# Megawin 8051 GNU Debugger

## User Manual

*By Vincent Y. C. Yu*

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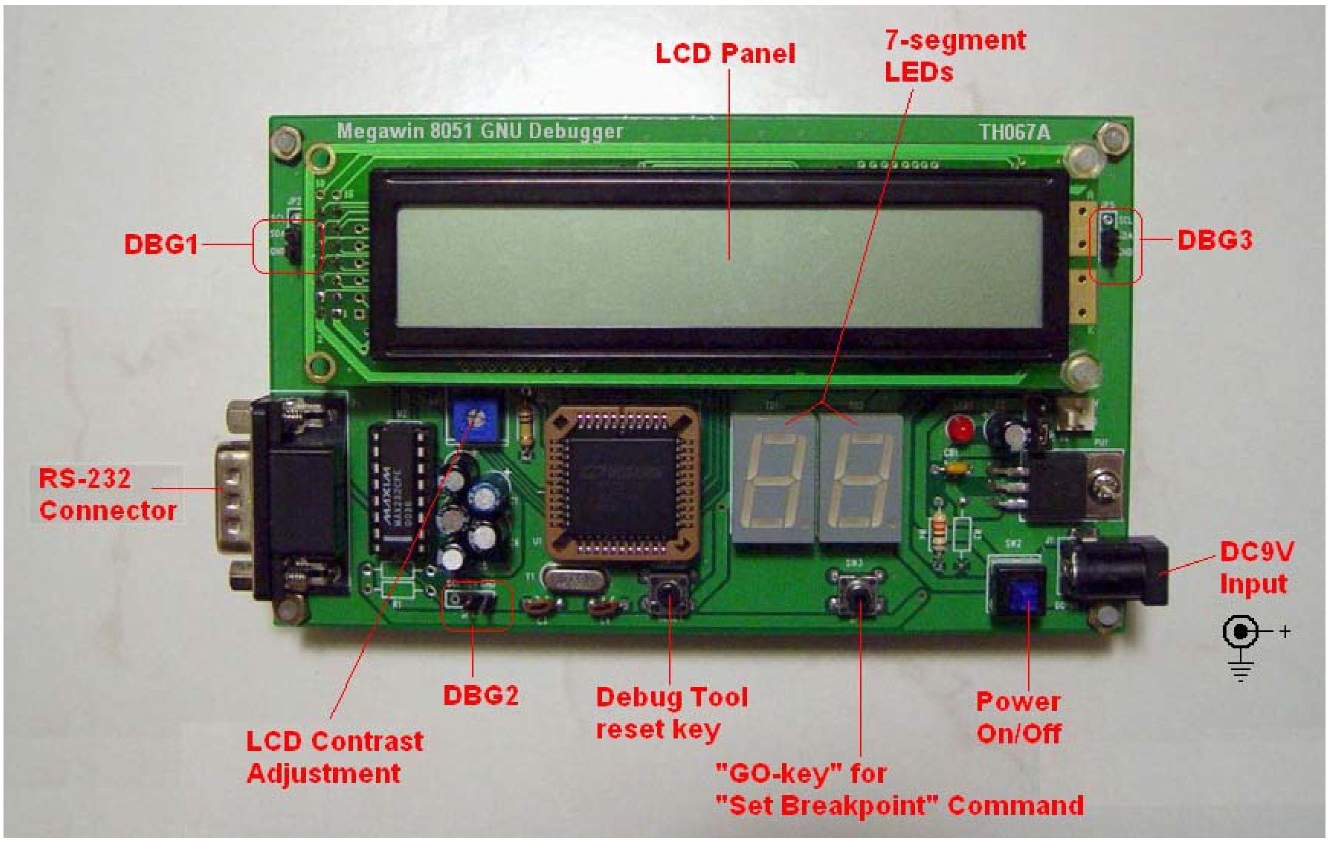
# 1 Introduction and Features

## 1-1 Introduction

The “Megawin 8051 GNU Debugger” is a powerful and low-cost development kit, which is proprietarily designed for Megawin 8051 MCU products. Like the traditional ICE (In-Circuit Emulator), this Debugger provides the necessary functions for embedded firmware developing and debugging. Additionally, its compact hardware with an LCD panel (as shown in the following picture) can work stand-alone. That is it doesn’t need the host intervened, and thus also provides an off-line debugging.

The design concept of this Debugger is somewhat like the popular ***GNU Debugger***, which is an extremely powerful and flexible tool for embedded system development. The key point of the GNU Debugger is to implement a ***Debug Agent***, *which is a small program running in the target’s hardware and helps the* ***Debugger*** *carry out requests to monitor and control the target’s application code being debugged*. So, the “Megawin 8051 GNU Debugger” consists of the *Debugger* and the *Debug Agent* (a library function code for developing and debugging).

**Picture of the “Megawin 8051 GNU Debugger”**



*Note:*
*There are three debug interface connectors (DBG1, DBG2 and DBG3, which are all the same) for user’s convenience to connect this Debugger to the target system.*

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## 1-2 Features

Six useful and powerful features help you develop your application code and catch the bugs in the application code:

**Feature-1:**
**Real chip debugging via a 1-pin serial interface. It means only one I/O pin of the Target is needed for debugging.**

**Feature-2:**
**Run-time displaying any message you want to check, such as SFR value, RAM data, state of input port, etc.**

**Feature-3:**
**Pseudo "Breakpoint". It makes the application code stay anywhere you want, like "stop", to let you inspect what has happened in the system. And, pressing the "GO-key" makes CPU continue to go ahead.**

**Feature-4:**
**Pseudo "Step-debugging". By successive inserting the "Set Breakpoint" command in the critical program section can emulate Step execution.**

**Feature-5:**
**While linked to PC, much more messages can be shown on the PC's monitor or saved to hard disk for later analysis.**

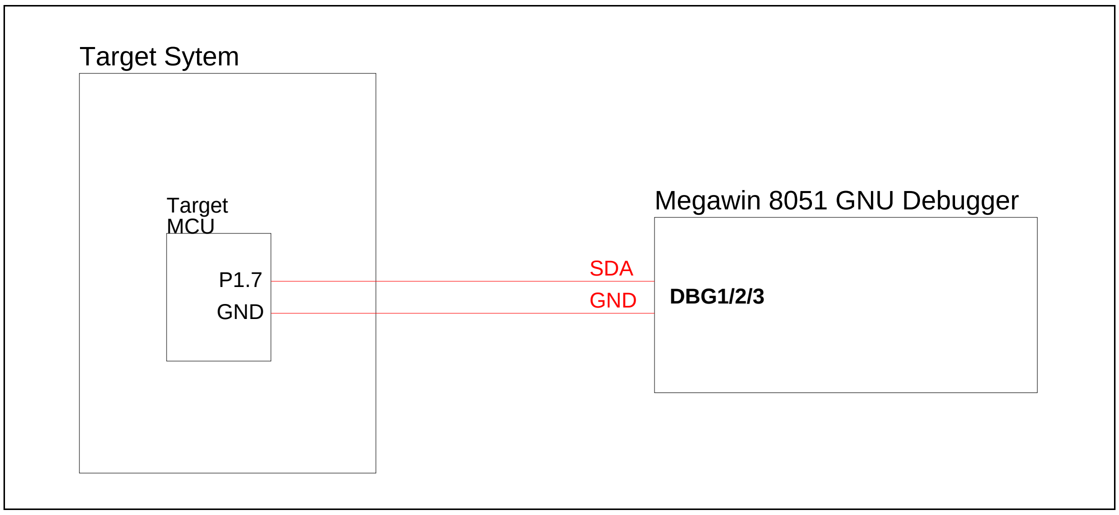
**Feature-6:**
**While linked to PC, the debugged Target can ask some arguments from PC for debugging or specific developing purpose.**

**In addition:**
**Available for both 5V and 3.3V Target system.**

# 2 System Requirements

## 2-1 Hardware

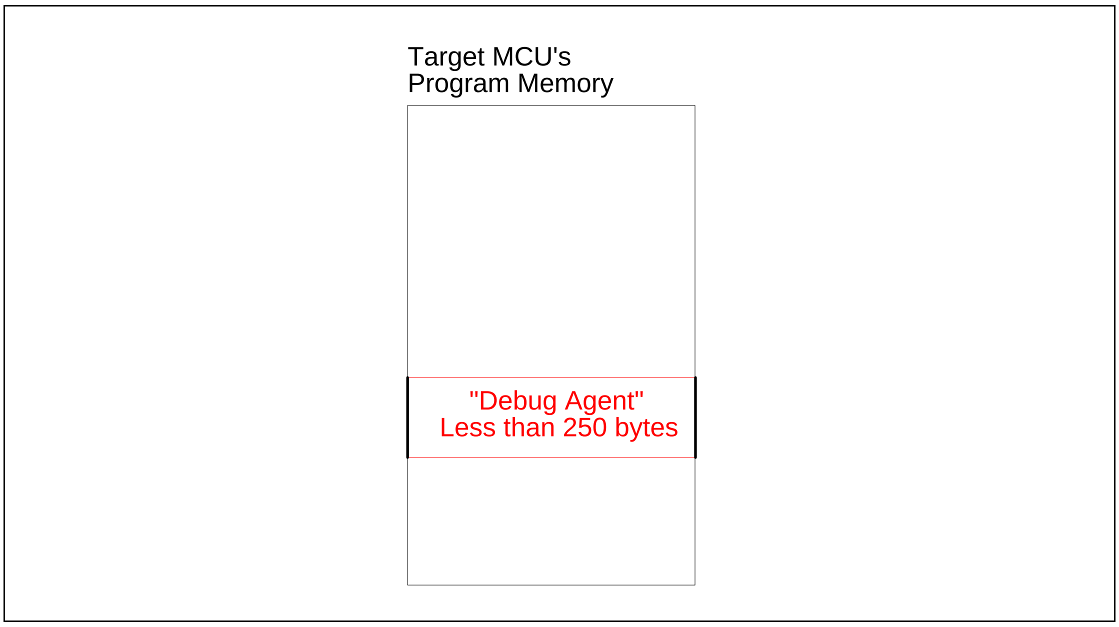
Just one pin of target MCU's GPIO is reserved for communicating with the "*Debugger*".



*Note:*
*In this example, target MCU's P1.7 is used for the debug interface.*

## 2-2 Firmware

Less than 250 bytes of target MCU's program memory are reserved for the "*Debug Agent*".


Target MCU's Program Memory
"Debug Agent" Less than 250 bytes

*Note:*
*The absolute memory address where the "Debug Agent" is located is determined by the Linker after compiled or assembled.*

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# 3 Use the Debugger

As described in Section 2-2, to use the Debugger, the user must insert the “Debug Agent” in his application code. The following sections will demonstrate how to do it.

## 3-1 Insert the Debug Agent

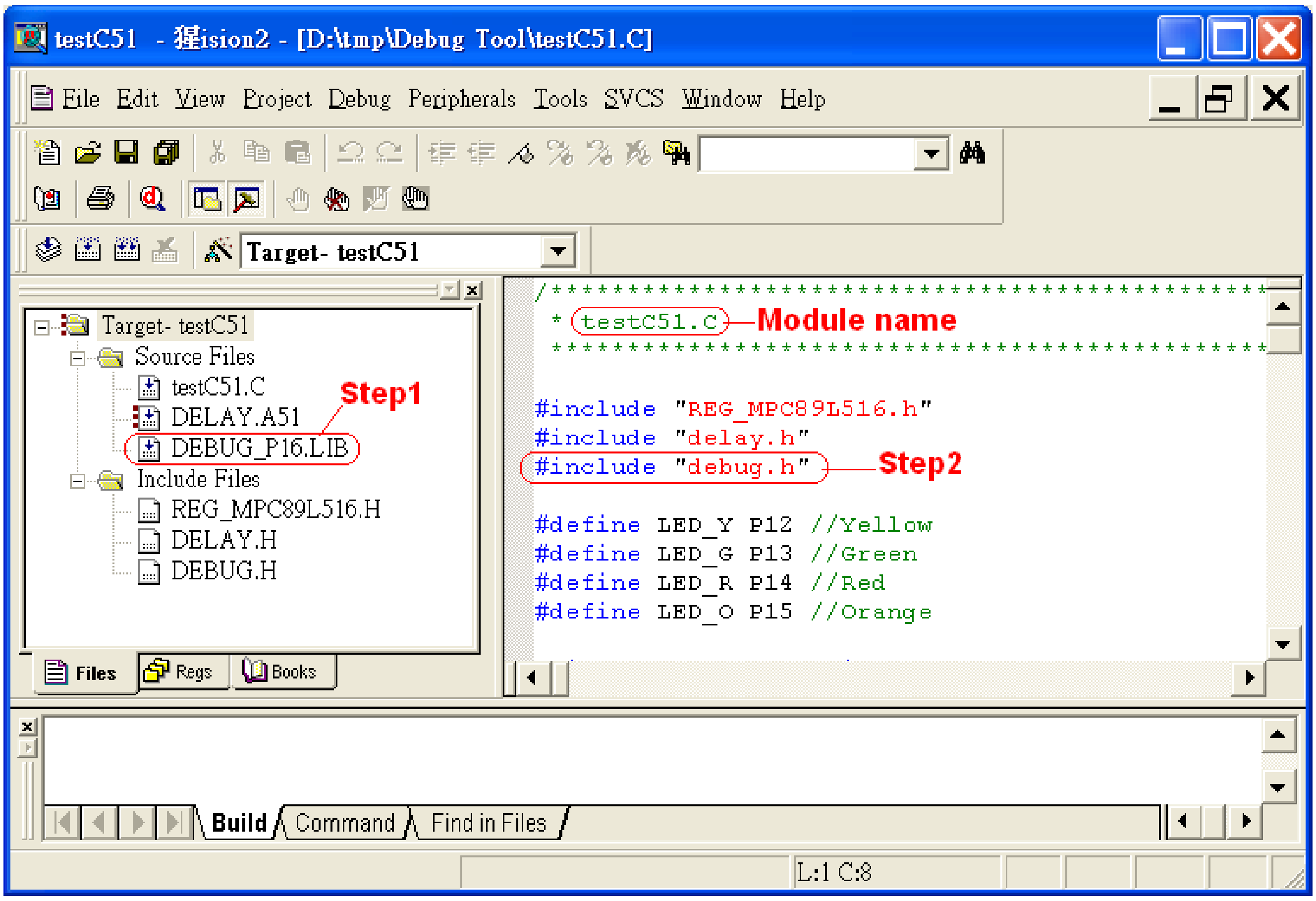
Follow the steps:

Step1: Add the Debug Agent “**DEBUG_Pxx.LIB**” into the project.

Step2: Include the header file “**DEBUG.H**” or “**DEBUG.INC**” in the source modules which will call the debug functions.

Where, “Pxx” stands for any GPIO pin which is assigned for the debug interface by user. For example, “DEBUG_P16.LIB” means P1.6 is used as the debug interface. Of course, the Debug Agents which use different GPIO pin are also provided. The “DEBUG.H” is used for C-language modules while the “DEBUG.INC” is used for assembly modules. See the following examples.

Example-1: For a C-language Module

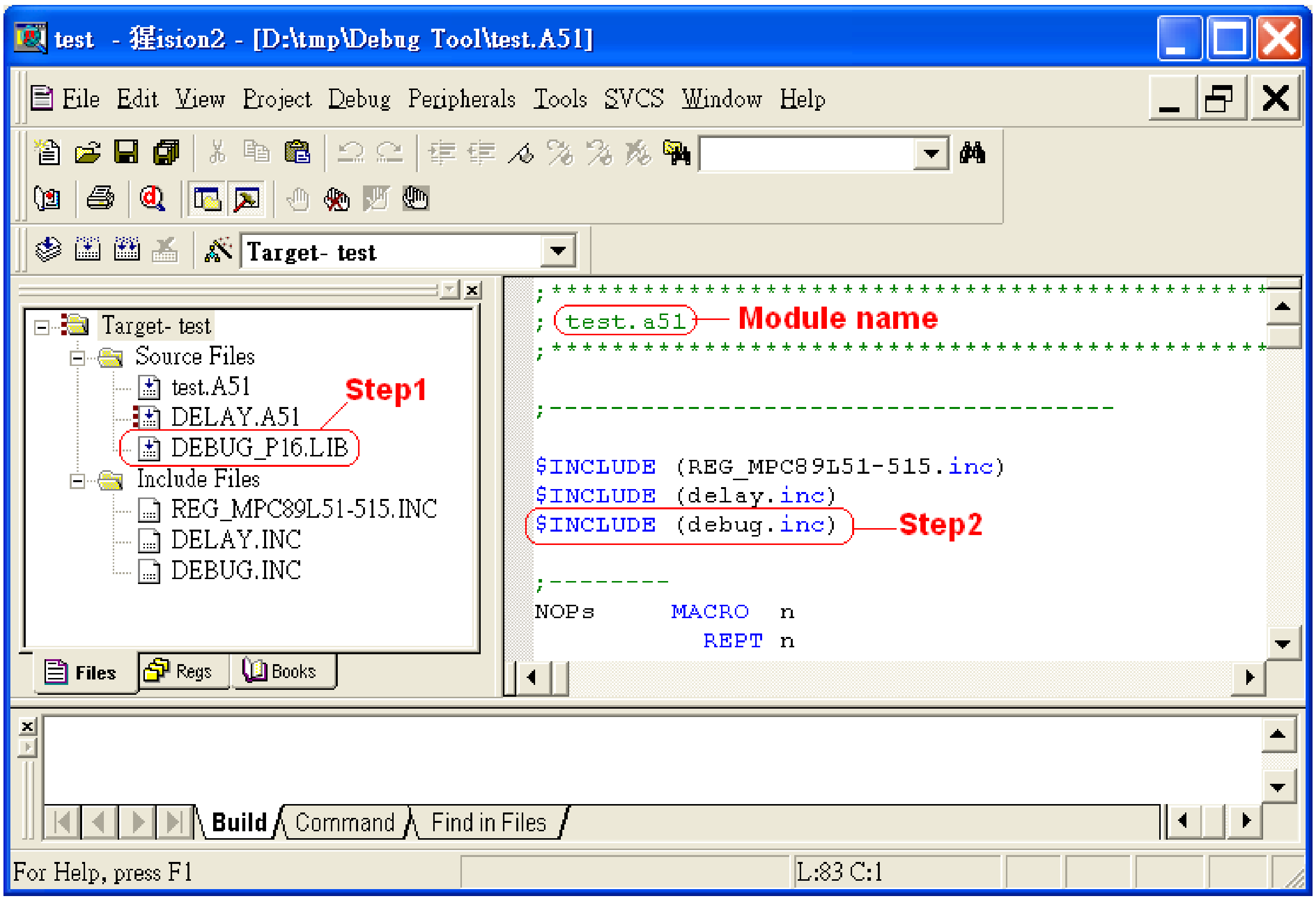


```
/*********************************************
 * testC51.c
 *********************************************

#include "REG_MPC89L516.h"
#include "delay.h"
#include "debug.h"

#define LED_Y P12 //Yellow
#define LED_G P13 //Green
#define LED_R P14 //Red
#define LED_O P15 //Orange
```

Example-2: For an Assembly Module



```
;*************************************************
; test.a51
;*************************************************

;---------------------------------------

$INCLUDE (REG_MPC89L51-515.inc)
$INCLUDE (delay.inc)
$INCLUDE (debug.inc)

;---------
NOPs      MACRO  n
            REPT  n
```

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### 3-1-1 Debug Agent Functions for a C-language Module

"DEBUG.H" defines the debug functions for C-language modules, as listed below.

| | |
|---|---|
| Function name | **Debug_clear_LCD ();** |
| Description | Clear the LCD panel of the Debugger |
| Argument | (N/A) |

| | |
|---|---|
| Function name | **Debug_show_msg_to_LCD (**unsigned char msg**);** |
| Description | Show a message on the LCD panel of the Debugger |
| Argument | msg, which is to be shown on the LCD panel |

| | |
|---|---|
| Function name | **Debug_show_msg_to_7seg (**unsigned char msg**);** |
| Description | Show a message on the 7-segment of the Debugger |
| Argument | msg, which is to be shown on the 7-segment |

| | |
|---|---|
| Function name | **Debug_set_breakpoint (**unsigned char BP_no**);** |
| Description | Set a breakpoint in the application code, and pressing the "GO-key" on the Debugger will let the application code continue to go |
| Argument | BP_no, which is the breakpoint number (assigned by user) to be shown on the 7-segment |

| | |
|---|---|
| Function name | **Debug_show_msg_to_PC (**unsigned char msg**);** |
| Description | Show a message to PC's monitor |
| Argument | msg, which is to be shown on PC |

| | |
|---|---|
| Function name | unsigned char arg = **Debug_get_argument_from_PC ();** |
| Description | Get one byte data from PC, to be used in the application code |
| Argument | arg, which is the destination of the data from PC |

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Sample Code

```
#include "debug.h"

void main(void)
{
unsigned char var1,var2,var3,var4,var5;
unsigned char arg;

   ...

   Debug_clear_LCD();             //clear the LCD panel

   Debug_show_msg_to_LCD(0x5A);   //show immediate value 0x5A to LCD panel
   Debug_show_msg_to_LCD(var1);   //show var1’s value to LCD panel
   Debug_show_msg_to_LCD(P1);     //read P1 and show to LCD panel

   Debug_show_msg_to_7seg(0x5B); //show immediate value 0x5B to 7-segment
   Debug_show_msg_to_7seg(var2); //show var2’s value to 7-segment
   Debug_show_msg_to_7seg(P2);   //read P2 and show to 7-segment

    //set a Breakpoint with No.=0x01, which will blink on the 7-segment
   Debug_set_breakpoint(0x01);

    //set a Breakpoint with No.=0xF2, which will blink on the 7-segment
   Debug_set_breakpoint(0xF2);

    //set a Breakpoint with No.=var5, which will blink on the 7-segment
   var5=0xB1;
   Debug_set_breakpoint(var5);

   Debug_show_msg_to_PC(0x5C);   //show immediate value 0x5C to PC monitor
   Debug_show_msg_to_PC(var3);   //show var3’s value to PC monitor
   Debug_show_msg_to_PC(P3);     //read P3 and show to PC monitor

    //get an argument from PC, and store into var4
   arg=Debug_get_argument_from_PC();
   var4=arg;

   ...

}
```

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### 3-1-2 Debug Agent Functions for an Assembly Module

"DEBUG.INC" defines the debug functions by *MACRO-type* for assembly modules, as listed below.

| | |
|---|---|
| MACRO name | **Debug_clear_LCD** |
| Description | Clear the LCD panel of the Debugger |
| Argument | (N/A) |

| | |
|---|---|
| MACRO name | **Debug_show_msg_to_LCD** msg |
| Description | Show a message on the LCD panel of the Debugger |
| Argument | msg, which is to be shown on the LCD panel |

| | |
|---|---|
| MACRO name | **Debug_show_msg_to_7seg** msg |
| Description | Show a message on the 7-segment of the Debugger |
| Argument | msg, which is to be shown on the 7-segment |

| | |
|---|---|
| MACRO name | **Debug_set_breakpoint** BP_no |
| Description | Set a breakpoint in the application code, and pressing the "GO-key" on the Debugger will let the application code continue to go |
| Argument | BP_no, which is the breakpoint number (assigned by user) to be shown on the 7-segment |

| | |
|---|---|
| MACRO name | **Debug_show_msg_to_PC** msg |
| Description | Show a message to PC's monitor |
| Argument | msg, which is to be shown on PC |

| | |
|---|---|
| MACRO name | **Debug_get_argument_from_PC** arg |
| Description | Get one byte data from PC, to be used in the application code |
| Argument | arg, which is the destination of the data from PC |

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Sample Code

```
$INCLUDE (debug.inc)

;===============================================================================
data_test SEGMENT DATA
         RSEG   data_test

var1:           DS   1
var2:           DS   1
var3:           DS   1
var4:           DS   1
var5:           DS   1
arg:            DS   1

;===============================================================================
code_test SEGMENT CODE
         RSEG   code_test
         USING  0
;-------------------------------------------------------------------------------
start:
         ...
         Debug_clear_LCD             ;clear the LCD panel

         Debug_show_msg_to_LCD #5Ah  ;show immediate value #5Ah to LCD panel
         Debug_show_msg_to_LCD var1  ;show var1's value to LCD panel
         Debug_show_msg_to_LCD ACC   ;show SFR ACC's value to LCD panel
         Debug_show_msg_to_LCD B     ;show SFR B's value to LCD panel
         Debug_show_msg_to_LCD P1    ;read P1 and show to LCD panel
         Debug_show_msg_to_LCD 30h   ;show RAM addr. 30h's value to LCD panel

         Debug_show_msg_to_7seg #5Bh ;show immediate value 0x5B to 7-segment
         Debug_show_msg_to_7seg var2 ;show var2's value to 7-segment
         Debug_show_msg_to_7seg ACC  ;show SFR ACC's value to 7-segment
         Debug_show_msg_to_7seg B    ;show SFR B's value to 7-segment
         Debug_show_msg_to_7seg P2   ;read P2 and show to 7-segment
         Debug_show_msg_to_7seg 31h  ;show RAM addr. 31h's value to 7-segment

         //set a Breakpoint with No.=0x01, which will blink on the 7-segment
         Debug_set_breakpoint #01h

         //set a Breakpoint with No.=0xF2, which will blink on the 7-segment
         Debug_set_breakpoint #0F2h

         //set a Breakpoint with No.=var5, which will blink on the 7-segment
         MOV    var5,#0B1h
         Debug_set_breakpoint var5

         Debug_show_msg_to_PC #5Ch   ;show immediate value 0x5C to PC monitor
         Debug_show_msg_to_PC var3   ;show var3's value to PC monitor
         Debug_show_msg_to_PC ACC    ;show SFR ACC to PC monitor
         Debug_show_msg_to_PC B      ;show SFR B to PC monitor
         Debug_show_msg_to_PC P3     ;read P3 and show to PC monitor
         Debug_show_msg_to_PC 32h    ;show RAM(addr=32h) content to PC monitor

         ;get an argument from PC, and store into var4
         Debug_get_argument_from_PC arg
         MOV    var4,arg
         ...
```

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## 3-2 Insert the Debug Agent for a Non-relocatable Project

If the user's project consists of only one assembly program which has its code-segment and data-segment not re-locatable (that is its code address and variable address are absolutely specified by the user rather than automatically arranged by the Linker), then what Section 3-1 mentions can not be used.

The following example shows a non-relocatable assembly program. The user should open the file "DEBUG.PIN" to edit the definition for 'SDA', which is one of the target's I/O pin used as the interface to the Debugger, as shown below.

```
SDA     BIT     P1.6 ;!!!!! the user may change P1.6 to the other wanted I/O pin
```

In this example, the user should notice where to include "DEBUG.PIN" and where to insert the Debug Agent "DEBUG.A51".

```
$INCLUDE (DEBUG.INC)           ;include header file

var1     DATA   30h            ;Variables are absolutely assigned by
var2     DATA   31h            ;"non-relocatable" definition.
var3     DATA   32h            ;
                               ;
flag1    BIT    20h.0          ;
flag2    BIT    20h.1          ;
flag3    BIT    20h.2          ;

;================================================================================
         CSEG   AT  0000h  ;absolutely assign code address
         JMP    start

         ORG    0040h          ;absolutely assign code address
start:
         MOV    SP,#7Fh

         ;... (Instruction)
         ;... (Instruction)


         JMP    Label_1

         ORG    1000h          ;absolutely assign code address
Label_1:
         ;... (Instruction)
         ;... (Instruction)

         JMP    Label_2


         ORG    2000h          ;absolutely assign code address
Label_2:

         ;... (Instruction)
         ;... (Instruction)


;================================================================================

$INCLUDE (DEBUG.A51)           ;insert the Debug Agent

         END                   ;end of program
```

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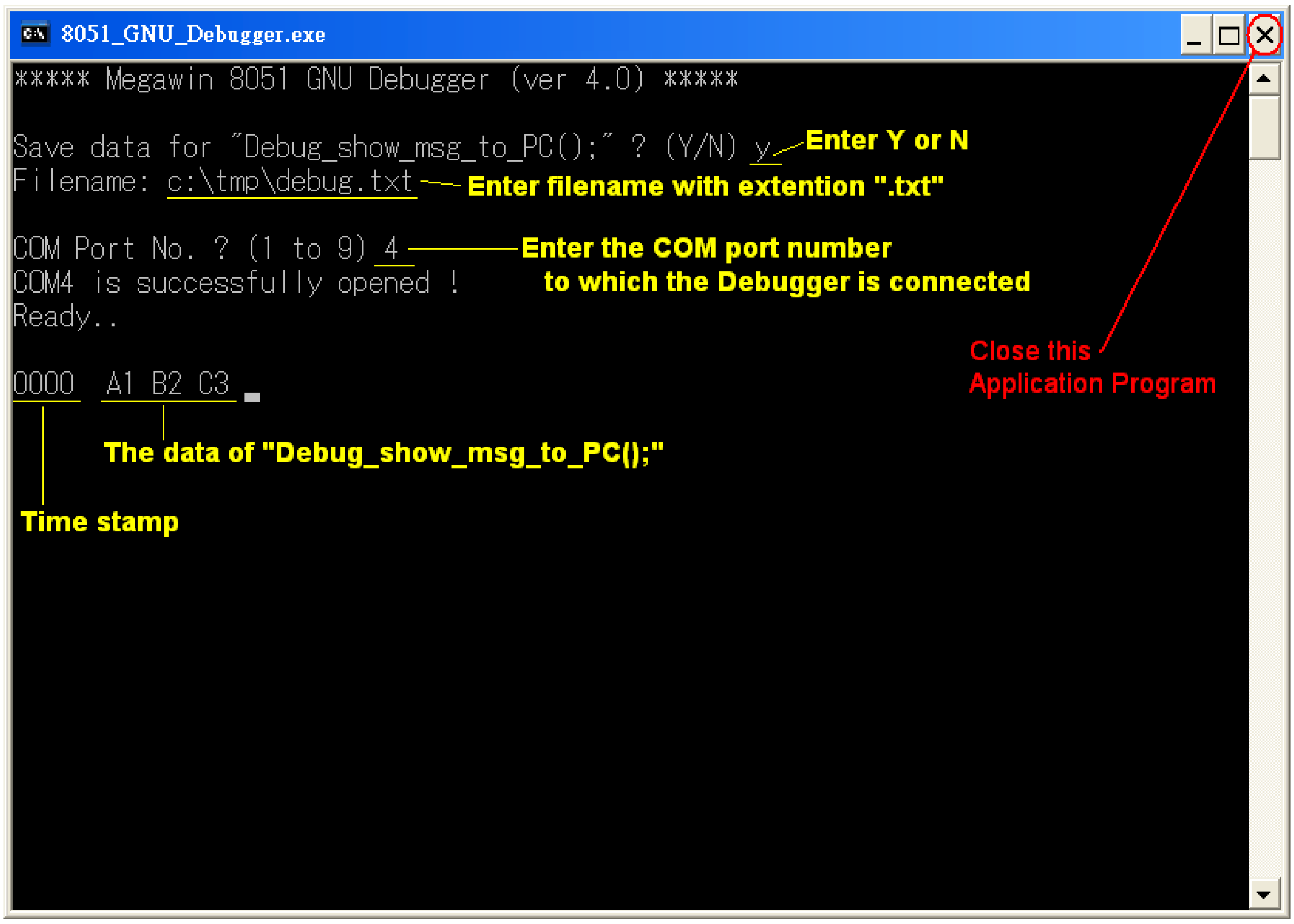
# 4 Application Program on PC-site

The PC-site application program is just a console-mode software program and is very easy to use. It is responsible for displaying (and even saving) the message from the debugged Target which calls the debug function “Debug_show_msg_to_PC();”. Of course, the user should connect the Debugger to PC via an RS-232 cable in order to use this debug function. Another debug function “Debug_get_argument_from_PC()” also needs to run this application program.

To run this program, just doubly click “***8051_GNU_Debugger.exe***”, then follow its instructions as shown below. If you want the displayed data to be saved, answer yes by entering “Y” or “y”, and then enter the file name with extension “.txt” (because the data are saved as text format). The user should enter the correct COM port number (1~9) to which the Debugger is connected. After the specified COM port is successfully opened, the message “COMx is successfully opened !” & “Ready..” will appear on the PC monitor. Now, user can use the debug functions “Debug_show_msg_to_PC()” and “Debug_get_argument_from_PC()”.

To close this application program, just click “☒” at upper-right corner. If any error happens, close it and re-open it. The following picture shows the execution “*8051_GNU_Debugger.exe*”.


8051_GNU_Debugger.exe
Enter Y or N
Enter filename with extention ".txt"
Enter the COM port number
to which the Debugger is connected
Close this
Application Program
The data of "Debug_show_msg_to_PC();"
Time stamp

```
***** Megawin 8051 GNU Debugger (ver 4.0) *****

Save data for "Debug_show_msg_to_PC();" ? (Y/N) y
Filename: c:\tmp\debug.txt

COM Port No. ? (1 to 9) 4
COM4 is successfully opened !
Ready..

0000  A1 B2 C3
```

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# 5 Demonstration Examples

This Debugger provides versatile functions for embedded firmware developing and debugging. Several examples are presented in this section. They are:

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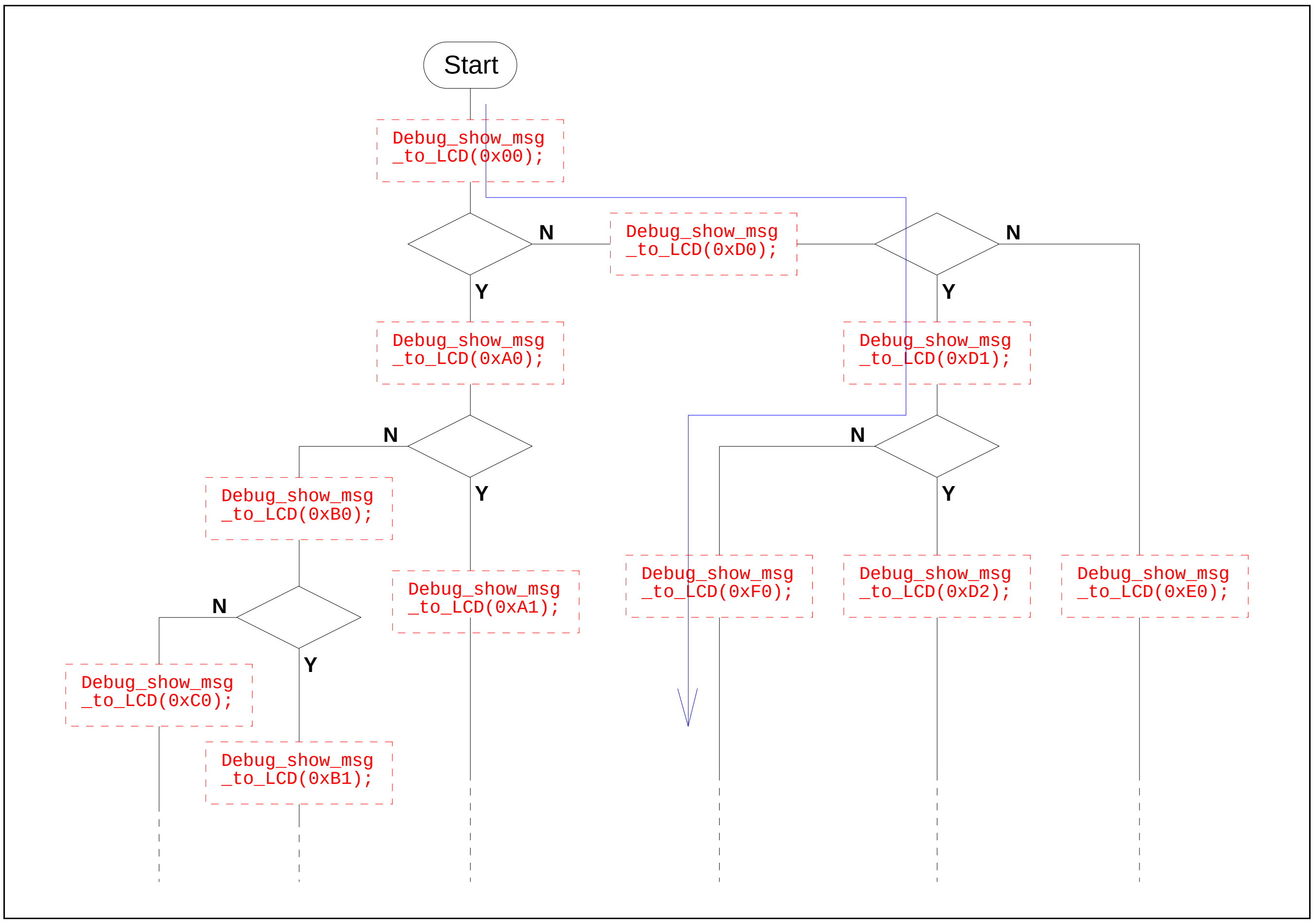
## Example-1: Check the program flow

In program developing stage, checking the program flow and monitoring where the MCU runs is very important. For this purpose, user can insert the debug function “Debug_show_msg_to_LCD()” with different arguments into the key branch points, as illustrated in the following diagram. Suppose 0x00, 0xD0, 0xD1 and 0xF0 are sequentially displayed on the LCD panel while the MCU start to run, then we can know the program flow is shown as the blue line.


Start
Debug_show_msg _to_LCD(0x00);
N
Debug_show_msg _to_LCD(0xD0);
N
Y
Y
Debug_show_msg _to_LCD(0xA0);
Debug_show_msg _to_LCD(0xD1);
N
N
Debug_show_msg _to_LCD(0xB0);
Y
Y
Debug_show_msg _to_LCD(0xA1);
Debug_show_msg _to_LCD(0xF0);
Debug_show_msg _to_LCD(0xD2);
Debug_show_msg _to_LCD(0xE0);
N
Y
Debug_show_msg _to_LCD(0xC0);
Debug_show_msg _to_LCD(0xB1);

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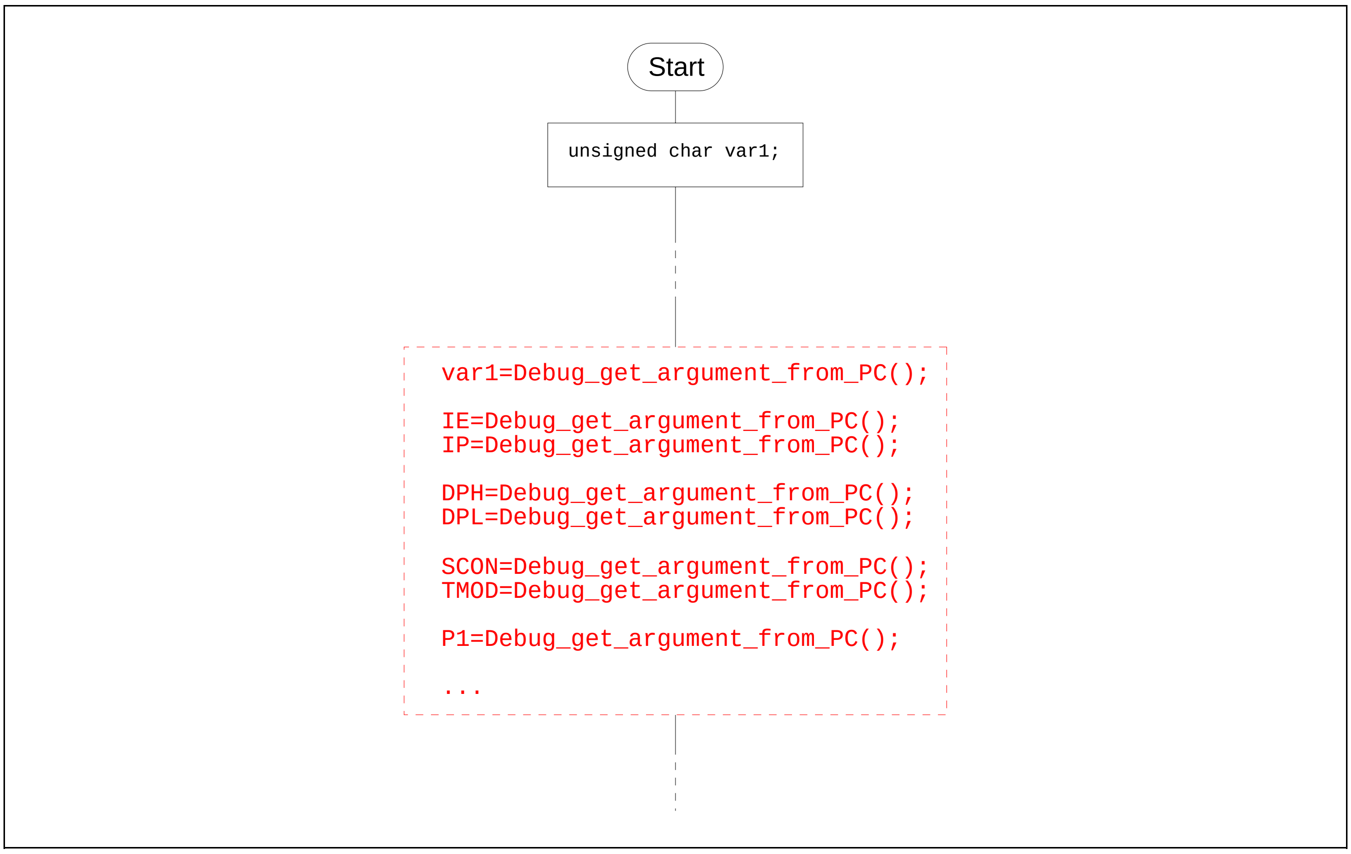
## Example-2: Modify contents of SFR and RAM

Sometimes, user would like to modify the contents of some SFR or RAM while MCU is running. Use the debug function “Debug_get_argument_from_PC()” to do it. Refer to the following diagram.

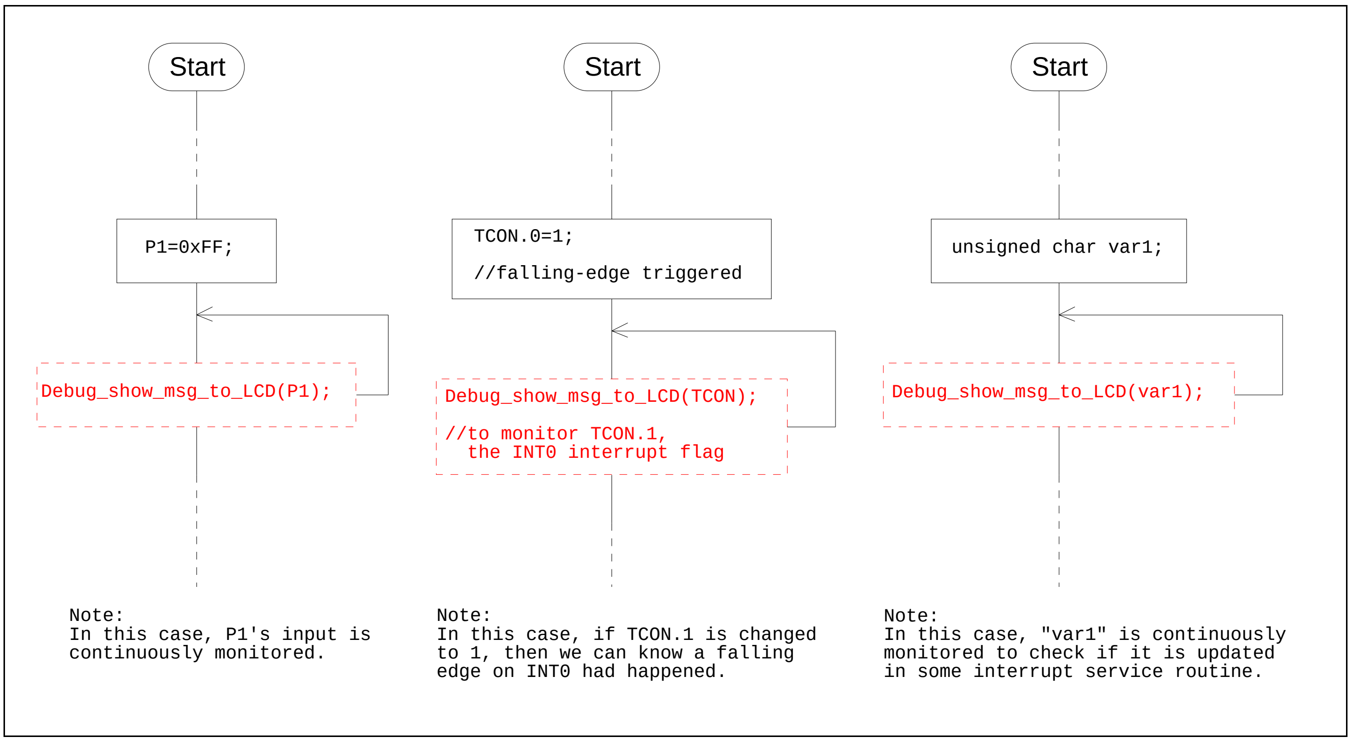


```
unsigned char var1;
```

```
var1=Debug_get_argument_from_PC();

IE=Debug_get_argument_from_PC();
IP=Debug_get_argument_from_PC();

DPH=Debug_get_argument_from_PC();
DPL=Debug_get_argument_from_PC();

SCON=Debug_get_argument_from_PC();
TMOD=Debug_get_argument_from_PC();

P1=Debug_get_argument_from_PC();

...
```

## Example-3: Continuously monitor the MCU's internal status

User can continuously monitor the MCU's internal status, such as state of an input port, contents of RAM or SFR, etc. See the following examples. The status is continuously displayed on the LCD panel.


Start
P1=0xFF;
Debug_show_msg_to_LCD(P1);
Start
TCON.0=1;
//falling-edge triggered
Debug_show_msg_to_LCD(TCON);
//to monitor TCON.1, the INT0 interrupt flag
Start
unsigned char var1;
Debug_show_msg_to_LCD(var1);

```
Note:
In this case, P1's input is
continuously monitored.
```

```
Note:
In this case, if TCON.1 is changed
to 1, then we can know a falling
edge on INT0 had happened.
```

```
Note:
In this case, "var1" is continuously
monitored to check if it is updated
in some interrupt service routine.
```

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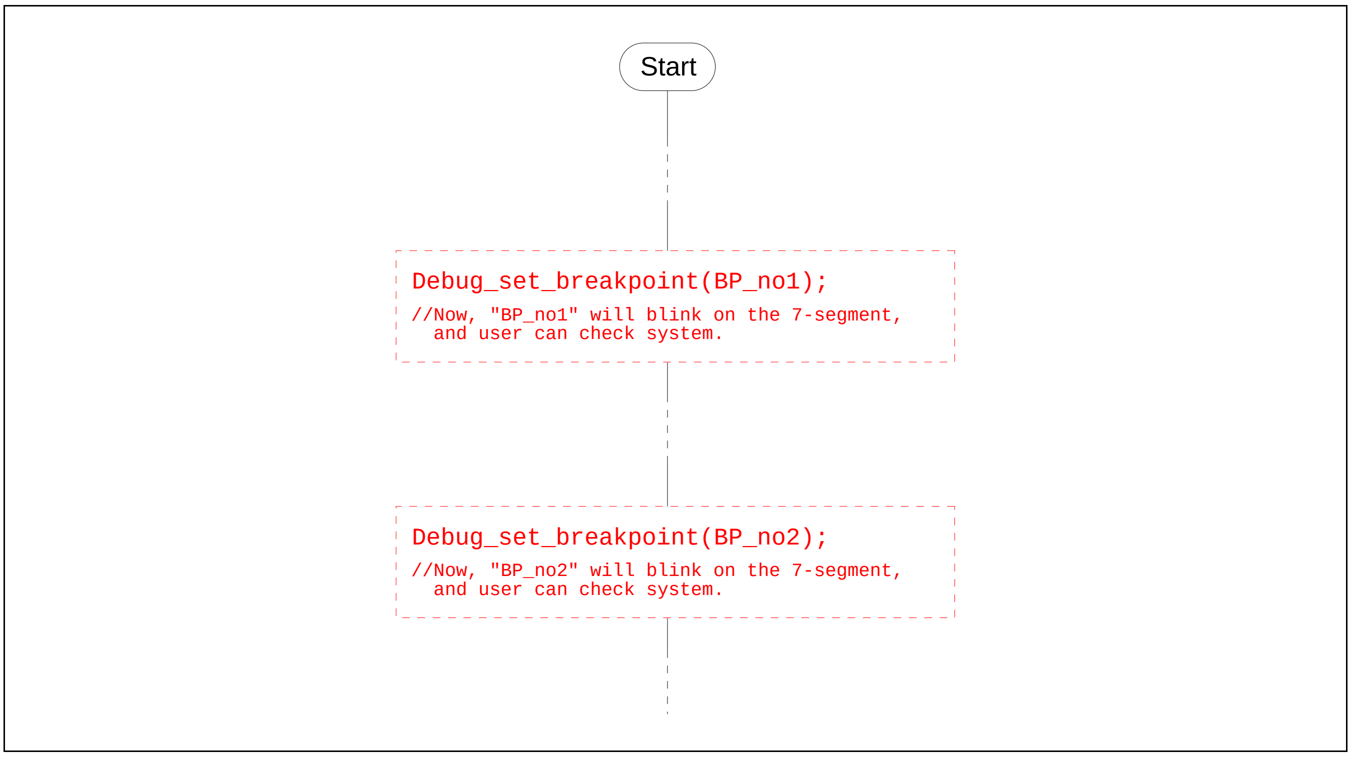
## Example-4:  Pseudo "Breakpoint"

Sometimes, user would like to have the MCU temporarily stay somewhere, not go ahead but like "stop", for checking what happened in the system. Use the debug function "Debug_set_breakpoint()" to do it. And, pressing the "GO-key" on the Debugger will let the MCU continue to go ahead.

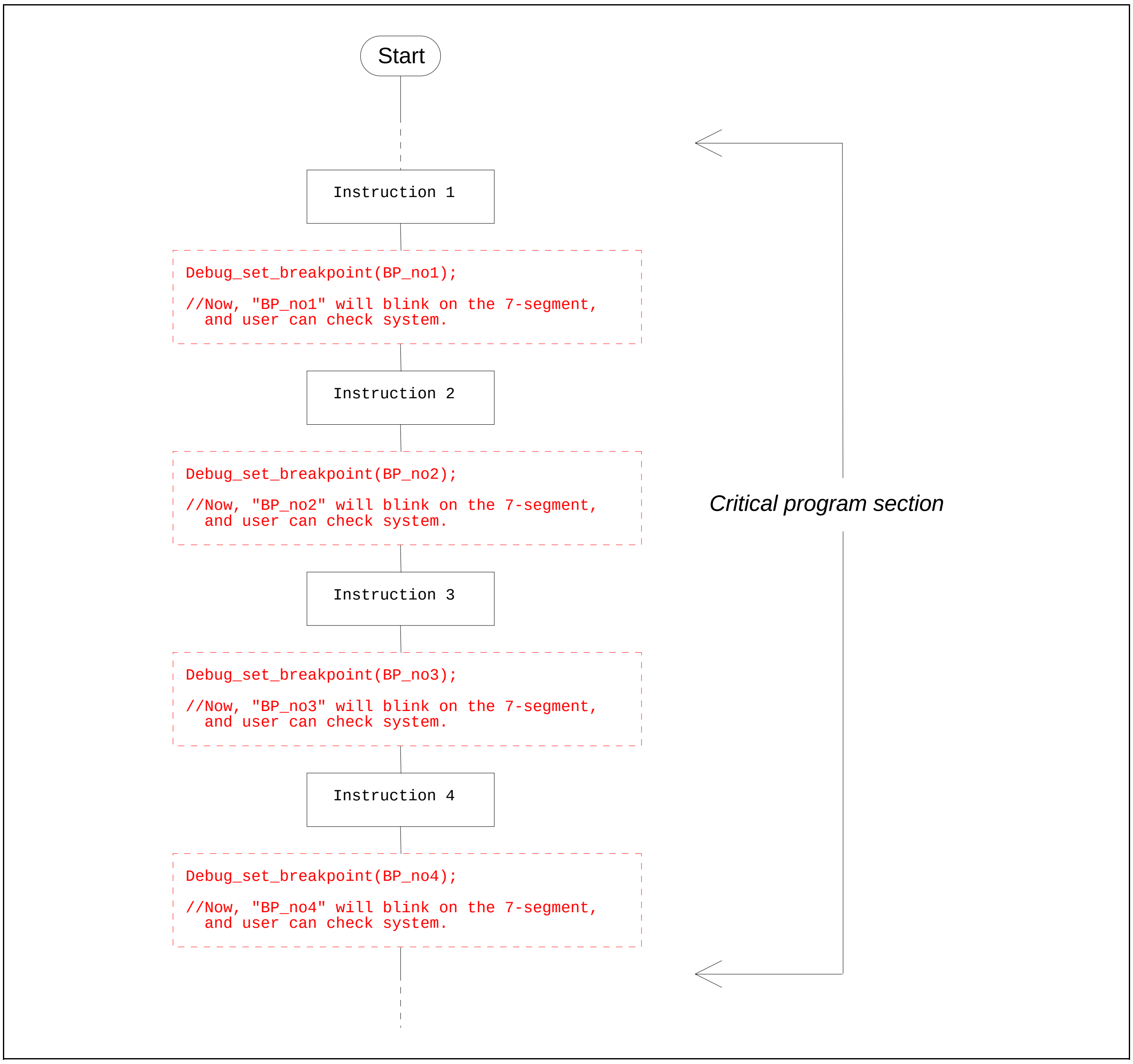


```
Debug_set_breakpoint(BP_no1);
//Now, "BP_no1" will blink on the 7-segment,
  and user can check system.
```

```
Debug_set_breakpoint(BP_no2);
//Now, "BP_no2" will blink on the 7-segment,
  and user can check system.
```

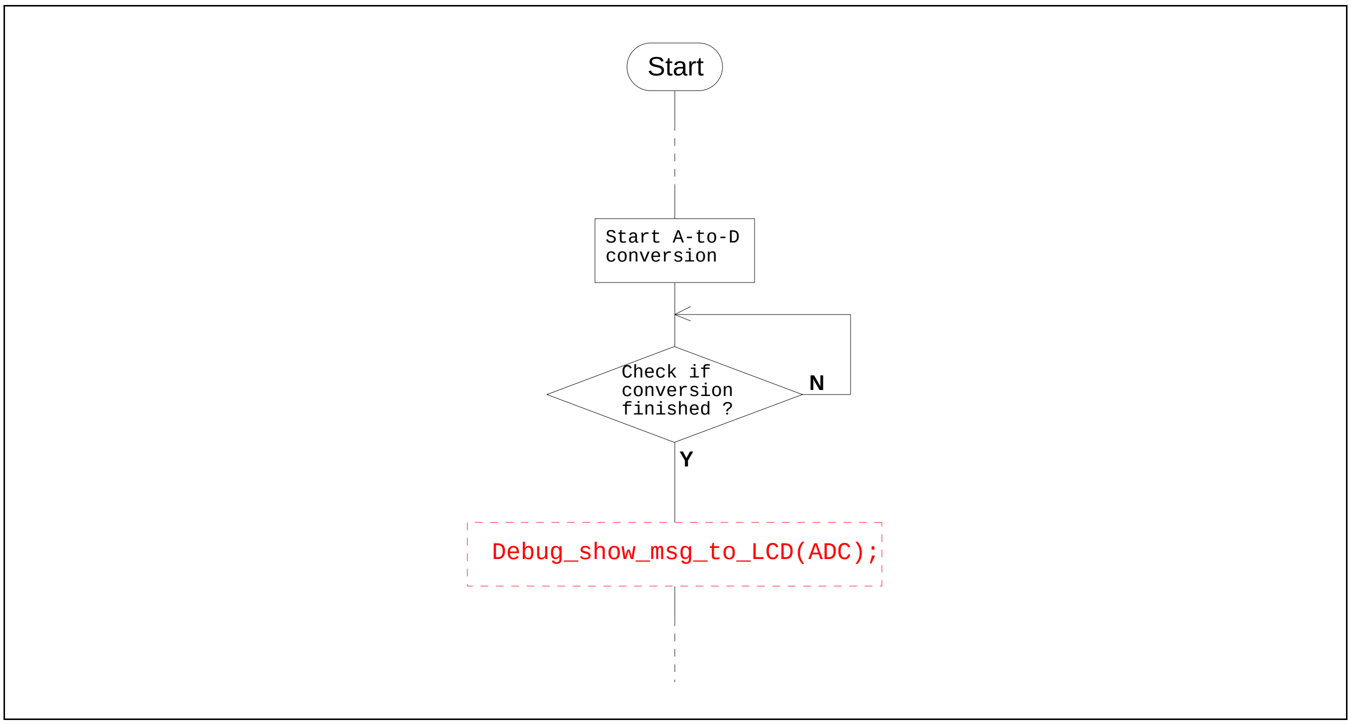
## Example-5: Pseudo "Step-debugging"

Sometimes, user would like to step-by-step execute the program for debugging. By successively inserting the debug function "Debug_set_breakpoint()" within the *critical program section* (where the bug is most probably found), the Debugger can emulate quasi-Step debugging. Pressing the "GO-key" on the Debugger will let the MCU execute the next instruction.


Start
Instruction 1
Debug_set_breakpoint(BP_no1);
//Now, "BP_no1" will blink on the 7-segment, and user can check system.
Instruction 2
Debug_set_breakpoint(BP_no2);
//Now, "BP_no2" will blink on the 7-segment, and user can check system.
Instruction 3
Debug_set_breakpoint(BP_no3);
//Now, "BP_no3" will blink on the 7-segment, and user can check system.
Instruction 4
Debug_set_breakpoint(BP_no4);
//Now, "BP_no4" will blink on the 7-segment, and user can check system.
Critical program section

## Example-6:  Check the ADC result

There is an ADC function in Megawin MPC82-series MCU. To check the ADC result, user can insert the debug function “Debug_show_msg_to_LCD()” after an A-to-D conversion is finished. As shown in the following diagram, the ADC result will be displayed on the LCD panel.



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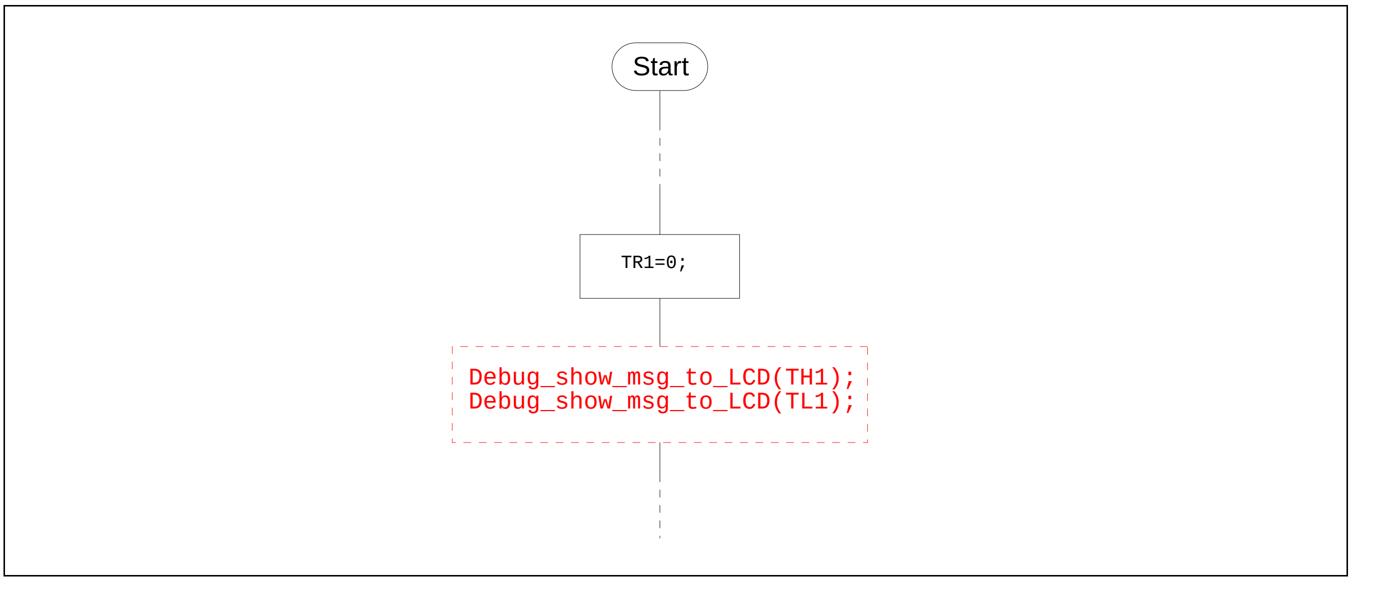
## Example-7: Check a Timer's counting value

To check a Timer's counting value whenever you want, please stop the Timer prior to inserting the debug function "Debug_show_msg_to_LCD()" with argument "THx" or "TLx". In this example, Timer1's counting value is to be checked.



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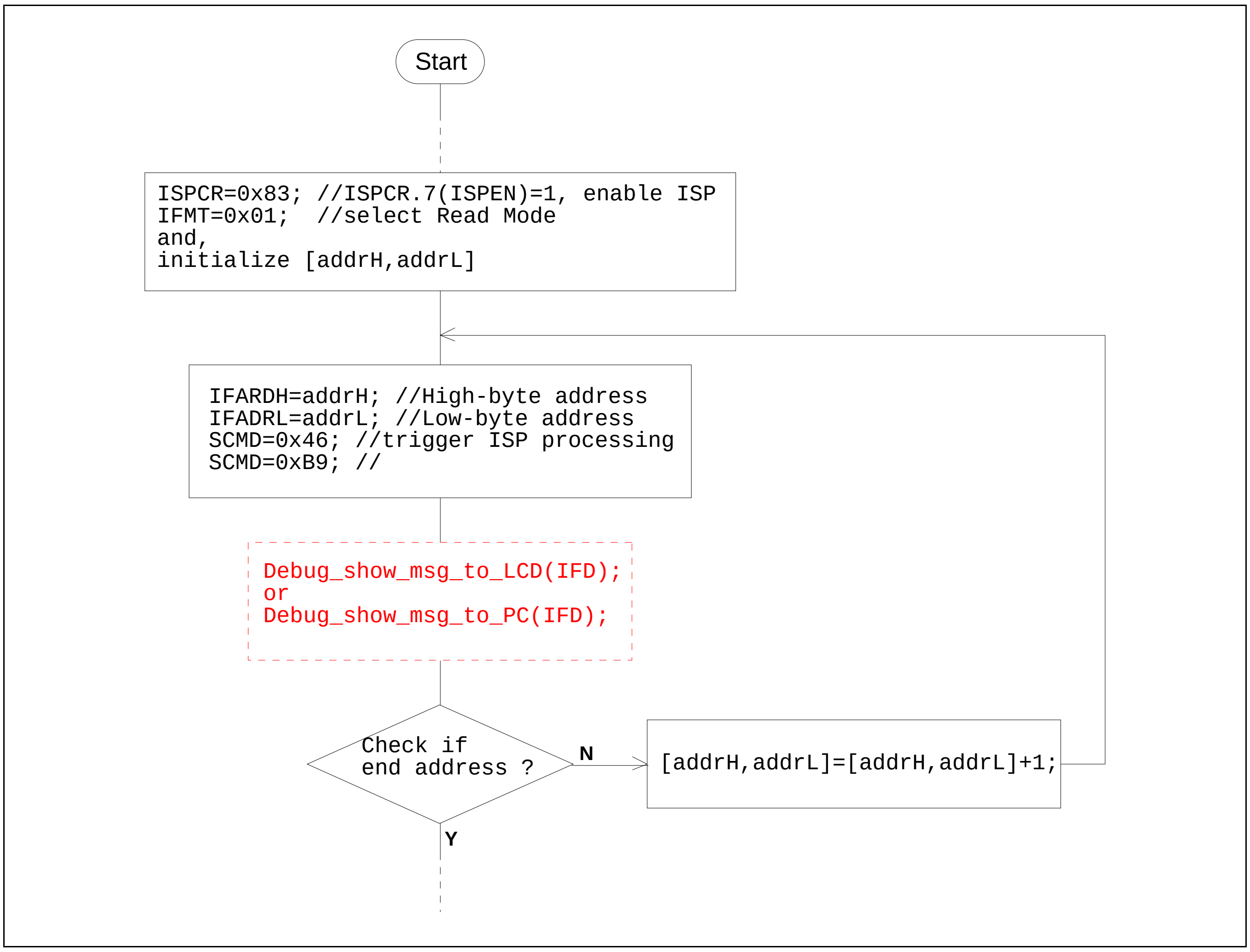
## Example-8:  Check data in the IAP-memory

To check the IAP data, use the debug function “Debug_show_msg_to_LCD()”. See the following flow chart. If use “Debug_show_msg_to_PC()”, it is necessary to connect the Debugger to PC’s COM port and execute the “8051_GNU_Debugger.exe”. (See Section 4 for the Application Program on the PC-site.)


Start
ISPCR=0x83; //ISPCR.7(ISPEN)=1, enable ISP
IFMT=0x01;  //select Read Mode
and,
initialize [addrH,addrL]
IFARDH=addrH; //High-byte address
IFADRL=addrL; //Low-byte address
SCMD=0x46; //trigger ISP processing
SCMD=0xB9; //
Debug_show_msg_to_LCD(IFD);
or
Debug_show_msg_to_PC(IFD);
Check if
end address ?
N
[addrH,addrL]=[addrH,addrL]+1;
Y

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# 6 Special Notes for the Debugger

Normally, the LCD panel will show “**Ready ..**” whenever the Debugger is in its ready state, which means the Debugger is ready to receive the debug commands from the debugged Target. However, if the Debugger is connected to a powered-off Target system, the Debugger’s LCD panel & 7-segment LEDs will show “**Timeout !**” (or “**Command error !**”) and “**Er**”, respectively. It is because the state of the SDA-pin scanned by the Debugger is logic “0”, which means a START condition of a debug command is sent to the Debugger, but it is a fake START caused by the powered-off Target system. Anyway, it does not matter for this condition. The LCD panel will stably show “**Ready ..**” as long as the Target system is powered on.

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