 Introduction

The examples are designed taking into consideration all the facilities available in the trainers.

You have two options to load the example programs and the routines into the trainer.

The first option is when you are using the trainer in the standalone mode.

You have a function called 'Load Examples' using which you can load all the examples and common routines in the RAM locations F600H to FCFFH.

Now the programs are readily available in the RAM for execution.

The other option comes into picture when you are using Topview Debugger.

The CD supplied along with trainer contains hex, assembly and listing files of the example programs and routines.

By using the 'Load Program' option in the Topview Debugger, select the file 'Examples.hex' in the 'Examples' directory. The examples will be loaded into the trainer and it can be executed.

The following table gives necessary details required for the examples.

Name	Address	Description
Example 1	F600H	Flashing the LED connected to port line P1.4 using CPL instruction.
Example 2	F610H	Flashing the LED connected to port line P1.4 using SETB and CLR instructions.
Example 3	F620H	Read the status of the switch SW1 (connected to port line P1.2) and display it on LED connected to Port line P1.5
Example 4	F630H	AND operation using ANL instruction
Example 5	F640H	NAND operation using ORL instruction.
Example 6	F650H	OR operation using ORL instruction.
Example 7	F660H	NOR operation using ORL instruction.
Example 8	F670H	Up/Down Counter
Example 9	F6A0H	Study of INT1 interrupt - (using Level triggering)
Example 10	F6C0H	Study of INT1 interrupt - (Using Edge triggering)
Example 11	F6E0H	Study of Timer 0 - External Event Counter
Example 12	F700H	Study of Serial Port
Example 13	F740H	Addition of two 8 bit numbers
Example 14	F750H	Subtraction of two 8 bit numbers
Example 15	F760H	Multiplication of two 8 bit numbers
Example 16	F770H	Division of two 8 bit numbers
Example 17	F780H	Display message "HELLO"
Example 18	F7A0H	Flash message "HELP"
Example 19	F7D0H	32 Bit Addition
Example 20	F800H	32 Bit Subtraction
Example 21	F830H	5 Digit BCD to binary conversion
Example 22	F8A0H	16 bit binary to BCD conversion

The following table gives necessary details required for the routines.

Routine Name	Address	Description
CLEAR_DISPLAY	F900H	Clears the seven segment display.
DISPLAY_MESSAGE	F910H	Displays a message.
DISPLAY_CARRY_ACC	F930H	Displays Carry and Accumulator contents on seven segment display.
DISPLAY_B_ACC	F960H	Displays B register and Accumulator contents on seven segment display in first 4 digits.
DISPLAY_ACC_NIBBLE	F980H	Displays the lower nibble of Acc (hex) on the seven segment display.
DISPLAY_ONE_CHARACTER	F9B0H	Displays a character on seven segment display.
DELAY	F9C0H	Delay Routine (approximately one second).
DISPLAY_DPTR	F9E0H	Displays the contents of DPTR in first four digits
DISPLAY_ACC	FA10H	Displays the contents of accumulator
CHKKEYSTATUS	FA50H	Checks the keyboard status and waits until a key is pressed. But the key value is not read from Keyboard display controller.
READKEYBOARD	FA60H	Checks the keyboard status waits until a key is pressed. The key value is returned in Acc.
GET4DIGIT	FA80H	Reads a four digit data from keyboard and displays them in the first 4 digits.
GET2DIGIT	FAB0H	Reads 2 digit data from keyboard and displays it.
READ_ONE_BYTE	FAE0H	Reads a byte from keyboard/display controller.
SEND_ONE_BYTE	FB10H	Writes a byte to keyboard/ display controller.

INITIALIZE_SERIALPORT	FB40H	Serial Port initialization routine.
RECEIVE_BYTE	FB90H	Waits until a byte of data is received on serial port.
TRANSMIT_BYTE	FBA0H	Sends the Accumulator data to Serial port.
HEX_TO_DECIMAL_INTERNAL	FBB0H	Hexadecimal to Decimal conversion routine. (Both Input and output values are in internal memory)
HEX_TO_DECIMAL_EXTERNAL	FBE0H	Hexadecimal to Decimal Conversion routine. (Both Input and output values are stored in external memory)
DEC_DPTR	FC20H	Decrements DPTR by one (16 bit decrement)
WRITEBYTE	FC30H	Writes a byte to RTC
READBYTE	FC60H	Read a byte from RTC

1.2 Interrupts

When an interrupt occurs the control branches to its vector address which is in the first page of the code memory (Flash memory). To make available the vector locations to the user a call instruction to the RAM address is provided in that location. The control will execute the instruction and branch to RAM location found in the instruction.

The following table gives the interrupt vector addresses and the equivalent RAM locations.

Interrupt	Vector addresses	RAM locations
Timer 0	000BH	FD00H
Interrupt1	0013H	FD04H
Timer 1	001BH	FD08H
Timer 2	002BH	FD0CH

You can load the interrupt service routine in the respective RAM locations.

Note:

Since INT0 and serial port interrupts are used by the monitor, it is not available to the users.



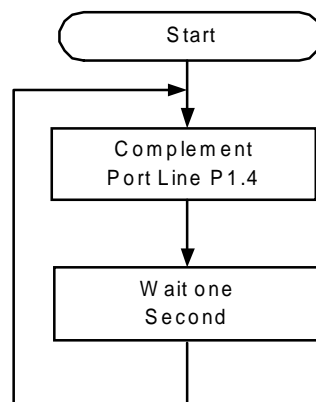
Example 1:

```

;-----
;Flashing the LED connected to port line P1.4 using CPL instruction.
;
;
;Output : LED1 will be flashing with an on time of 1 sec
;         and an off time of 1 sec.
;-----

```

Flow chart:



Program Listing:

```

F600                ORG    0F600H

F600                FLASH1:
F600 B2 94          CPL    P1.4    ;Complement the Level at port
                               ;line P1.4
F602 12 F9 C0      LCALL  DELAY    ;Delay for one second (approx)
F605 80 F9          SJMP   FLASH1  ;Repeat

```

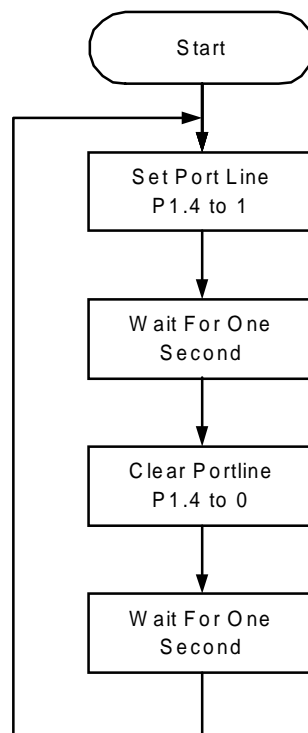
Example 2:

```

;-----
;Flashing the LED connected to port line P1.4 using SETB and CLR
;instructions.
;
;Output : LED1 will be flashing with an on time of 1 sec
;         and an off time of 1 sec.
;-----

```

Flow chart:



Program Listing:

```

F610                ORG    0F610H

F610                FLASH2:
F610 D2 94          SETB   P1.4    ;Set the level of port line P1.4 to 1
F612 12 F9 C0      LCALL  DELAY    ;Delay for one second (approx)
F615 C2 94          CLR     P1.4    ;Clear the port line P1.4
F617 12 F9 C0      LCALL  DELAY    ;Delay for one second (approx)
F61A 80 F4          SJMP   FLASH2  ;Repeat

```

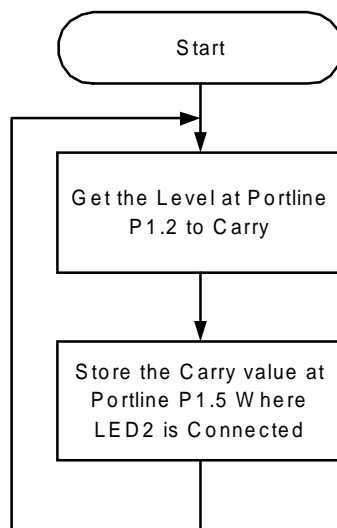
Example 3:

```

;-----
;Read the status of the switch SW1 (connected to portline P1.2)
;and display it on LED connected to Port line P1.5.
;
;Input : Through switch SW1 condition - '1' level
;          condition - '0' level
;
;Output: LED2 will glow when SW1 is in 'off' position
;        and LED2 will be switched off if SW1 is in 'on' position.
;-----

```

Flow Chart:



Program Listing:

```

F620                ORG    0F620H

F620                REPEAT:
F620 A2 92          MOV    C,P1.2    ;Move the level at port line P1.2 to
                                ;Carry
F622 92 95          MOV    P1.5,C    ;Move the carry to port line P1.5
F624 80 FA          SJMP   REPEAT    ;Repeat

```

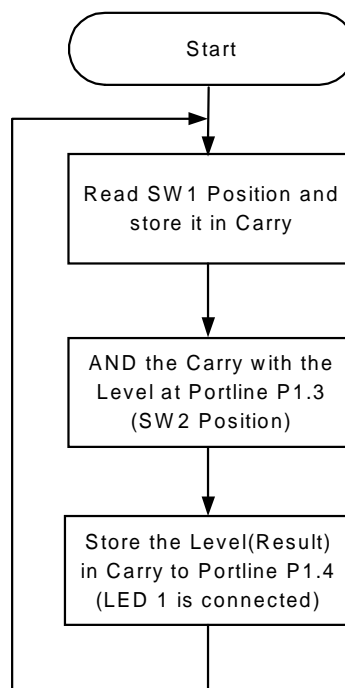
Example 4:

```

;-----
;AND operation using ANL instruction.
;
;Input : Through Toggle switches SW1 and SW2 connected to
;        P1.2 and P1.3 respectively
;
;Output: LED connected to P1.4 (LED1)
;-----

```

Flow Chart:



Program Listing:

```

F630                ORG    0F630H

F630                REPEAT1:
F630 A2 92          MOV    C,P1.2    ;Move the level at port line P1.2 to
                                ;Carry
F632 82 93          ANL    C,P1.3    ;AND the carry with port line P1.3
F634 92 94          MOV    P1.4,C    ;Move the carry (result) to port line
                                ;P1.4
F636 80 F8          SJMP   REPEAT1   ;Repeat

```

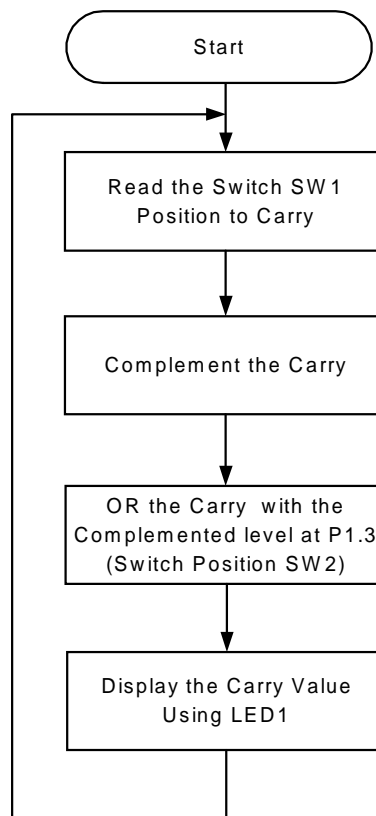
Example 5:

```

;-----
;NAND operation using ORL instruction.
;
;Input : Through Toggle switches SW1 and SW2 connected to
;        P1.2 and P1.3 respectively
;
;Output: LED connected to P1.4 (LED1)
;-----

```

Flow Chart:



Program Listing:

```

F640                ORG    0F640H
F640                REPEAT2:
F640 A2 92          MOV    C,P1.2    ;Move the level at port line P1.2
                                   ;to Carry
F642 B3            CPL    C
F643 A0 93          ORL    C,/P1.3   ;OR the carry with port line P1.3
F645 92 94          MOV    P1.4,C    ;Move the carry (result) to port line
                                   ;P1.4
F647 80 F7          SJMP   REPEAT2   ;Repeat

```

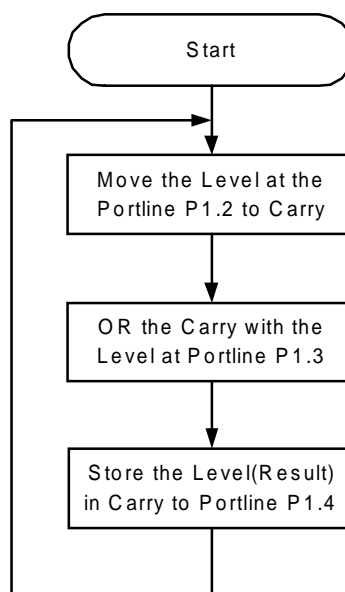

Example 6:

```

;-----
;OR operation using ORL instruction.
;
;Input : Through Toggle switches SW1 and SW2 connected to
;        P1.2 and P1.3 respectively
;
;Output: LED connected to P1.4 (LED1)
;-----

```

Flow Chart:



Program Listing:

```

F650                ORG    0F650H

F650                REPEAT3:
F650 A2 92          MOV    C,P1.2    ;Move the level at port line P1.2 to
                                ;Carry
F652 72 93          ORL    C,P1.3    ;OR the carry with port line P1.3
F654 92 94          MOV    P1.4,C    ;Move the carry (result) to port
                                ;line P1.4
F656 80 F8          SJMP   REPEAT3   ;Repeat

```

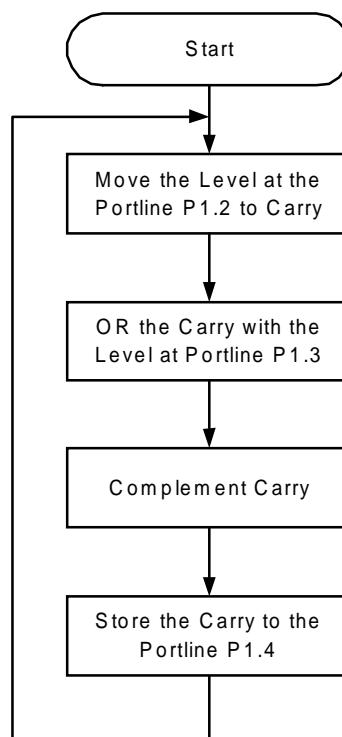
Example 7:

```

;-----
;NOR operation using ORL instruction.
;
;Input : Through Toggle switches SW1 and SW2 connected to
;        P1.2 and P1.3 respectively
;
;Output: LED connected to P1.4 (LED1)
;-----

```

Flow Chart:



Program Listing:

```

F660                ORG    0F660H

F660                REPEAT4:
F660 A2 92          MOV    C,P1.2    ;Move the level at port line P1.2
                                ;to Carry
F662 72 93          ORL    C,P1.3    ;OR the carry with port line P1.3
F664 B3             CPL    C         ;Invert the carry to get NOR operation
F665 92 94          MOV    P1.4,C    ;Move the carry (result) to port line
                                ;P1.4
F667 80 F7          SJMP   REPEAT4   ;Repeat

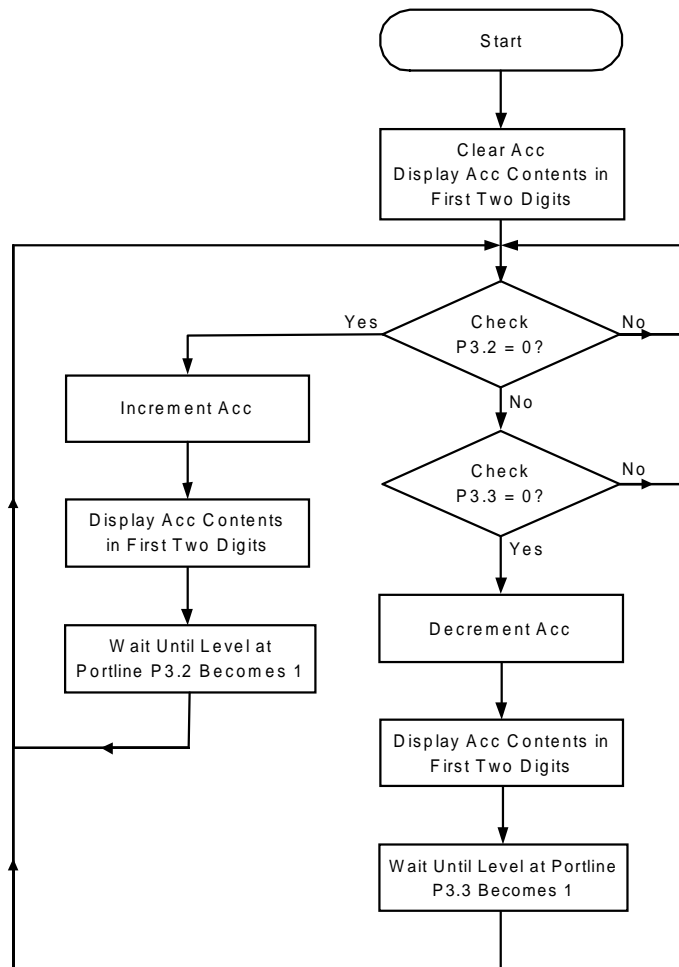
```

Example 8:

```

;-----
;Up/Down Counter
;
;Input : Up count clock through push button switch connected to
;        P3.2 (SW3) Down count clock through push button switch connec-
;        ted to P3.3 (SW4)
;
;Output: In the Seven segment display of trainer.
;
;Observation:
; After entering and executing the program,
; 1. Press SW3 to count up and the incremented count value is
;    displayed in seven segment display.
; 2. Press SW4 to count down and the decremented count value is
;    displayed in seven segment display.
;-----
    
```

Flow Chart:



Program Listing:

```

F670                ORG      0F670H

F670 74 00          MOV     A,#00H    ;Clear Accumulator
F672 7F 90          MOV     R7,#90H   ;Move first digit address to R7
F674 12 F9 00       LCALL  CLEAR_DISPLAY
                                ;Clear display
F677 12 FA 10       LCALL  DISPLAY_ACC
                                ;Display Acc contents
F67A                RPT_UP_DOWN:
F67A 30 B2 05       JNB     P3.2,COUNTUP
                                ;Jump to count up if switch SW3
                                ;is pressed
F67D 30 B3 11       JNB     P3.3,COUNTDOWN
                                ;Jump to count down if switch SW4
                                ;is pressed
F680 80 F8          SJMP   RPT_UP_DOWN
                                ;Repeat
F682                COUNTUP:
F682 04             INC     A        ;Increment Acc contents(count)
F683 C0 E0          PUSH   ACC       ;Store it on stack
F685 7F 90          MOV     R7,#90H   ;Move first digit address to R7
F687 12 FA 10       LCALL  DISPLAY_ACC
                                ;Display Acc contents
F68A D0 E0          POP     ACC       ;Restore Acc contents from stack
F68C 30 B2 FD       JNB     P3.2,$    ;Wait until switch depressed
F68F 80 E9          SJMP   RPT_UP_DOWN
                                ;Jump to continue
F691                COUNTDOWN:
F691 14             DEC     A        ;Decrement Acc contents(count)
F692 C0 E0          PUSH   ACC       ;Store it on stack
F694 7F 90          MOV     R7,#90H   ;Move first digit address to R7
F696 12 FA 10       LCALL  DISPLAY_ACC
                                ;Display Acc contents
F699 D0 E0          POP     ACC       ;Restore Acc contents from stack
F69B 30 B3 FD       JNB     P3.3,$    ;Wait until switch depressed
F69E 80 DA          SJMP   RPT_UP_DOWN
                                ;Jump to continue

```

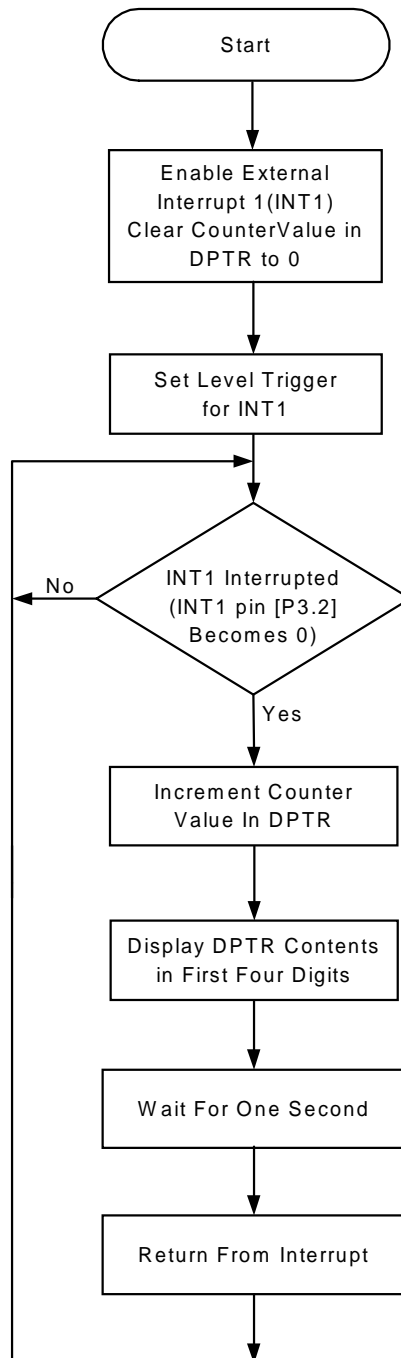
Example 9:

```

;-----
;Study of INT1 interrupt - (using Level triggering)
;
;Input : INT1 is Activated by a switch (SW4) connected to P3.3
;
;Output: Displayed in the Seven segment display of trainer. Whenever
;        INT1 is activated, a 16 bit count is Incremented by one
;        and displayed in the seven segment display.
;
;        In interrupt service routine, after displaying the DPTR
;        contents, a 1 second delay is called. If you keep on
;        pressing the switch the count will be incremented for
;        every second, which means interrupt occurs again and again
;        with a delay of one second
;
;
;Note:   You have to enter opcodes for LJMP instruction to the
;        interrupt routine(INT1_ROUTINE) in the RAM locations
;        starting from FD04H as shown below:
;        (In the monitor, a jump instruction to the RAM address
;        FD04H is provided in the vector branch address of
;        the interrupt INT1).
;
;        Address      Opcode   Description
;        -----
;        FD04          02       LJMP opcode
;        FD05          F6       High byte address of INT1_ROUTINE
;        FD06          AD       Low byte address of INT1_ROUTINE
;-----

```

Flow Chart:



Program Listing:

```

F6A0          ORG      0F6A0H

F6A0 43 A8 84    ORL      IE,#84H    ;Enable INT1
F6A3 90 00 00    MOV      DPTR,#0000H
                                ;Clear DPTR (16 bit count)
F6A6 12 F9 00    LCALL   CLEAR_DISPLAY
                                ;Clear display
F6A9 C2 8A      CLR      IT1      ;Set level trigger for INT1
F6AB 80 FE      SJMP   $        ;Halt

F6AD          INT1_ROUTINE:
F6AD A3          INC      DPTR      ;Increment 16 bit count in DPTR
F6AE C0 83      PUSH   DPH
F6B0 C0 82      PUSH   DPL      ;Store DPTR on stack
F6B2 12 F9 E0    LCALL   DISPLAY_DPTR
                                ;Display DPTR contents on display
F6B5 D0 82      POP    DPL
F6B7 D0 83      POP    DPH      ;Restore DPTR from stack
F6B9 12 F9 C0    LCALL   DELAY      ;one second delay
F6BC 32          RETI     ;Return from interrupt

```

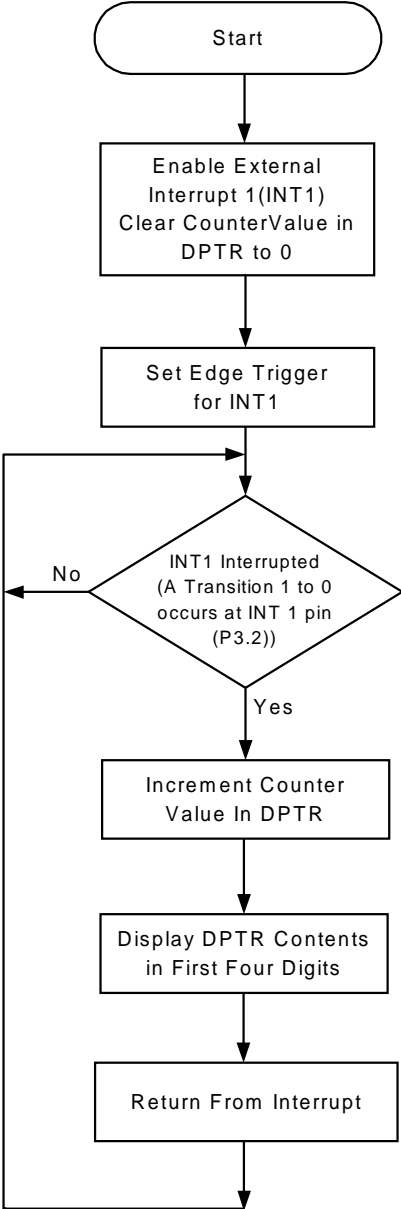
Example 10:

```

;-----
;Study of INT1 interrupt - (Using Edge triggering)
;
;Input : INT1 is Activated by a switch (SW4) connected to P3.3
;
;Output: DPTR value is displayed Seven segment display of trainer.
;        Whenever INT1 is activated, a 16 bit count is incremented
;        by one and displayed in seven segment display.
;
;Note:   Negative edge triggering is used here. When you press
;        the key, the transition generates an interrupt. If you keep
;        on pressing the key without releasing, there will not be
;        change in the count, since edge triggering is used. Hence
;        release the key and press once again to generate an
;        interrupt signal.
;
;Note:   You have to enter opcodes for LJMP instruction to the
;        interrupt routine(INT1_ROUTINE) in the RAM locations
;        starting from FD04H as shown below:
;        (In the monitor, a jump instruction to the RAM address
;        FD04H is provided in the vector branch address of
;        the interrupt INT1).
;
;        Address          Opcode    Description
;        -----
;        FD04             02         LJMP opcode
;        FD05             F6         High byte address of INT1_ROUTINE
;        FD06             CD         Low byte address of INT1_ROUTINE
;-----

```


Flow Chart:



Program Listing:

```
F6C0          ORG      0F6C0H

F6C0 43 A8 84      ORL      IE,#84H    ;Enable INT1
F6C3 90 00 00      MOV      DPTR,#0000H
                                ;Clear DPTR (16 bit count)
F6C6 12 F9 00      LCALL   CLEAR_DISPLAY
                                ;Clear display
F6C9 D2 8A          SETB    IT1      ;Set Edge trigger for INT1
F6CB 80 FE          SJMP    $          ;Halt

F6CD          INT1_ROUTINE1:
F6CD A3            INC      DPTR      ;Increment 16 bit count in DPTR
F6CE C0 83          PUSH   DPH
F6D0 C0 82          PUSH   DPL      ;Store DPTR on stack
F6D2 12 F9 E0      LCALL   DISPLAY_DPTR
                                ;Display DPTR contents on display
F6D5 D0 82          POP    DPL
F6D7 D0 83          POP    DPH      ;Restore DPTR from stack
F6D9 12 F9 C0      LCALL   DELAY    ;one second delay
F6DC 32            RETI     ;Return from interrupt
```

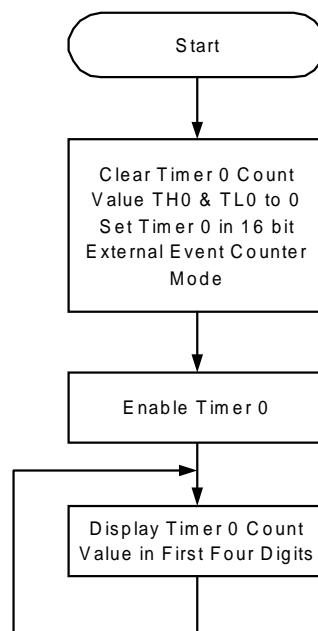
Example 11:

```

;-----
;Study of Timer 0 - External Event Counter
;
;Input : The external clock is given through a push button
;        switch (SW4) connected to P3.4
;
;Output: On Seven segment display of the trainer. The 16 bit count
;        value (TH0 and TL0) are read and displayed.
;-----

```

Flow Chart:



Program Listing:

```

F6E0                ORG      0F6E0H
F6E0 75 8C 00        MOV     TH0,#00H
F6E3 75 8A 00        MOV     TL0,#00H      ;Clear Timer 0 count value
F6E6 75 89 05        MOV     TMOD,#05H    ;Set Timer 0 in external event
                                ;counter mode
F6E9 12 F9 00        LCALL  CLEAR_DISPLAY ;Clear display
F6EC D2 8C           SETB   TR0           ;Enable Timer 0
F6EE                RPT_TIMER0:
F6EE 85 8C 83        MOV     DPH,TH0
F6F1 85 8A 82        MOV     DPL,TL0     ;Move the Timer 0 count to DPTR
F6F4 12 F9 E0        LCALL  DISPLAY_DPTR ;Display DPTR contents
F6F7 80 F5          SJMP   RPT_TIMER0  ;Repeat

```

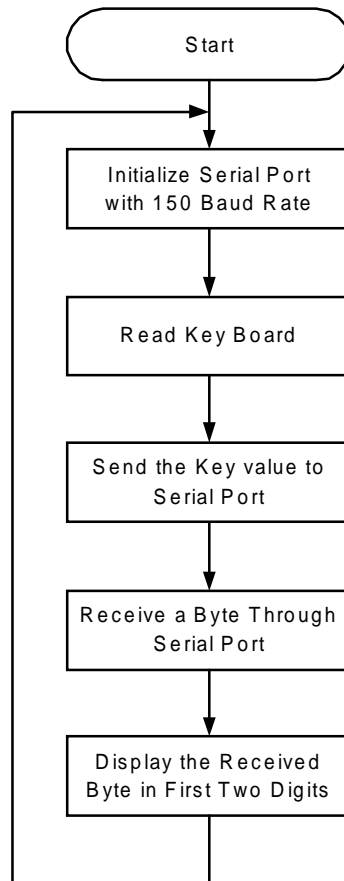
Example 12:

```

;-----
;Study of Serial Port
;
;Note:   Before executing program short pin 2 and pin 3
;        of the serial port connector CON3.
;
;        The pressed key value will be sent through serial port.
;        The same character will be received back via serial port.
;        This is possible only if pins 2 and 3 are shorted in
;        the serial port connector.
;
;        A minimum baud rate of 150 is used for data transfer.
;        Hence LED's connected to port lines P3.0 and P3.1 will be
;        flashing during data transfer and it can be observed.
;-----

```

Flow Chart:



Program Listing:

```

F700                ORG      0F700H

F700 12 F9 00        LCALL   CLEAR_DISPLAY ;Clear display
F703 12 F7 16        LCALL   INI_SERIALPORT
                                ;Initialize serial port

F706                RPT_SERIAL:
F706 12 FA 60        LCALL   READKEYBOARD ;Wait for a key press and get the
                                ;key code for pressed key.
F709 12 F7 2A        LCALL   TRANSMITBYTE ;Send the key code to serial port
F70C 12 F7 22        LCALL   RECEIVEBYTE ;Receive a byte from serial port
F70F 7F 90          MOV     R7,#90H ;Move first digit address to R7
F711 12 FA 10        LCALL   DISPLAY_ACC ;Display it on display
F714 80 F0          SJMP    RPT_SERIAL ;Repeat

                                ;-----
                                ; Serial Port INITIALISATION ROUTINE.
                                ;-----

F716                INI_SERIALPORT:
F716 75 98 52        MOV     SCON,#52H ;Load SCON with 52H Chooses mode
                                ;1 makes REN = 1 & TI = 1
F719 75 89 20        MOV     TMOD,#20H ;Load TMOD with 20H
                                ;chooses Timer 1 in Timer Auto
                                ;reload mode
F71C 75 8D 30        MOV     TH1,#30H ;Load Timer 1 high byte with baud
                                ;rate count value(30H -> 150)
F71F D2 8E          SETB   TR1 ;Start Timer 1
F721 22             RET

                                ;-----
                                ;WAITS UNTIL A BYTE OF DATA RECEIVED ON SERIAL PORT.
                                ;-----

F722                RECEIVEBYTE:
F722 30 98 FD        JNB     RI,$ ;Repeat until a character received
F725 E5 99          MOV     A,SBUF ;Get the received character from
                                ;serial port buffer
F727 C2 98          CLR     RI ;Clear receiver flag
F729 22             RET

```

```

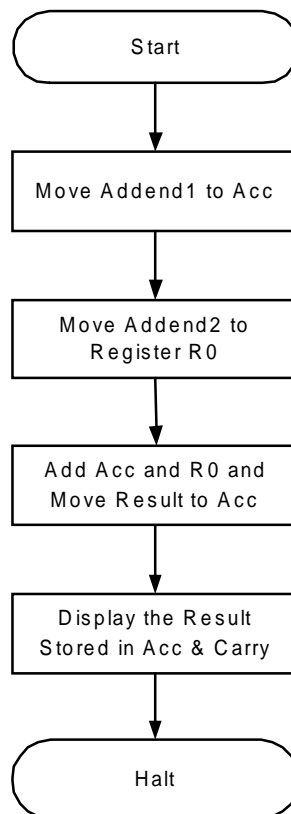
;-----
;SENDS THE DATA IN ACCUMULATOR TO SERIAL PORT.
;-----

F72A          TRANSMITBYTE:
F72A F5 99          MOV     SBUF,A           ;Write the data in Acc to serial
                                           ;transmit buffer
F72C 30 99 FD      JNB     TI,$           ;Wait until transmit buffer be
                                           ;comes empty
F72F C2 99          CLR     TI           ;Clear transmit flag
F731 22           RET
```

Example 13:

```
-----  
;Addition of two 8 bit numbers  
;  
;Input : Acc - Addend1  
;       R0  - Addend2  
;  
;Output: Result will be displayed in the seven segment display.  
;  
;Example: Addend1 in F741H - 50H  
;         Addend2 in F743H - 10H  
;         Result will be   - 060H  
-----
```

Flow Chart:



Program Listing:

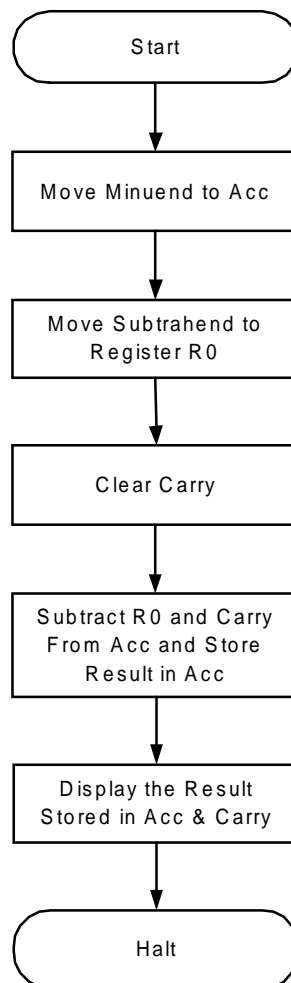
```
F740                ORG      0F740H

F740 12 F9 00      LCALL   CLEAR_DISPLAY
                                ;Clear display
F743 74 50        MOV     A,#50H   ;Move Addend1 to Acc
F745 78 10        MOV     R0,#10H  ;Move Addend2 to R0
F747 28           ADD     A,R0    ;Subtract
F748 12 F9 30      LCALL   DISPLAY_CARRY_ACC
                                ;Display the result
F74B 80 FE        SJMP   $        ;Halt
```


Example 14:

```
-----  
;Subtraction of two 8 bit numbers  
;  
;Input : Acc - Minuend  
;       R0 - Subtrahend  
;  
;Output: Result will be displayed in the seven segment display.  
;  
;Example: Minuend in F751H   - 50H  
;         Subtrahend in F753H - 10H  
;         Result will be    - 040H  
-----
```

Flow Chart:



Program Listing

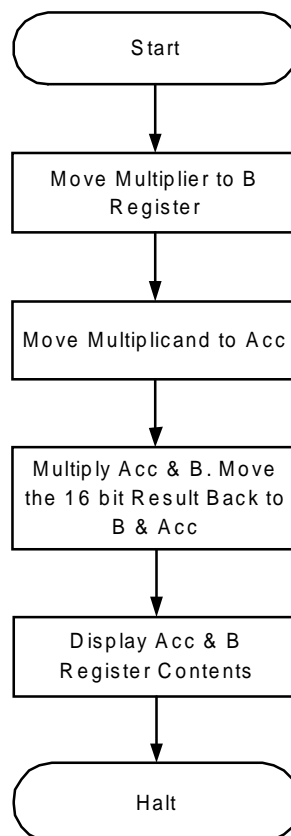
```
F750          ORG      0F750H

F750 12 F9 00      LCALL  CLEAR_DISPLAY
                                ;Clear display
F753 74 50          MOV   A,#50H    ;Move Minuend to Acc
F755 78 10          MOV   R0,#10H   ;Move subtrahend to R0
F757 C3            CLR   C          ;Clear carry
F758 98            SUBB  A,R0       ;Subtract
F759 12 F9 30      LCALL  DISPLAY_CARRY_ACC
                                ;Display the result
F75C 80 FE          SJMP  $         ;Halt
```

Example 15:

```
-----  
;Multiplication of two 8 bit numbers  
;  
;Input : Acc - Multiplicand  
;      B   - Multiplier  
;  
;Output: Result will be displayed in the seven segment display.  
;  
;Example: Multiplicand in F762H - 50H  
;      Multiplier in F764H - 10H  
;      Result will be      - 0500H  
-----
```

Flow Chart:



Program Listing

```
F760          ORG      0F760H

F760 12 F9 00      LCALL  CLEAR_DISPLAY
                                ;Clear display
F763 75 F0 50      MOV    B,#50H    ;Move Multiplier to B register
F766 74 10          MOV    A,#10H    ;Move Multiplicand to Acc
F768 A4            MUL    AB        ;Multiply Acc and B contents
F769 12 F9 60      LCALL  DISPLAY_B_ACC
                                ;Display the result
F76C 80 FE          SJMP  $
```

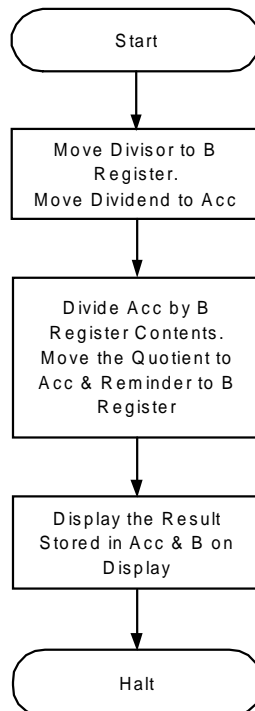
Example 16:

```

;-----
;Division of two 8 bit numbers
;
;Input : Acc  - Dividend
;        B    - Divisor
;
;Output: Result will be displayed in the seven segment display.
;
;Example :   Divisor in F772H  - 10H
;            Dividend in F774H - 50H
;            Result will be    - 0005H
;-----

```

Flow Chart:



Program Listing:

```

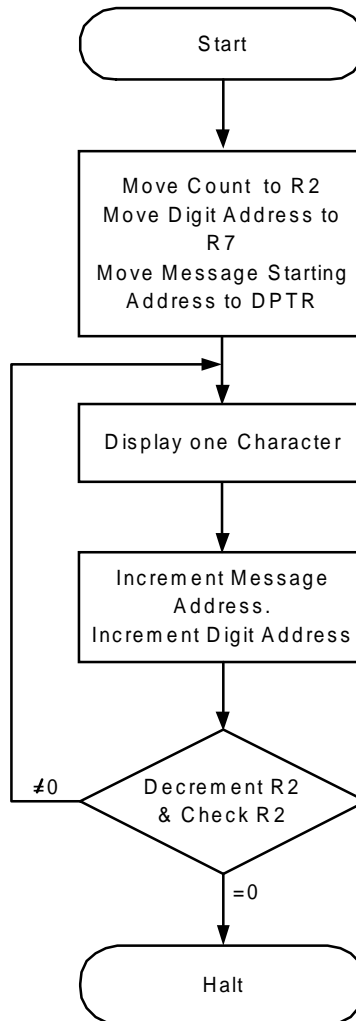
F770                ORG    0F770H
F770 12 F9 00       LCALL  CLEAR_DISPLAY ;Clear display
F773 75 F0 10       MOV    B,#10H      ;Move Divisor to B register
F776 74 50          MOV    A,#50H      ;Move Dividend to Acc
F778 84             DIV    AB          ;Divide Acc by B content
F779 12 F9 60       LCALL  DISPLAY_B_ACC ;Display the result
F77C 80 FE         SJMP   $

```

Example 17:

```
-----  
;Display message "HELLO"  
-----
```

Flow Chart:



Program Listing

```

F780                ORG      0F780H

F780 7A 06          MOV      R2,#06H    ;Move count value to R2
F782 7F 90          MOV      R7,#90H    ;Move first digit address to R7
F784 90 F7 91      MOV      DPTR,#ADD_HELLO
                                      ;Move address of seven segment codes

F787                RPT_HELLO:
F787 E0            MOVX     A,@DPTR
F788 12 F9 B0      LCALL    DISPLAY_ONE_CHARACTER
                                      ;Display one digit
F78B A3            INC      DPTR        ;Increment table address
F78C 0F            INC      R7          ;Increment digit address
F78D DA F8        DJNZ     R2,RPT_HELLO
                                      ;Decrement count and repeat until it
                                      ;becomes 0
F78F 80 FE        SJMP     $           ;Halt

F791                ADD_HELLO:
F791 7A            DB       7AH        ;"H"
F792 B3            DB       0B3H       ;"E"
F793 13            DB       13H        ;"L"
F794 13            DB       13H        ;"L"
F795 DB            DB       0DBH       ;"O"
F796 00            DB       00H        ;Blank

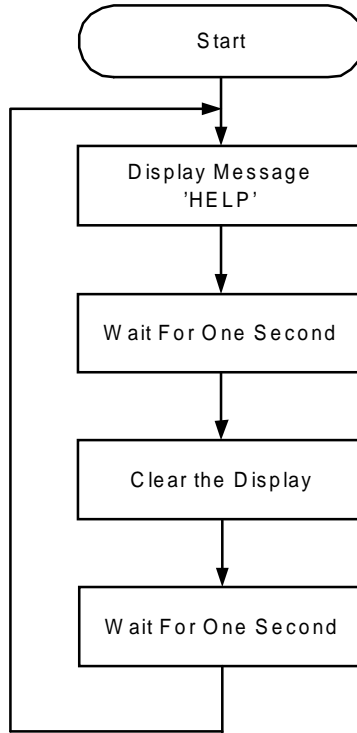
```

Example 18:

```

;-----
;Flash message "HELP"
;-----
    
```

Flow Chart:



Program Listing:

```

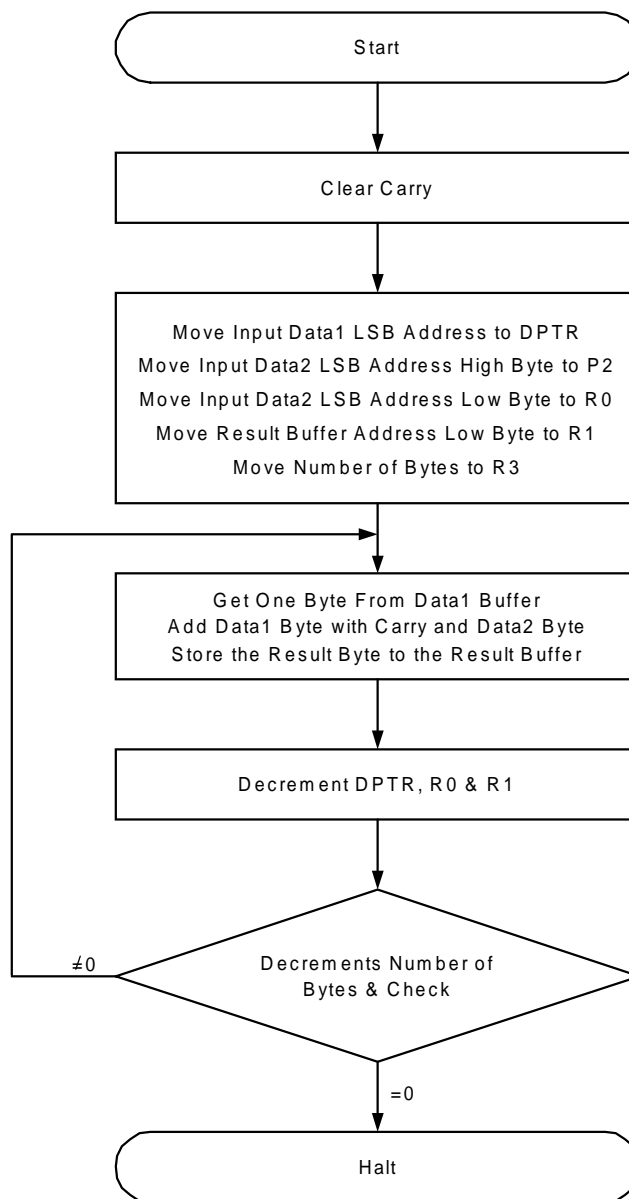
F7A0                ORG        0F7A0H
F7A0                HELP_START:
F7A0 90 F7 B4       MOV        DPTR,#ADD_HELP        ;Move starting address of
                                                ;Message to DPTR
F7A3 12 F9 10       LCALL     DISPLAY_MESSAGE      ;Display the message
F7A6 12 F9 C0       LCALL     DELAY                ;Wait for one second
F7A9 90 F7 BA       MOV        DPTR,#ADD_BLANK
F7AC 12 F9 10       LCALL     DISPLAY_MESSAGE      ;Clear display
F7AF 12 F9 C0       LCALL     DELAY                ;Wait for one second
F7B2 80 EC          SJMP      HELP_START           ;Repeat
F7B4                ADD_HELP:
F7B4 7A B3 13 F2    DB         7AH,0B3H,13H,0F2H    ;Data for displaying
F7B8 00 00          DB         00H,00H             ;Message 'HELP'
F7BA                ADD_BLANK:
F7BA 00 00 00 00    DB         00H,00H,00H,00H      ;Data for clearing
F7BE 00 00          DB         00H,00H             ;Display
    
```


Example 19:

```

;-----
;32 Bit Addition
;
;Input:  32 Bit Data1 -- F7EFH (MSB) TO F7F2H (LSB)
;        32 Bit Data2 -- F7F3H (MSB) TO F7F6H (LSB)
;
;Output: 32 Bit Result -- F7F7H (MSB) TO F7FBH (LSB)
;-----
    
```

Flow Chart:



Program Listing

```

F7D0          ORG      0F7D0H

F7D0 C3          CLR      C          ;Clear carry flag
F7D1 90 F7 F2    MOV      DPTR,#DATA1+3
                                ;Move data1 address to DPTR
F7D4 75 A0 F7    MOV      P2,#HIGH DATA2
                                ;Move high byte address of Data2 to P2
F7D7 78 F6          MOV      R0,#LOW DATA2+3
                                ;Move low byte address of Data2 to R2
F7D9 79 FB          MOV      R1,#LOW RESULT+4
                                ;Move low byte address of Result to R1
F7DB 7B 04          MOV      R3,#04      ;Move number of bytes to R3
F7DD E2          L12:  MOVX   A,@R0      ;Get data1 to Acc
F7DE FA          MOV      R2,A          ;Move it to R2
F7DF E0          MOVX   A,@DPTR      ;Get data2 into ACC
F7E0 3A          ADDC   A,R2          ;Add
F7E1 F3          MOVX   @R1,A        ;Move the result to memory
F7E2 15 82       DEC     DPL          ;Decrement data1 address
F7E4 18          DEC     R0           ;Decrement data2 address
F7E5 19          DEC     R1           ;Decrement result address
F7E6 DB F5       DJNZ   R3,L12        ;Decrement count and repeat until it
                                ;becomes 0
F7E8 50 03       JNC     H10         ;If Carry=0 GOTO H10
F7EA 74 01       MOV     A,#01        ;Move 01 to Acc
F7EC F3          MOVX   @R1,A        ;Store it in memory
F7ED 80 FE       H10:  SJMP   $

F7EF          DATA1:
F7EF 00 FF FF FE  DB      00H,0FFH,0FFH,0FEH
F7F3          DATA2:
F7F3 00 00 00 02  DB      00H,00H,00H,02H
F7F7          RESULT:
F7F7 00          DB      00H          ;Carry
F7F8 00 00 00 00  DB      00H,00H,00H,00H
                                ;32 Bit result

```

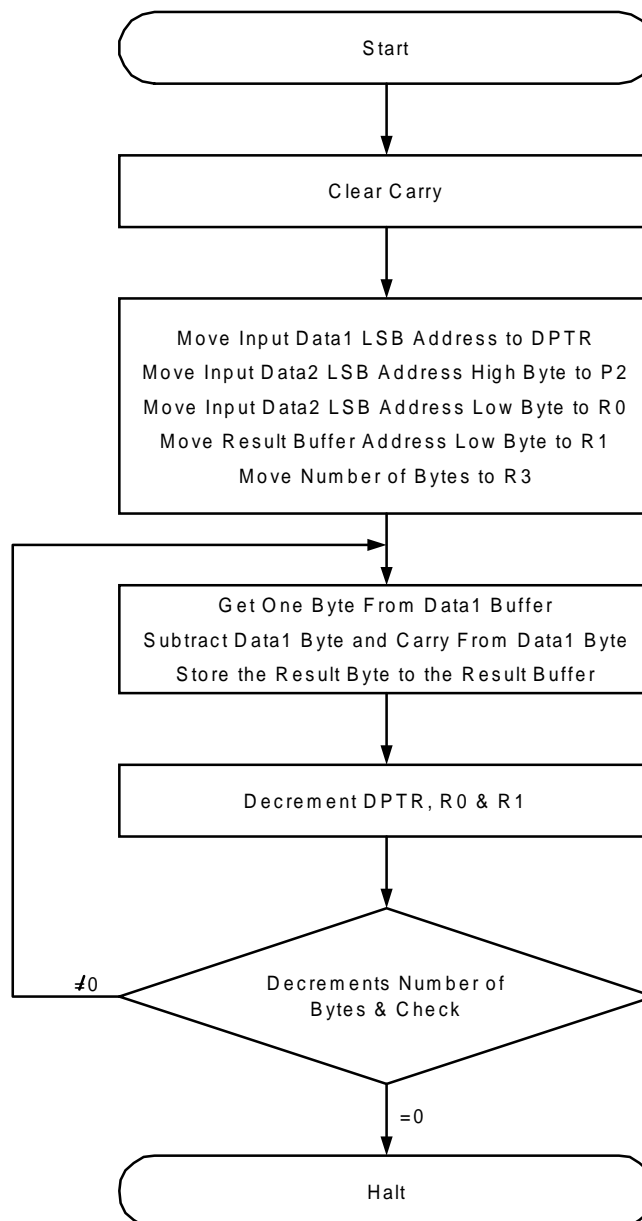
Example 20:

```

;-----
;32 Bit Subtraction
;
;Input:  32 Bit Data1 -- F81FH (MSB) TO F822H (LSB)
;        32 Bit Data2 -- F823H (MSB) TO F826H (LSB)
;
;Output:32 Bit Result -- F827H (MSB) TO F82BH (LSB)
;-----

```

Flow Chart:



Program Listing

```

F800          ORG      0F800H

F800 C3          CLR      C          ;Clear carry flag
F801 90 F8 22    MOV      DPTR,#S_DATA1+3
                                   ;Move data1 address to DPTR
F804 75 A0 F8    MOV      P2,#HIGH S_DATA2
                                   ;Move high byte address of
                                   ;Data2 to P2
F807 78 26      MOV      R0,#LOW S_DATA2+3
                                   ;Move low byte address of Data2
                                   ;to R2
F809 79 2B      MOV      R1,#LOW S_RESULT+4
                                   ;Move low byte address of
                                   ;Result to R1
F80B 7B 04      MOV      R3,#04      ;Move number of bytes to R3
F80D E2      S_L12:  MOVX   A,@R0      ;Get data1 to Acc
F80E FA          MOV      R2,A        ;Move it to R2
F80F E0          MOVX   A,@DPTR      ;Get data2 into ACC
F810 9A          SUBB   A,R2        ;subtract
F811 F3          MOVX   @R1,A        ;Move the result to memory
F812 15 82      DEC     DPL          ;Decrement data1 address
F814 18          DEC     R0          ;Decrement data2 address
F815 19          DEC     R1          ;Decrement result address
F816 DB F5      DJNZ   R3,S_L12      ;Decrement count and repeat
                                   ;until it becomes 0
F818 50 03      JNC     S_H10        ;If Carry=0 GOTO S_H10
F81A 74 01      MOV     A,#01        ;Move 01 to Acc
F81C F3          MOVX   @R1,A        ;Store it in memory
F81D 80 FE      S_H10: SJMP   $

F81F          S_DATA1:
F81F 00 FF FF FE  DB      00H,0FFH,0FFH,0FEH
F823          S_DATA2:
F823 00 00 00 02  DB      00H,00H,00H,02H
F827          S_RESULT:
F827 00          DB      00H          ;Carry
F828 00 00 00 00  DB      00H,00H,00H,00H
                                   ;32 Bit result

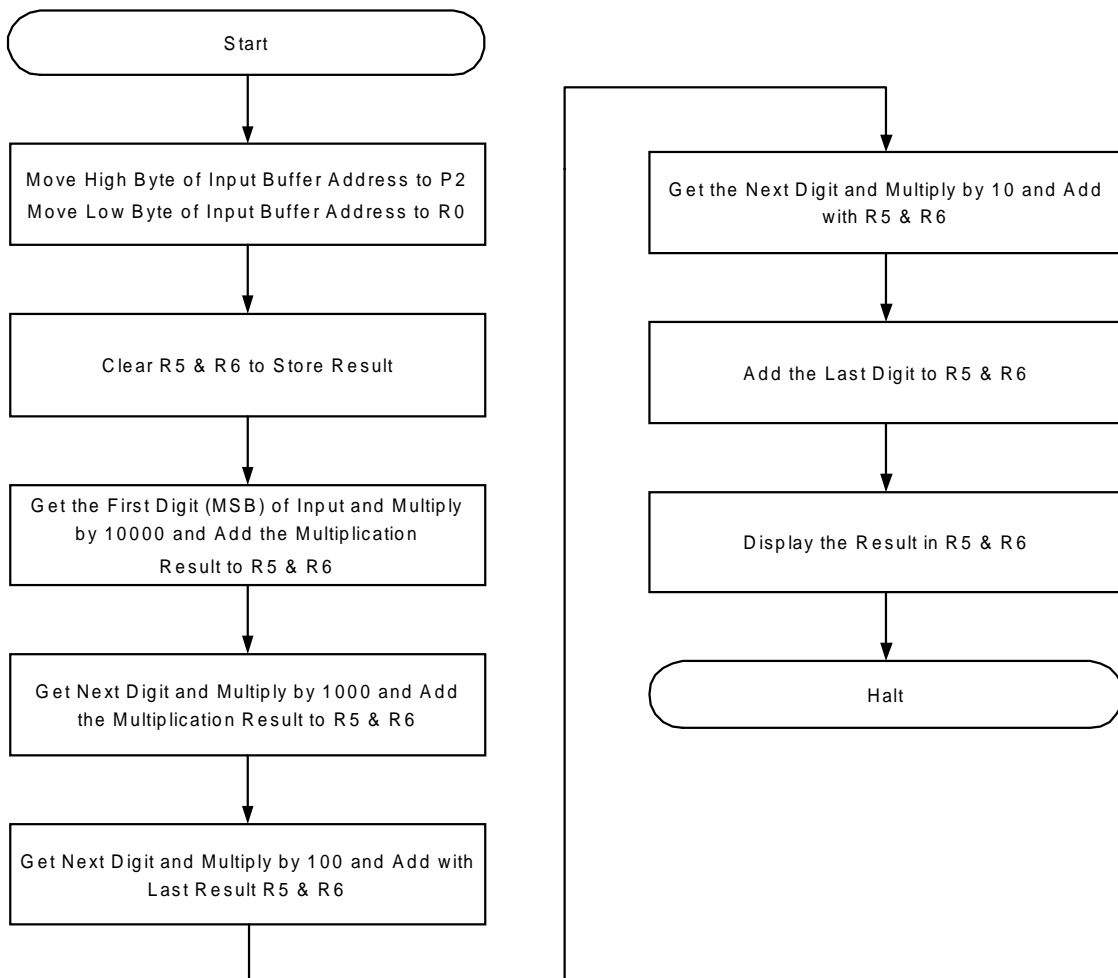
```

Example 21:

```

;-----
;5 Digit BCD to binary conversion
;
;Input: BCD input is given at locations (F88FH (MSB) to F893H (LSB))
;
;Output:The result will be displayed on display.
;-----
    
```

Flow Chart:



Program Listing:

```

F830          ORG      0F830H

F830 12 F9 00      LCALL  CLEAR_DISPLAY ;Clear display
F833 75 A0 F8      MOV    P2,#HIGH BCD_IP
                                   ;Move high byte address of i/p to P2
F836 78 8F        MOV    R0,#LOW BCD_IP
                                   ;Move low byte address of i/p to R0

F838 7E 00        MOV    R6,#00H
F83A 75 F0 10      MOV    B,#10H          ;Move low byte of Multiplier
F83D 7D 00        MOV    R5,#00H
F83F 12 F8 7E      LCALL  L15          ;Call multiply routine
F842 75 F0 27      MOV    B,#27H          ;Move high byte of Multiplier
F845 12 F8 84      LCALL  L16          ;Call multiply routine
F848 08           INC    R0
F849 75 F0 E8      MOV    B,#0E8H        ;Move low byte of multiplier
F84C 12 F8 7E      LCALL  L15
F84F 75 F0 03      MOV    B,#03H          ;Move high byte of multiplier
F852 12 F8 84      LCALL  L16
F855 08           INC    R0
F856 75 F0 64      MOV    B,#64H          ;Move low byte of multiplier
F859 12 F8 7E      LCALL  L15
F85C 75 F0 00      MOV    B,#00H
F85F 12 F8 84      LCALL  L16
F862 08           INC    R0
F863 75 F0 0A      MOV    B,#0AH          ;Move low byte of multiplier
F866 12 F8 7E      LCALL  L15
F869 75 F0 00      MOV    B,#00H          ;Move high byte of multiplier
F86C 12 F8 84      LCALL  L16
F86F 08           INC    R0
F870 E2           MOVX  A,@R0          ;Get data into Acc
F871 2D           ADD   A,R5          ;Add R5 with Acc
F872 F5 82        MOV   DPL,A
F874 74 00        MOV   A,#00H
F876 3E           ADDC  A,R6          ;Add Acc with R6 and Carry
F877 F5 83        MOV   DPH,A
F879 12 F9 E0      LCALL  DISPLAY_DPTR
F87C 80 FE        SJMP  $
F87E E2          L15:  MOVX  A,@R0          ;Get data digit into ACC
F87F A4           MUL   AB          ;Multiply A & B

```

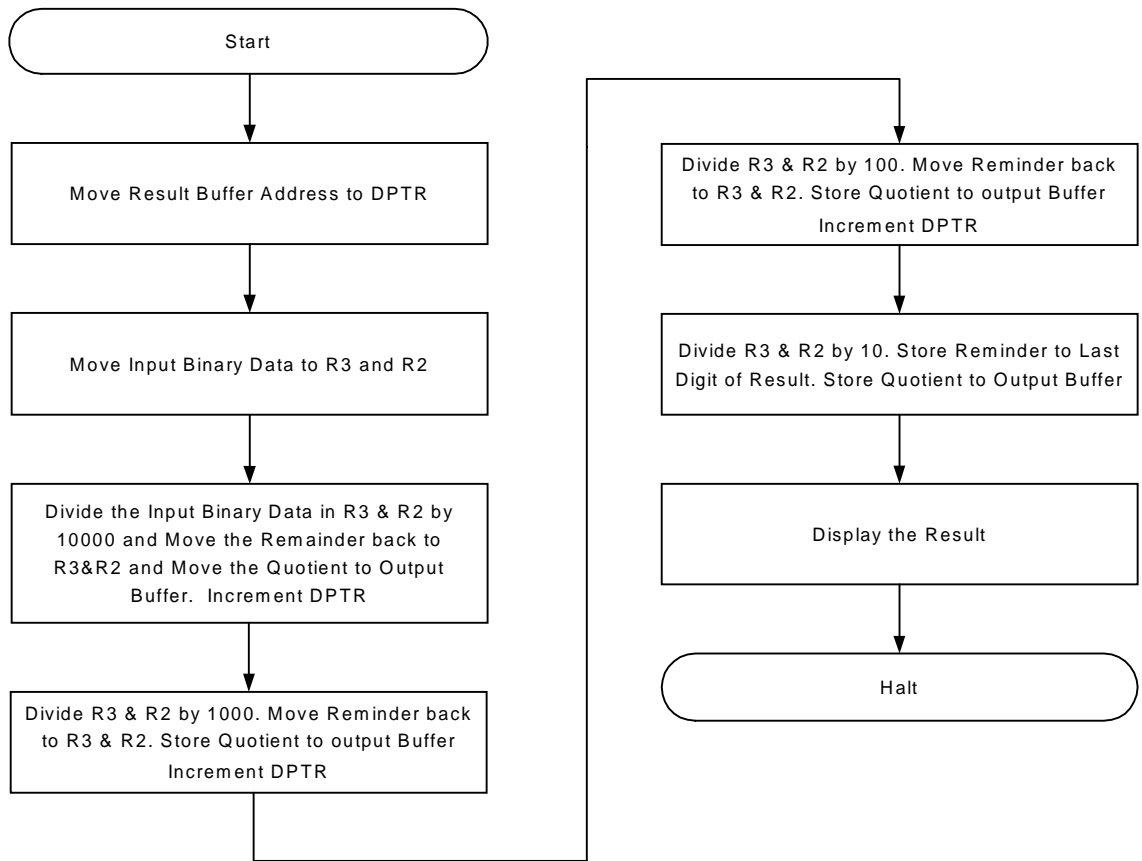
```
F880 FB          MOV    R3,A          ;Save Acc Content to R3
F881 AA F0       MOV    R2,B          ;Save B reg content to R2
F883 22          RET
F884 E2          L16:  MOVX   A,@R0       ;Get data digit into Acc
F885 A4          MUL    AB           ;Multiply A & B
F886 2A          ADD    A,R2         ;Add R2 with Acc
F887 FC          MOV    R4,A         ;Move Acc content into R4
F888 ED          MOV    A,R5         ;Move R5 content into Acc
F889 2B          ADD    A,R3         ;Add R3 with Acc
F88A FD          MOV    R5,A         ;Move Acc content into R5
F88B EE          MOV    A,R6         ;Move R6 content into Acc
F88C 3C          ADDC   A,R4         ;Add Acc with R4 and carry
F88D FE          MOV    R6,A         ;Save Acc content into R6
F88E 22          RET
F88F             BCD_IP:
F88F 06 05 05 03 DB    06H,05H,05H,03H
F893 05          DB    05H
```

Example 22:

```

;-----
;16 bit binary to BCD conversion
;
;Input: Binary input is given at locations F8A4H (MSB) & F8A6H (LSB)
;
;Output: The result will be displayed on display.
;-----
    
```

Flow Chart:



Program Listing:

```

F8A0          ORG      0F8A0H

F8A0 90 F8 F1      MOV      DPTR,#B_BCD_OP
                                   ;Move result starting address
                                   ;to DPTR

F8A3 7A FF          MOV      R2,#0FFH      ;Move low byte of input to R2
F8A5 7B FF          MOV      R3,#0FFH      ;Move high byte of input to R3
F8A7 7C 10          MOV      R4,#10H      ;Load 2710H in
F8A9 7D 27          MOV      R5,#27H      ;R5 and R4
F8AB 7E 00          MOV      R6,#00H      ;Initialize R6
F8AD 12 F8 D8       LCALL   L17          ;Call convert
F8B0 7C E8          MOV      R4,#0E8H      ;Load 03E8H in R5 &
F8B2 7D 03          MOV      R5,#03H      ;R4
F8B4 12 F8 D8       LCALL   L17          ;Call convert
F8B7 7C 64          MOV      R4,#64H      ;Load 0064H in R5 and
F8B9 7D 00          MOV      R5,#00H      ;R4
F8BB 12 F8 D8       LCALL   L17          ;Call convert
F8BE 7C 0A          MOV      R4,#0AH      ;Load R4 with 0AH
F8C0 7D 00          MOV      R5,#00H
F8C2 12 F8 D8       LCALL   L17          ;Call convert
F8C5 EA            MOV      A,R2          ;Move content of R2 into Acc
F8C6 F0            MOVX   @DPTR,A      ;Move Acc content into DPTR
F8C7 90 F8 F0       MOV      DPTR,#B_BCD_OP-1
                                   ;Move data address into DPTR

F8CA 7A 06          MOV      R2,#06H      ;Move number of digits to R2
F8CC 7F 90          MOV      R7,#90H      ;Move first digit address to R7
F8CE              RPT_DISP_B_BCD:
F8CE E0            MOVX   A,@DPTR      ;Move result into ACC
F8CF 12 F9 80       LCALL   DISPLAY_ACC_NIBBLE
                                   ;Display Lower nibble of Acc

F8D2 A3            INC      DPTR          ;Increment address
F8D3 0F            INC      R7           ;Increment digit address
F8D4 DA F8         DJNZ   R2,RPT_DISP_B_BCD
                                   ;Decrement count and repeat
                                   ;until it becomes 0

F8D6 80 FE         SJMP   $           ;Halt

```

```

;*****
;Routine to divide R3,R2 by R5,R4
;Using repeated subtraction principle
;*****
F8D8 C3      L17:  CLR    C           ;Clear carry flag
F8D9 EA            MOV    A,R2        ;Move R2 into Acc
F8DA 9C            SUBB   A,R4        ;Sub R4 from Acc
F8DB FA            MOV    R2,A        ;Move Acc content to R2
F8DC EB            MOV    A,R3        ;Move R3 into acc
F8DD 9D            SUBB   A,R5        ;Sub R5 from acc
F8DE FB            MOV    R3,A        ;Save Acc content into R3
F8DF 40 03         JC     L18         ;If CY=1 goto L18
F8E1 0E            INC    R6         ;Increment quotient reg
F8E2 80 F4         SJMP  L17         ;Goto L17
F8E4 EA      L18:  MOV    A,R2        ;move content of R2 into acc
F8E5 2C            ADD    A,R4        ;Add R4 with acc
F8E6 FA            MOV    R2,A        ;Save acc content into R2
F8E7 EB            MOV    A,R3        ;Move R3 into acc
F8E8 3D            ADDC   A,R5        ;Add R5 with acc and carry
F8E9 FB            MOV    R3,A        ;Move acc content into R3
F8EA EE            MOV    A,R6        ;Move R6 into acc
F8EB F0            MOVX   @DPTR,A      ;Move acc content into DPTR
F8EC A3            INC    DPTR
F8ED 7E 00         MOV    R6,#00        ;Initialize R6
F8EF 22            RET

F8F0 00            DB     00H        ;Dummy data

F8F1      B_BCD_OP:
F8F1 00 00 00 00   DB     00H,00H,00H,00H
F8F5 00            DB     00H

```



Routine 1:

```

;-----
; Clears the seven segment display.
;
; Input:  None.
;
; Output: None.
;-----
F900                ORG      0F900H

F900                CLEAR_DISPLAY:
F900 C0 F0          PUSH    B
F902 C0 00          PUSH    00H
F904 C0 E0          PUSH    ACC
F906 75 00 06      MOV     00H,#06H ;Move the number of digits to R0
F909 75 F0 90      MOV     B,#90H   ;Move the address field address
                                   ;to Acc

F90C                RPTCLR:
F90C E5 F0          MOV     A,B
F90E 71 10          ACALL   SEND_ONE_BYTE
F910 E4             CLR     A           ;Clear the content of Acc
F911 71 10          ACALL   SEND_ONE_BYTE
F913 05 F0          INC     B
F915 D5 00 F4      DJNZ   00H,RPTCLR
                                   ;Repeat until end of message(6digits)

F918 D0 E0          POP     ACC
F91A D0 00          POP     00H
F91C D0 F0          POP     B
F91E 22            RET

```

Routine 2:

```

;-----
; Displays a message.
;
; Input : Starting address of message in DPTR.
;
; Output: None.
;
; Segment mapping in Display:-
; -----
; Bit position  D7 D6 D5 D4  D3 D2 D1 D0
; Segment      a b g e c . f d
; (. indicates the Dot point segment)
;-----
F920          ORG      0F920H

F920          DISPLAY_MESSAGE:
F920 7F 06          MOV     R7,#06H    ;Move the number of digits to R7
F922          DISPSGN8:
F922 74 90          MOV     A,#90H    ;Move the address field address
;to Acc

F924 C0 F0          PUSH   B
F926 F5 F0          MOV     B,A
F928          RPTSGN:
F928 E5 F0          MOV     A,B
F92A 12 FB 10       LCALL  SEND_ONE_BYTE
F92D 74 00          MOV     A,#00H    ;Clear the content of Acc
F92F 93            MOVC   A,@A+DPTR
;Get the data from the program memory
;addressed by DPTR

F930 12 FB 10       LCALL  SEND_ONE_BYTE
F933 05 F0          INC     B
F935 A3            INC     DPTR    ;Increment message table address
;in DPTR

F936 DF F0          DJNZ  R7,RPTSGN ;Repeat until end of message(6digits)
F938 D0 F0          POP     B
F93A 22            RET

```

Routine 3:

```

;-----
; Displays Carry and Accumulator contents in the
; seven segment display.
;
; Input : In carry and Acc
;
; Output: None.
;-----
F940                ORG      0F940H

F940                DISPLAY_CARRY_ACC:
F940 C0 F0          PUSH    B           ;Store B register on Stack
F942 C0 E0          PUSH    ACC        ;Store Acc on stack
F944 C0 D0          PUSH    PSW        ;Store PSW on stack
F946 74 93          MOV     A,#93H     ;Move 4th digit address to Acc
F948 12 FB 10      LCALL   SEND_ONE_BYTE
                                ;Select 4th digit
F94B D0 D0          POP     PSW        ;Restore PSW
F94D 74 DB          MOV     A,#0DBH    ;Move code for '0'
F94F 50 02          JNC     SKIP_DISP_CY_1
;Check carry
F951 74 48          MOV     A,#48H     ;If carry =1 then move '1' code to Acc
F953                SKIP_DISP_CY_1:
F953 12 FB 10      LCALL   SEND_ONE_BYTE
                                ;Display 1/0 according to Carry
F956 D0 E0          POP     ACC        ;Restore Acc
F958 7F 94          MOV     R7,#94H    ;Move 5th digit
F95A 12 FA 10      LCALL   DISPLAY_ACC
                                ;Display Acc contents on display
F95D D0 F0          POP     B           ;Restore B register
F95F 22            RET

```

Routine 4:

```

;-----
; Displays B register and Accumulator contents in
; first 4 digits of seven segment display.
;
; Input : In Acc and B register.
;
; Output: None.
;-----
F960                ORG    0F960H

F960                DISPLAY_B_ACC:
F960 C0 82          PUSH   DPL
F962 C0 83          PUSH   DPH           ;Store DPTR on stack
F964 85 F0 83       MOV    DPH,B         ;Move High byte data to DPH
F967 F5 82          MOV    DPL,A         ;Move Low byte data to DPL
F969 12 F9 E0       LCALL  DISPLAY_DPTR ;Display it
F96C D0 83          POP    DPH
F96E D0 82          POP    DPL           ;Restore DPTR contents.
F970 22            RET

```

Routine 5:

```

;-----
; Displays the lower nibble of Acc(hex) in the seven segment display.
;
; Input : Data in Acc and Digit address in R7.
;        (90H for first digit)
;
; Output: None.
;
; Example: To display 2 in second digit,
;         Acc - 02H and R7 - 91H.
;-----
F980                ORG      0F980H

F980                DISPLAY_ACC_NIBBLE:
F980 C0 83          PUSH    DPH
F982 C0 82          PUSH    DPL      ;Store DPTR on stack
F984 F5 82          MOV     DPL,A    ;Move Data to be displayed to DPL
F986 EF            MOV     A,R7
F987 C0 E0          PUSH    ACC      ;Store digit address on stack
F989 12 FB 10      LCALL   SEND_ONE_BYTE
                                ;Select the digit for display
F98C E5 82          MOV     A,DPL    ;Get the data to displayed
F98E 90 FA 3F      MOV     DPTR,#SEVEN_SEGMENT_CODES
                                ;Move Seven segment codes table
                                ;address to DPTR
F991 54 0F          ANL     A,#0FH    ;Mask the upper 4 bits of Acc
F993 93            MOVC    A,@A+DPTR ;Get the seven segment code from table
F994 12 FB 10      LCALL   SEND_ONE_BYTE
                                ;Display it
F997 D0 E0          POP     ACC
F999 FF            MOV     R7,A     ;Restore digit address
F99A D0 82          POP     DPL
F99C D0 83          POP     DPH     ;Restore DPTR
F99E 22            RET

```


Routine 6:

```

;-----
; Displays a character in the seven segment display.
;
; Input : Seven segment data in Acc and Digit address in R7.
;        (90H for first digit)
;
; Output: None.
;
; Segment mapping in Display:-
; -----
; Bit position  D7 D6 D5 D4  D3 D2 D1 D0
; Segment      a  b  g  e  c  .  f  d
; (. indicates the Dot point segment)
;
; Example:
;   To display 'A' in first digit,
;   Acc - 0FAH and R7 - 90H.
;-----
F9B0          ORG      0F9B0H

F9B0          DISPLAY_ONE_CHARACTER:
F9B0 C0 E0          PUSH  ACC          ;Store data in Acc on stack
F9B2 EF          MOV   A,R7          ;Move the digit address
F9B3 12 FB 10      LCALL SEND_ONE_BYTE
                                   ;Send it to display controller
F9B6 D0 E0          POP   ACC          ;Restore the data from stack
F9B8 12 FB 10      LCALL SEND_ONE_BYTE
                                   ;Send it to display controller
F9BB 22          RET

```

Routine 7:

```

;-----
; Delay Routine (approximately one second).
;
; Input : None
;
; Output: None.
;
; Note: User can adjust the delay timing according to user
;       requirement by changing the data in F9C8H, F9CBH and F9CEH
;-----
F9C0          ORG      0F9C0H

F9C0          DELAY:
F9C0 C0 00          PUSH  00H      ;Store internal location 00H contents
F9C2 C0 01          PUSH  01H      ;Store internal location 01H contents
F9C4 C0 02          PUSH  02H      ;Store internal location 02H contents
F9C6 75 02 05       MOV    02H,#05H ;Move 05H to internal location 00H

F9C9          USER_L2:
F9C9 75 01 FF       MOV    01H,#0FFH ;Move 0FFH to internal location 01H

F9CC          USER_L1:
F9CC 75 00 FF       MOV    00H,#0FFH ;Move 0FFH to internal location 00H
F9CF D5 00 FD       DJNZ  00H,$    ;Decrement internal location 00H
                                ;content Repeat until it becomes 0
F9D2 D5 01 F7       DJNZ  01H,USER_L1
                                ;Decrement internal location 01H
                                ;content Repeat until it becomes 0
F9D5 D5 02 F1       DJNZ  02H,USER_L2
                                ;Decrement internal location 02H
                                ;content Repeat until it becomes 0
F9D8 D0 02          POP    02H      ;Restore internal location 02H contents
F9DA D0 01          POP    01H      ;Restore internal location 01H contents
F9DC D0 00          POP    00H      ;Restore internal location 00H contents
F9DE 22            RET

```

Routine 8:

```

;-----
;Displays the contents of DPTR in first four digits of
;the display
;
;Input : Data to be displayed in DPTR
;
;Output: None.
;-----
F9E0                ORG      0F9E0H

F9E0                DISPLAY_DPTR:
F9E0 C0 E0          PUSH    ACC      ;Store Acc contents on stack
F9E2 EF            MOV     A,R7
F9E3 C0 E0          PUSH    ACC      ;Store R7 contents on stack
F9E5 7F 90          MOV     R7,#90H   ;Move the first digit address to R7
F9E7 E5 83          MOV     A,DPH   ;Move the content of DPH to Acc
F9E9 51 10          ACALL   DISPLAY_ACC
                        ;Display it
F9EB 7F 92          MOV     R7,#92H   ;Move the third digit address to R7
F9ED E5 82          MOV     A,DPL   ;Move the contents of DPL to Acc
F9EF 51 10          ACALL   DISPLAY_ACC
                        ;Display it
F9F1 D0 E0          POP     ACC
F9F3 FF            MOV     R7,A      ;Restore R7
F9F4 D0 E0          POP     ACC      ;Restore Acc
F9F6 22            RET

```

Routine 9:

```

;-----
;Displays the contents of accumulator
;
;Input : Digit Address in R7 and data to be displayed in Acc
;
;Output : None
;-----
FA10          ORG      0FA10H

FA10          DISPLAY_ACC:
FA10 C0 82          PUSH   DPL
FA12 C0 83          PUSH   DPH      ;Store DPTR on stack
FA14 CF           XCH    A,R7      ;Exchange digit address & data to be
                                   ;displayed
FA15 C0 E0          PUSH   ACC
FA17 12 FB 10      LCALL  SEND_ONE_BYTE
                                   ;Send digit address to keyboard
                                   ;display controller
FA1A CF           XCH    A,R7      ;Exchange R2 & Acc again
FA1B FF           MOV    R7,A      ;Move data in Acc to R7
FA1C 54 F0          ANL    A,#0F0H  ;Mask the lower nibble
FA1E C4           SWAP   A         ;Swap the contents of Acc
FA1F 90 FA 3C      MOV    DPTR,#SEVEN_SEGMENT_CODES
                                   ;Move seven segment code table
                                   ;address to DPTR
FA22 93           MOVC   A,@A+DPTR
                                   ;Get the seven segment code
                                   ;corresponding to Acc contents.
FA23 12 FB 10      LCALL  SEND_ONE_BYTE
                                   ;Send the seven segment code to
                                   ;controller
FA26 D0 E0          POP    ACC      ;Restore digit address from stack
                                   ;to Acc
FA28 04           INC    A         ;Increment to point next digit
FA29 12 FB 10      LCALL  SEND_ONE_BYTE
                                   ;Send the digit address to
                                   ;controller
FA2C EF           MOV    A,R7      ;Get the data in R7 to Acc
FA2D 54 0F          ANL    A,#0FH  ;Mask the lower nibble

```

```

FA2F 90 FA 3C      MOV    DPTR,#SEVEN_SEGMENT_CODES
                   ;Move seven segment code table
                   ;address to DPTR
FA32 93           MOVC   A,@A+DPTR
                   ;Get the seven segment code
                   ;corresponding to Acc contents
FA33 12 FB 10     LCALL  SEND_ONE_BYTE
                   ;Send the seven segment code to
                   ;controller
FA36 EF          MOV    A,R7      ;Move the data in R7 to Acc
FA37 D0 83       POP    DPH
FA39 D0 82       POP    DPL      ;Restore DPTR contents
FA3B 22          RET

```

```

;*****
;Seven Segment Code Table
;*****

```

```

FA3C          SEVEN_SEGMENT_CODES:
FA3C DB 48 F1 E9      DB    0DBH,048H,0F1H,0E9H
FA40 6A AB BB C8     DB    06AH,0ABH,0BBH,0C8H
FA44 FB EB FA 3B     DB    0FBH,0EBH,0FAH,03BH
FA48 93 79 B3 B2     DB    093H,079H,0B3H,0B2H

```

Routine 10:

```

;-----
; Checks the keyboard status and waits until a key is pressed.
; Note that the key value is not read from Keyboard display
; controller.
;
;Input : None.
;
;Output: None.
;-----
FA50          ORG      0FA50H

FA50          CHKKEYSTATUS:
FA50 74 A0          MOV     A,#0A0H  ;Command to read the keyboard status
FA52 12 FB 10      LCALL  SEND_ONE_BYTE
                          ;Send the command
FA55 12 FA E0      LCALL  READ_ONE_BYTE
                          ;Get the keyboard status
FA58 60 F6          JZ      CHKKEYSTATUS
                          ;Repeat until a key was pressed
FA5A 22            RET

```

Routine 11:

```

;-----
;Checks the keyboard status waits until a key is pressed.
;The key value is read and returned in Acc.
;
;Input : None
;
;Output: Key value in Acc.
;-----
FA60                ORG      0FA60H

FA60                READKEYBOARD:
FA60 74 A0          MOV      A,#0A0H  ;Command to read the keyboard status
FA62 12 FB 10      LCALL    SEND_ONE_BYTE
                        ;Send the command
FA65 12 FA E0      LCALL    READ_ONE_BYTE
                        ;Get the keyboard status
FA68 60 F6          JZ       READKEYBOARD
                        ;Repeat until a key was pressed
FA6A 74 A1          MOV      A,#0A1H  ;Command to read key value
FA6C 12 FB 10      LCALL    SEND_ONE_BYTE
                        ;Send the command
FA6F 12 FA E0      LCALL    READ_ONE_BYTE
                        ;Read the key value
FA72 B4 20 00      CJNE    A,#020H,$+3
                        ;Check for a valid key code
FA75 50 E9          JNC     READKEYBOARD
                        ;If not repeat until a valid key
                        ;code read
FA77 22            RET

```

Routine 12:

```

;-----
; Reads a four digit data from keyboard and displays them in the
; first 4 digits of the display.
;
; Input : Old data in DPTR
;
; Output: New address in DPTR, Last pressed key value in Acc.
;-----
FA80          ORG      0FA80H

FA80          GET4DIGIT:
FA80 51 60          ACALL  READKEYBOARD
                                ;Read the key board
FA82 B4 10 01 CONT41:CJNE  A,#010H,NEXT5
                                ;Check pressed key is data key
                                ;then continue
FA85 22          NEXT6: RET      ;else return
FA86 50 FD          NEXT5: JNC    NEXT6
FA88 F8          MOV     R0,A     ;Move the key value to R0
FA89 C3          CLR     C       ;Clear C
FA8A 7F 04          MOV     R7,#04H ;Move the loop counter to R7
FA8C E5 82 RPT4DGT: MOV     A,DPL  ;Move the low byte address in DPL to Acc
FA8E 25 82          ADD     A,DPL  ;Add it to DPL
FA90 F5 82          MOV     DPL,A  ;Move it to DPL
FA92 E5 83          MOV     A,DPH  ;Move the high byte address in DPH
                                ;to Acc
FA94 35 83          ADDC    A,DPH  ;Add it to DPH
FA96 F5 83          MOV     DPH,A  ;Move it to DPH
FA98 DF F2          DJNZ   R7,RPT4DGT
                                ;Repeat four times to move the con-
                                ;tents of DPTR by four bit position left
FA9A 53 82 F0          ANL     DPL,#0F0H ;Mask the lower nibble of DPL
FA9D E8          MOV     A,R0     ;Get the key value in R0 to Acc
FA9E 54 0F          ANL     A,#0FH  ;Mask the higher nibble of key value
FAA0 42 82          ORL     DPL,A  ;Add the key value to DPL
FAA2 31 E0          ACALL  DISPLAY_DPTR
                                ;Display the contents of DPTR with
                                ;dot at end of address field
FAA4 80 DA          SJMP   GET4DIGIT ;Jump to read keyboard

```


Routine 13:

```

;-----
;Reads 2 digit data from keyboard and displays it in the
;display.
;
;Input : Old data in Acc and Digit address in R7.
;
;OUTPUT : New Data in R2 and Last pressed key code in Acc
;-----
FAB0                ORG      0FAB0H

FAB0                GET2DIGIT:
FAB0 C0 F0          PUSH    B
FAB2 8F F0          MOV     B,R7
FAB4                GET2DIGIT1:
FAB4 AF F0          MOV     R7,B
FAB6 FA             MOV     R2,A      ;Move the old value to R2
FAB7                RPT2DGT:
FAB7 51 60          ACALL   READKEYBOARD
                                ;Read the keyboard
FAB9 B4 10 03      CONT21: CJNE  A,#010H,NEXT7
                                ;Check pressed key is data key or not?

FABC                NEXT8:
FABC D0 F0          POP     B
FABE 22            RET              ;If it is not data key then return
FABF 50 FB          NEXT7: JNC    NEXT8
FAC1 54 0F          CONT221: ANL   A,#0FH  ;Mask the higher nibble of key value
FAC3 CA            XCH     A,R2      ;Exchange the contents of Acc & R2
FAC4 54 0F          ANL     A,#0FH  ;Mask the lower nibble of old data
FAC6 C4            SWAP   A          ;Convert the lower nibble into higher
                                ;nibble
FAC7 4A            ORL     A,R2      ;Add the new key value to R2
FAC8 C0 07          PUSH   07H      ;Store R7
FACA 51 10          ACALL   DISPLAY_ACC
                                ;Display the new data
FACC D0 07          POP     07H      ;Restore R7
FACE FA            MOV     R2,A      ;Move the new data in Acc to R2
FACF 80 E6          SJMP   RPT2DGT  ;Jump to read the keyboard

```

Routine 14:

```

;-----
;Reads a byte from keyboard/display controller.
;
;Input : None.
;
;Output: Read data in Acc.
;-----
FAE0                ORG    0FAE0H

FAE0                READ_ONE_BYTE:
FAE0 20 91 FD        JB     P1.1,$    ;Wait until start bit comes
FAE3 C0 F0          PUSH   B         ;Store B register on stack
FAE5 8F F0          MOV    B,R7
FAE7 C0 F0          PUSH   B         ;Store R7 on stack
FAE9 12 FB 38      LCALL  DELAY_208 ;call half delay duration
FAEC 74 00          MOV    A,#00H    ;Clear Acc
FAEE 12 FB 33      LCALL  DELAY_416 ;Call full delay for one bit
FAF1 75 F0 08      MOV    B,#08H    ;Move number of bits to B

FAF4                RPT_RD:
FAF4 A2 91          MOV    C,P1.1    ;Move data bit to Carry
FAF6 13            RRC    A         ;Rotate and form data
FAF7 12 FB 33      LCALL  DELAY_416 ;Wait for one bit time
FAFA D5 F0 F7      DJNZ   B,RPT_RD ;Decrement count and repeat until it
                        ;becomes 0
FAFD 12 FB 33      LCALL  DELAY_416 ;Wait for stop bit time
FB00 D0 F0          POP    B
FB02 AF F0          MOV    R7,B     ;Restore R7
FB04 D0 F0          POP    B         ;Restore B register
FB06 22            RET

```

Routine 15:

```

;-----
; Writes a byte to keyboard/display controller.
;
; Input : Data to be written in Acc
;
; Output: None.
;-----
FB10                ORG      0FB10H

FB10                SEND_ONE_BYTE:
FB10 C0 F0          PUSH    B           ;Store B register on stack
FB12 8F F0          MOV     B,R7
FB14 C0 F0          PUSH    B           ;Store R7 on stack
FB16 C2 90          CLR     P1.0        ;Send start bit - Low level
FB18 12FB 33        LCALL   DELAY_416 ;Wait for one bit time
FB1B 75 F0 08       MOV     B,#08H      ;Move number of bits to B

FB1E                RPT_SEND:
FB1E 13            RRC     A           ;Move data bit to Carry
FB1F 92 90          MOV     P1.0,C      ;Move it to port line
FB21 12 FB 33        LCALL   DELAY_416 ;Wait for one bit time
FB24 D5 F0 F7       DJNZ   B,RPT_SEND
                                ;Decrement bit count and repeat until
                                ;it becomes 0
FB27 D2 90          SETB   P1.0        ;send stop bit - high level
FB29 12 FB 33        LCALL   DELAY_416 ;Wait for one bit time
FB2C D0 F0          POP     B
FB2E AF F0          MOV     R7,B       ;Restore R7
FB30 D0 F0          POP     B       ;Restore B
FB32 22            RET

;*****
;Full bit delay(416 Micro Seconds for 2400 baudrate)
;*****
FB33                DELAY_416:
FB33 7F D0          MOV     R7,#0D0H
FB35 DF FE          DJNZ   R7,$
FB37 22            RET

```

```

;*****
;Half bit delay(208 Mico Seconds for 2400 baudrate)
;*****
FB38          DELAY_208:
FB38 7F 50          MOV    R7,#050H
FB3A DF FE          DJNZ  R7,$
FB3C 22            RET
```

Routine 16:

```

;-----
;Serial Port initialization routine.
;(Using Timer 1 as baud rate generator)
;Input:  Baud rate value in DPTR.(BCD value)
;
;Output: On success Acc will have 00H.
;        On Error Acc will have 01H.
;-----
FB40          ORG      0FB40H

FB40          INITIALIZE_SERIALPORT:
FB40 75 A0 FB      MOV      P2,#HIGH BAUDRATE
                                   ;Move high byte address of baudrate
                                   ;to P2
FB43 78 78        MOV      R0,#LOW BAUDRATE
                                   ;Move low byte address of baudrate
                                   ;to R0
FB45 75 98 52      MOV      SCON,#52H
                                   ;Load SCON with 52H Chooses mode 1
                                   ;makes REN = 1 & TI = 1
FB48 75 89 20      MOV      TMOD,#20H
                                   ;Load TMOD with 20H chooses Timer 1
                                   ;in Timer Auto reload mode
FB4B 7F 05        MOV      R7,#05H ;Move count to R7
FB4D          RPT_INI_SRL:
FB4D E2          MOVX     A,@R0    ;Get first byte(High byte of baud rate)
FB4E B5 83 1F      CJNE     A,DPH,NEXT_INI_SRL
                                   ;Compare with user baudrate
FB51 08          INC      R0      ;If equal,Increment address to get
                                   ;next byte
FB52 E2          MOVX     A,@R0    ;Get second byte(Low byte of baud rate)
FB53 B5 82 1B      CJNE     A,DPL,NEXT1_INI_SRL
                                   ;Compare with user baudrate
FB56 08          INC      R0      ;If equal,Increment address to get
                                   ;next byte
FB57 E2          MOVX     A,@R0    ;Get SMOD status byte from table
FB58 60 0B        JZ       CLR_SMOD ;If zero goto clear SMOD bit
FB5A 43 87 80      ORL      PCON,#080H
                                   ;Set SMOD bit

```

```

FB5D 08          INC      R0          ;Increment table address
FB5E E2          MOVX     A,@R0        ;Get count value from table
FB5F F5 8D       MOV      TH1,A      ;Load Timer 1 high byte
                                   ;with baud rate count
FB61 D2 8E       SETB     TR1        ;Start Timer 1
FB63 E4          CLR      A          ;Success code to Acc
FB64 22          RET
FB65             CLR_SMOD:
FB65 53 87 7F    ANL      PCON,#07FH
                                   ;Clear SMOD bit
FB68 08          INC      R0          ;Increment table address
FB69 E2          MOVX     A,@R0        ;Get count value from table
FB6A F5 8D       MOV      TH1,A      ;Load Timer 1 high byte
                                   ;with baud rate count
FB6C D2 8E       SETB     TR1        ;Start Timer 1
FB6E E4          CLR      A          ;Success code to Acc
FB6F 22          RET

FB70             NEXT_INI_SRL:
FB70 08          INC      R0
FB71             NEXT1_INI_SRL:
FB71 08          INC      R0
FB72 08          INC      R0          ;Increment table address to get
                                   ;next baud rate details
FB73 DF D8       DJNZ     R7,RPT_INI_SRL
                                   ;Decrement count and repeat until
                                   ;it becomes zero
FB75 74 01       MOV      A,#01H     ;Move Error code to Acc
FB77 22          RET

FB78             BAUDRATE:
FB78 03 00 00 98 DB      03H,00H,00H,098H ;Baudrate , SMOD value,
                                   ;count for TH1 - 300
FB7C 06 00 00 CC DB      06H,00H,00H,0CCH ;Baudrate , SMOD value,
                                   ;count for TH1 - 600
FB80 12 00 00 E6 DB      12H,00H,00H,0E6H ;Baudrate , SMOD value,
                                   ;count for TH1 - 1200
FB84 24 00 00 F3 DB      24H,00H,00H,0F3H ;Baudrate , SMOD value,
                                   ;count for TH1 - 2400
FB88 48 00 01 F3 DB      48H,00H,01H,0F3H ;Baudrate , SMOD value,
                                   ;count for TH1 - 4800

```

Routine 17:

```
-----  
;Waits until a byte of data is received on serial port.  
;  
;Input : None.  
;  
;Output: Received data in Acc.  
-----  
FB90                ORG      0FB90H  
  
FB90                RECEIVE_BYTE:  
FB90 30 98 FD        JNB     RI,$      ;Repeat until a character received  
FB93 E5 99          MOV     A,SBUF    ;Get the received character from  
                                ;serial port buffer  
FB95 C2 98          CLR     RI      ;Clear receiver flag  
FB97 22            RET
```

Routine 18:

```

;-----
;Sends the Accumulator data to Serial port.
;
;Input: Data to be transmitted in Acc.
;-----
FBA0                ORG    0FBA0H

FBA0                TRANSMIT_BYTE:
FBA0 F5 99          MOV    SBUF,A    ;Write the data in Acc to serial
                                ;transmit buffer
FBA2 30 99 FD      JNB    TI,$      ;Wait until tranmit buffer becomes emty
FBA5 C2 99          CLR    TI        ;Clear transmit flag
FBA7 22            RET

```


Routine 19:

```

;-----
;Hexadecimal to Decimal conversion routine.
;(Both Input and output values are in internal memory)
;
;Input:  Hex value input in Internal locations 18H & 19H
;        18H - High byte & 19H - Low byte
;
;Output: The converted decimal value will be stored in the
;        internal locations 1AH(MSB),1BH and 1CH(LSB)
;-----
FBB0          ORG      0FBB0H

FBB0          HEX_TO_DECIMAL_INTERNAL:
FBB0 AE 18          MOV     R6,18H    ;Move hbyte hex value
FBB2 12FB BB       LCALL  HEXA      ;Convert hex to decimal
FBB5 AE 19          MOV     R6,19H    ;Move lbyte hex value
FBB7 12 FB C2      LCALL  HEX1      ;Convert hex to decimal
FBBA 22           RET              ;Return converts hex to decimal
;input in R6 output in 1AH,1BH,and 1CH

FBBB E4          HEXA: CLR     A      ;Clear accumulator
FBBC F5 1A          MOV     1AH,A     ;Move 00H in ACC to 1AH
FBBE F5 1B          MOV     1BH,A     ;Move 00H in ACC to 1BH
FBC0 F5 1C          MOV     1CH,A     ;Move 00H in ACC to 1CH
FBC2 7C 08        HEX1: MOV     R4,#08H ;Move number of bits to R4
FBC4 EE          HEX2: MOV     A,R6    ;Move the content of R6 to ACC
FBC5 33           RLC     A          ;Rotate ACC left to get bit
;ACC.7 to carry

FBC6 FE          MOV     R6,A        ;Move rotated value to R6
FBC7 E5 1C        MOV     A,1CH      ;Move the content of 1CH to ACC
FBC9 35 1C        ADDC    A,1CH      ;Add the ACC with carry and 1CH
FBCB D4           DA      A          ;Decimal adjust the content of ACC
FBCC F5 1C        MOV     1CH,A     ;Move the result to 1CH
FBCE E5 1B        MOV     A,1BH      ;Move the content of 1BH to ACC
FBD0 35 1B        ADDC    A,1BH      ;Add the ACC with carry and 1BH
FBD2 D4           DA      A          ;Decimal adjust the content of ACC
FBD3 F5 1B        MOV     1BH,A     ;Move the result to 1BH
FBD5 E5 1A        MOV     A,1AH      ;Move the content of 1AH to ACC
FBD7 35 1A        ADDC    A,1AH      ;Add the ACC with carry and 1AH
FBD9 D4           DA      A          ;Decimal adjust the content of ACC

```

```
FBDA F5 1A      MOV    1AH,A      ;Move the result to 1AH
FBDC DC E6      DJNZ  R4,HEX2   ;Decrement and repeat the above step
                ;if bit count(in R4) not equal to zero
FBDE 22         RET                    ;Return
```

Routine 20:

```

;-----
;Hexadecimal to Decimal conversion routine.
;(Both Input and output values are stored in external memory)
;
;Input:  Hex value input in External memory location
;        addressed by DPTR (DPTR, DPTR+1)
;
;Output: The converted decimal value will be stored in
;        external memory locations. (DPTR+2, DPTR+3, DPTR+4)
;-----
FBE0          ORG      0FBE0H

FBE0          HEX_TO_DECIMAL_EXTERNAL:
FBE0 E0          MOVX   A,@DPTR   ;Move hbyte in external data memory
                                ;to ACC
FBE1 FE          MOV    R6,A      ;Move content of ACC to R6
FBE2 C0 83       PUSH   DPH      ;Save the data pointer hbyte on stack
FBE4 C0 82       PUSH   DPL      ;Save the data pointer lbyte on stack
FBE6 12 FB F7    LCALL  HEXA_EXT  ;Convert hex value in R6 to decimal
FBE9 D0 82       POP    DPL      ;Restore lbyte of data pointer from
                                ;stack
FBEB D0 83       POP    DPH      ;Restore hbyte of data pointer from
                                ;stack
FBED A3          INC    DPTR     ;Increment the data pointer by one
FBEE E0          MOVX   A,@DPTR  ;Move lbyte of hex value to ACC
FBEF A3          INC    DPTR     ;Increment data pointer
FBF0 A3          INC    DPTR     ;Increment data pointer
FBF1 A3          INC    DPTR     ;Increment data pointer
FBF2 FE          MOV    R6,A      ;Move the contents of ACC to R6
FBF3 12 FB FF    LCALL  HEX1_EXT  ;Convert hex value in R6 to decimal
FBF6 22          RET           ;Return

FBF7          HEXA_EXT:
FBF7 E4          CLR    A        ;Clear the accumulator
FBF8 A3          INC    DPTR     ;Increment the data pointer twice
FBF9 A3          INC    DPTR     ;to point the starting of result buffer
FBFA F0          MOVX   @DPTR,A  ;Clear the result buffer
FBFB A3          INC    DPTR     ;(three locations)
FBFC F0          MOVX   @DPTR,A

```

```

FBFD A3          INC    DPTR
FBFE F0          MOVX   @DPTR,A
FBFF            HEX1_EXT:
FBFF 7C 08       MOV    R4,#08H    ;Move the number of bits to the bit
                                ;count(R4)

FC01            HEX2_EXT:
FC01 EE         MOV    A,R6      ;Move the hex value in R6 to ACC
FC02 33         RLC    A        ;Rotate ACC left to get bit ACC.7
                                ;to carry
FC03 FE         MOV    R6,A      ;Move the rotated value to R6
FC04 E0         MOVX   A,@DPTR  ;Get the last byte(LSB) of the result
FC05 FD         MOV    R5,A      ;Move it to R5
FC06 3D         ADDC   A,R5      ;Add ACC and R5 with carry
FC07 D4         DA     A        ;Decimal adjust the content of ACC
FC08 F0         MOVX   @DPTR,A  ;Store the ACC at last byte of
                                ;the result
FC09 12 FC 30   LCALL  DEC_DPTR ;Decrement the data pointer once
FC0C E0         MOVX   A,@DPTR  ;Get the second byte of the result
FC0D FD         MOV    R5,A      ;Move it to R5
FC0E 3D         ADDC   A,R5      ;Add ACC and R5 with carry
FC0F D4         DA     A        ;Decimal adjust the content of ACC
FC10 F0         MOVX   @DPTR,A  ;Move the ACC to second byte of
                                ;the result
FC11 12 FC 30   LCALL  DEC_DPTR ;Decrement the data pointer once
FC14 E0         MOVX   A,@DPTR  ;Get the third byte(MSB) of the result
FC15 FD         MOV    R5,A      ;Move it to R5
FC16 3D         ADDC   A,R5      ;Add ACC and R5 with carry
FC17 D4         DA     A        ;Decimal adjust the content of ACC
FC18 F0         MOVX   @DPTR,A  ;Move the ACC to third byte(msb)
                                ;of the result
FC19 A3         INC    DPTR      ;Increment data pointer
FC1A A3         INC    DPTR      ;Increment data pointer
FC1B DC E4       DJNZ   R4,HEX2_EXT
                                ;Decrement the bit count and repeat
                                ;above steps until it reaches zero
FC1D 22         RET            ;Return

```

Routine 21:

```
-----  
; Decrements DPTR by one (16 bit decrement)  
;  
; No flags and registers are affected  
-----  
FC20          ORG      0FC20H  
FC20          DEC_DPTR:  
FC20 C5 82          XCH      A,DPL      ;Swap ACC and DPL  
FC22 70 02          JNZ      DEC_DPL    ;DPH = DPH-1 if DPL=0  
FC24 15 83          DEC      DPH  
FC26 14  DEC_DPL:  DEC      A          ;DPL = DPL-1  
FC27 C5 82          XCH      A,DPL    ;Restore ACC  
FC29 22            RET              ;Return
```

```

;-----
; SERIAL REAL TIME CLOCK (I2C)
; -----

00A0 WRITE_C EQU 10100000B ;command for write
00A1 READ_C EQU 10100001B ;command for read
0085 ACK_READ EQU 10000101B ;command to get acknowledge
0090 SCL EQU 90H ;P1.0
0091 SDA EQU 91H ;P1.1

```

Routine 22:

```

;-----
; Writes a byte to RTC
; Input : Address in ACC
;         Data in B
;-----

FC30 ORG 0FC30H

FC30 WRITEBYTE:
FC30 C0 E0 PUSH ACC ;store ACC in stack
FC32 91 B2 ACALL START_BIT ;send start bit
FC34 74 A0 MOV A,#WRITE_C
;move write command byte to ACC

FC36 7F 08 MOV R7,#08H ;move number of bit to R7
FC38 91 A6 ACALL SHFTO ;send the data in ACC to RTC
FC3A 91 C7 ACALL SLAVE_ACK ;get the acknowledge from RTC
FC3C D0 E0 POP ACC ;restore ACC from stack
FC3E 7F 08 MOV R7,#08H ;move number of bit to R7
FC40 91 A6 ACALL SHFTO ;send the data in ACC to RTC
FC42 91 C7 ACALL SLAVE_ACK ;get the acknowledge from RTC
FC44 E5 F0 MOV A,B ;move the data in B to ACC
FC46 7F 08 MOV R7,#08H ;move number of bit to R7
FC48 91 A6 ACALL SHFTO ;send the data in ACC to RTC
FC4A 91 C7 ACALL SLAVE_ACK ;get the acknowledge from RTC
FC4C 91 BE ACALL STOP_BIT ;send the stop bit to RTC
FC4E 91 91 ACALL ACK_POL ;call ACK polling, wait for
;end of write cycle

FC50 22 RET

```

Routine 23:

```

;-----
; Reads a byte from RTC
; Input : Address in Acc
; Output: Data in Acc
;-----
FC60          ORG      0FC60H

FC60          READBYTE:
FC60 C0 E0          PUSH   ACC           ;store ACC in stack
FC62 91 B2          ACALL  START_BIT     ;send start bit
FC64 74 A0          MOV    A,#WRITE_C     ;move write command byte to ACC
FC66 7F 08          MOV    R7,#08H         ;move number of bits to R7
FC68 91 A6          ACALL  SHFTO        ;send the data in ACC to RTC
FC6A 91 C7          ACALL  SLAVE_ACK     ;get the acknowledge from RTC
FC6C D0 E0          POP    ACC           ;restore ACC from stack
FC6E 7F 08          MOV    R7,#08H         ;move number of bits to R7
FC70 91 A6          ACALL  SHFTO        ;send the address in ACC to RTC
FC72 91 C7          ACALL  SLAVE_ACK     ;get the acknowledge from RTC
FC74 91 B2          ACALL  START_BIT     ;send the start bit
FC76 74 A1          MOV    A,#READ_C      ;move read command byte to ACC
FC78 7F 08          MOV    R7,#08H         ;move number of bits to R7
FC7A 91 A6          ACALL  SHFTO        ;send it to RTC
FC7C 91 C7          ACALL  SLAVE_ACK     ;get the acknowledge from RTC
FC7E 7F 08          MOV    R7,#08H         ;move number of bits to R7
FC80 D2 90  CLOCK8: SETB   SCL           ;set the SCL(clock) bit
FC82 00             NOP                    ;wait for a moment
FC83 A2 91          MOV    C,SDA         ;read one bit data(SDA) to carry
FC85 C2 90          CLR    SCL           ;clear the SCL bit
FC87 ED            MOV    A,R5
FC88 33            RLC    A           ;rotate and store it in R5
FC89 FD            MOV    R5,A
FC8A DF F4          DJNZ  R7,CLOCK8     ;repeat reading until R7 reaches 0
FC8C 91 EA          ACALL  NO_ACK        ;no acknowledge
FC8E 91 BE          ACALL  STOP_BIT     ;send the stop bit
FC90 22            RET

```

```

;***** ACK_POL *****
FC91      ACK_POL:
FC91 7B 40      MOV     R3,#40H      ;# of times to poll device
FC93      ACK_LOOP:
FC93 DB 02      DJNZ    R3,DONE_YET
FC95 80 0C      SJMP    DN_ACKPOL
FC97      DONE_YET:
FC97 91 B2      ACALL   START_BIT   ;send start bit
FC99 74 85      MOV     A,#ACK_READ ;send read command
FC9B 7F 08      MOV     R7,#08H
FC9D 91 A6      ACALL   SHFTO
FC9F 91 C7      ACALL   SLAVE_ACK   ;send acknowledge
FCA1 40 F0      JC      ACK_LOOP   ;loop if no acknowledge received
FCA3      DN_ACKPOL:
FCA3 91 BE      ACALL   STOP_BIT    ;send stop bit before return
FCA5 22                RET

;***** SHFTO *****
FCA6 C2 90      SHFTO: CLR     SCL
FCA8 C2 90      NXTSHF: CLR     SCL
FCAA 33                RLC     A      ;rotate data into carry
FCAB 92 91      MOV     SDA,C      ;send carry to SDA
FCAD D2 90      SETB    SCL
FCAF DF F7      DJNZ    R7,NXTSHF
FCB1 22                RET

;***** START BIT *****
FCB2      START_BIT:
FCB2 D2 90      SETB    SCL
FCB4 00                NOP
FCB5 D2 91      SETB    SDA
FCB7 00                NOP
FCB8 C2 91      CLR     SDA
FCBA 00                NOP
FCBB C2 90      CLR     SCL
FCBD 22                RET

```



```

;***** STOP BIT *****

FCBE          STOP_BIT:
FCBE C2 91          CLR      SDA
FCC0 00          NOP
FCC1 D2 90          SETB    SCL
FCC3 00          NOP
FCC4 D2 91          SET      SDA
FCC6 22          RET

;***** SLAVE ACKNOWLEDGE ****

FCC7          SLAVE_ACK:
FCC7 00          NOP
FCC8 00          NOP
FCC9 C2 90          CLR      SCL
FCCB 00          NOP
FCCC D2 91          SETB    SDA
FCCE 00          NOP
FCCF 00          NOP
FCD0 D2 90          SETB    SCL
FCD2 00          NOP
FCD3 00          NOP
FCD4 00          NOP
FCD5 A2 91          MOV      C,SDA      ;read state of SDA and save it to CY
FCD7 C2 90          CLR      SCL
FCD9 22          RET

;***** MASTER ACKNOWLEDGE *****

FCDA          MSTR_ACK:
FCDA C2 90          CLR      SCL
FCDC 00          NOP
FCDD C2 91          CLR      SDA
FCDF 00          NOP
FCE0 00          NOP
FCE1 D2 90          SETB    SCL
FCE3 00          NOP
FCE4 C2 90          CLR      SCL
FCE6 00          NOP
FCE7 D2 91          SETB    SDA
FCE9 22          RET

```

```
                ;***** NO ACKNOWLEDGE *****  
  
FCEA D2 91    NO_ACK: SETB    SDA  
FCEC 00                NOP  
FCED D2 90                SETB    SCL  
FCEF 00                NOP  
FCF0 C2 90                CLR     SCL  
FCF2 22                RET
```

FRONTLINE ELECTRONICS PVT LTD

1/255C - Thatha Gounder St, Kumaran Nagar, Alagapuram,
Salem - 636 016, Tamilnadu. India.

Phone : 0091 427 - 244 9238 / 243 1312. Fax : 0091 427 - 244 9010.

Email : feplslm@frontlinemail.com

www.Frontline-Electronics.com