SDCC 8051 Assembly Language Programming Guide

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Overview

SDCC 8051 Development System has a built in 8051 Assembler that allows developing programs in assembly language or mixed C and assembly for project development and educational purpose.

Assembly language can be embedded in C programs as inline assembly. Alternatively, assembly language code may have its own source file. SDCC 8051 Development System allows having multiple assembly source files or mixing assembly and C source files in the same project.

Our 8051 Simulator and 8051 Debugger tools also support assembly language development. For example, it is possible to single step through assembly code, set breakpoints and watch register values. This simplifies assembly program development and is also a valuable learning tool for users learning about microcontrollers.

Software Setup

Download SDCC 8051 Development System from:

http://www.bipom.com/sdcc_down.php

Start the installation by downloading and running sdcc_devsys.exe

A Welcome screen will appear:

Welcome		×			
	Welcome to the Micro-IDE Setup program. This program will install Micro-IDE on your computer.				
	It is strongly recommended that you exit all Windows programs before running this Setup program.				
	lick Cancel to quit Setup and then close any programs you ave running. Click Next to continue with the Setup program.				
	WARNING: This program is protected by copyright law and international treaties.				
	Unauthorized reproduction or distribution of this program, or any portion of it, may result in severe civil and criminal penalties, and will be prosecuted to the maximum extent possible under law.	ł			
		_			
	[<u>N</u> ext>] Cancel				

Click on Next. End User Agreement will appear:

Software License Agreement	X						
Please read the following License Agreement. Press the PAGE DOWN key to se the rest of the agreement.	e						
END USER LICENSE AGREEMENT FROM BiPOM Electronics Please read the following End User License Agreement ("EULA") carefully. The EULA is a legal agreement between you the user and BiPOM Electronics for the use of Micro-IDE (the "Software"). This EULA contains the conditions under which you may use the software as well as warranty and liability disclaimers. By installing, copying or using the Software, you agree to be bound by the terms of this EULA. If you do not agree to the terms of this EULA, do not install, copy, or use the Software. This Software is protected by copyright laws and international copyright treaties, as well as other intellectual property laws and treaties. This Software is licensed, not sold. For more information about Micro-IDE, see the About box under Help menu in this program. To learn more about BiPOM Electronics and its products, visit							
Do you accept all the terms of the preceding License Agreement? If you choose No, Setup will close. To install Micro-IDE, you must accept this agreement.							
< <u>B</u> ack <u>Y</u> es <u>N</u> o							

Please read the agreement and click Yes if you wish to continue with installation.

User Information		×
	Please entr You may le size-restrict N <u>a</u> me: <u>C</u> ompany: <u>S</u> erial:	er your name, company name and serial number below. wave the serial number field blank to run this software in ted demo mode. jack BiPOM Electronics, Inc.
		< <u>B</u> ack <u>N</u> ext > Cancel

Enter your name, company (if applicable) and serial number:

Enter a serial number of 1. Click Next.

Select the disk location where the software will be installed. Using the default location of c:\bipom\devtools is recommended:

.

Choose Destination Loca	ation X						
	Setup will install Micro-IDE in the following folder.						
	To install to this folder, click Next.						
	To install to a different folder, click Browse and select another folder.						
	You can choose not to install Micro-IDE by clicking Cancel to exit Setup.						
	Destination Folder C:\bipom\devtools Browse						
	< <u>B</u> ack <u>Next</u> Cancel						

Click Next. Select the Program Folder where the icons for Micro-IDE will be installed. Default selection is **Micro-IDE** folder.



Click Next. Micro-IDE will be installed and you will see the progress:



When the installation is complete, you will be given an option to start Micro-IDE now:

Setup Complete	
	Setup has finished installing Micro-IDE on your computer.
	Setup can launch the Read Me file and Micro-IDE. Choose the options you want below.
	✓ I would like to launch Micro-IDE.
	IMPORTANT NOTE: If you have other development systems that use Micro-IDE, please make sure to update all other development systems to the latest versions from BiPOM web site to avoid unexpected behavior.
	< <u>B</u> ack Finish

Click Finish and Micro-IDE will start.

Downloading Example Programs

After installing the software, you can build assembly language programs and download programs to the board. Follow the steps below:

1. Make sure that your target board is powered and connected to the PC. This manual assumes that you are using a BiPOM microcontroller board such as MINI-MAX/51-C2, MINI-MAX/51-D, MINI-MAX/51-E or MINI-MAX/51-F. You can use other 8051 boards, too.

2. Run Micro-IDE from Windows Start menu. When Micro-IDE is started, the Project selection window appears:

Welcome	×
Welcome to Micro-IDE Program Development Environm	ient.
What do you want to start with:	(0K)
O Create a new project	
Open existing project	Lancel
Show this dialog at startup.	

Click OK to select an existing example project.

Micro-IDE is distributed with several example programs that illustrate how to program the 8051 micro-controller. Example projects are located under the Examples folder under the folder where you installed Micro-IDE. Some of the examples are written in C and some of them are written in assembly language.

3. Select Project, Open Project and open the example project asm.prj from:

C:\bipom\devtools\SDCC\Examples\8051\tiny\asm

Open					? 🗙
Look jn: ଢ	asm	•	(÷ 🖻) 📥	
asm.prj					
File <u>n</u> ame:					<u>O</u> pen
Files of <u>type</u> :	Project files (*.prj)		•		Cancel

III Mires TDE Factor actor	
III What or Dot _ Tost Mindshill	_ 8 ×
<u>HOV A</u> ,#5	
LABELI: INC A	
AJMP LABEL1	
Bit Files	
	[]
P I I I I I I I I I I I I I I I I I I I	
Ln 1, Col 1 Disconnected	

4. Click the Build button on the main toolbar. This will build the asm project:



If the project builds successfully, you should see the output messages from the assembler on the Output Window:

Y											
Assembling C:\bipom\devtools\SDCC\examples\asm\asm.asm											
Linking asm.rel											
-k C:\bipom\devtools\sdcc\bin\\lib\large											
-I C:\bipom\devtools\sdcc\lib\large\libbipom.lib											
-I mcs51											
-l libsdcc											
-l libint											
-l liblong											
-l libfloat											
asm.rel											
💈 Build 🛛 Debug 🛛 Find in Files 1 🗧 Find in Files 2 🖉 Loader											
Ready											

5. Download the executable (asm.ihx) file to the board by selecting Download under Build menu:

|--|

î Download button If the MINI-MAX/51-C2 board is powered and connected properly to the PC, a progress dialog will appear:

Downloading program	×
47%	
Cancel	

The progress dialog will disappear following a successful download. Details of the download are

shown on the Output Window:

<u>x</u> <u></u>	Success writing 32 bytes Success writing 32 bytes Success writing 32 bytes Success writing 32 bytes Success writing 32 bytes												
t -	Success writing 32 bytes Success writing 32 bytes Success writing 26 bytes												
З.													
out	Build	Debug	Find in	Files	1	Find i	n File	s 2	Loader	J			

When the download is finished, the progress indicator disappears. This means that the board has received the program successfully. After the program has been successful downloaded, it can be started using the Mode button on the main Toolbar:



Mode button puts the board into **Run** or **Program** mode. In Run mode, the microcontroller is executing the program in its memory. In Program mode, the microcontroller is in Reset state so no programs are running. In Program mode, microcontroller's flash memory can be changed and a new program can be downloaded.

The Mode button is Red in Program mode and Green in Run mode. Following a download, the Mode button will be Red. Click the Mode button to change the mode to Run mode. The program **asm.hex** that you just downloaded starts executing.

You should now see the characters that you type on the Terminal window being echoed back to you.

Congratulations!!! You have built and executed your first assembly language program on the MINI-MAX/51.

Click the Mode button once again so it turns Red. The board is in Program mode

Writing Your Own Programs

To create your own project, select Project menu and select New Project. This will display the New Project dialog:

New project		×
Project name:	test	It is recommended NOT to put spaces in project name as some toolkits may not support this.
Location:	c:\test	Browse
Toolkit:	SDCC 8051 Assembler	•
Debugger:	8051 Simulator	
Manufacturer II	Generic	
Chip ID	8052	
	ОК	Cancel

Enter the name of the new project and its location (this examples uses **test** as the project name and **c:\test** as the project location). Select the Toolkit as SDCC 8051 Assembler. Click OK. Say Yes to create new directory. You will be prompted to select a project type:

Create new file	×
SDCC Empty ASM Project	
	Cancel

Select "SDCC Empty ASM Project" and click OK.

The new project with the name of **test** under **c:\test** will be created. A blank assembly language file (test.asm) will be automatically created:

	te:	st.asm		
		.area .area	a HOME a CSEG	(CODE) (CODE)
		LABEI	L1:	
		i	; Do noth NOP	ing - NOP command
		i	; Jump to AJMP LABE) LABEL1 in endless loop L1
-	Ē			

Type the following sentence into the section where it says "Put your code here":

clr P1.0

The assembly program should now look like this:

```
test.asm
.area HOME (CODE)
.area CSEG (CODE)
LABEL1:
    ; Do nothing - NOP command
    NOP
    ; Put your code here
    clr P1.0
    ; Jump to LABEL1 in endless loop
    AJMP LABEL1
```

This program changes port pin P1.0 to logic low level. P1.0 is connected to the Green LED on the Training Board (TB-1) so this program will turn on the Green LED if TB-1 is installed. Build the program by clicking the Build button. If the program builds successfully, you will see the following messages on the Output Window:

Assembling c:\test\test.asm... Linking test.rel ... -k c:\bipom\devtools\sdcc\bin\..\lib\large -l c:\bipom\devtools\sdcc\lib\large\libbipom.lib -l mcs51 -l libsdcc -l libint -l liblong -l libfloat test.rel

Download the program to the board by clicking the Download button on the main toolbar. Run the program by clicking the Mode button on the main toolbar. You will see the Green LED on TB-1 turning on if TB-1 is connected.

Using the 8051 Simulator

BiPOM's 8051 Simulator fully supports the 8051 Assembly language programs written in SDCC. In the simulator, the 8051 instructions are simulated on the PC as if they are executing on the target board.

You can simulate the micro-controller and single-step through your program without actually having the board connected to your PC. The demo Simulator that comes with Micro-IDE is limited to 1K of 8051 code. You can purchase the SDCC 8051 Simulator option from BiPOM Electronics to remove this restriction and obtain a full-featured Simulator license.

To start the simulation, press F11 or click the Step Into button on the Debug toolbar:



This will start a simulation session and will bring up the Listing file (test.lst) for this project. Listing file is an Assembly language representation of your program with additional information. The execution will stop on the first code line that will be highlighted:

te	st.asm [*] test.lst		
		1 .area HOME (CODE) 2 .area CSEG (CODE) 3	
	0000	4 5 LABEL1: 6	
		7 ; Do nothing - NOP command	
	0000 00	8 NOP	
		9 10 ; Put your code here 11	
	0001 C2	90 12 clr P1.0 13	
	0003 00	14 ; Jump to LABEL1 in endless loop 00 15 AJMP LABEL1	
	ASxxxx As:	embler V01.70 + NoICE + SDCC mods + Flat24 Feb-1999 (Intel 8051), pag	ge 1.
	Symbol Tab	e	
	A	00D6	
	2 A\$test: 2 A\$test:	12 0001 GR	

To view the simulated 8051 registers, activate the Register window (if it is not already visible) by clicking the Register window button on the Window toolbar. To view the simulated 8051 memory, click the Memory window button on the Window Toolbar:

]] [2	2			ō.		2	F		
Progra	m Me	mory	/	•	<u>A</u> ddr	ess	0x0	000	0000)	<u>a ×</u>
	008 010 018 020 028 030 038 040 058 050 058 050 058 050 058 070 058 070 088 090 098	00 00 00 00 00 00 00 00 00 00 00 00 00			00 00 00 00 00 00 00 00 00 00 00 00 00						
000000 000000 000000	DA8 DB0 DB8	00 00 00	00 00 00	00 00 00	00 00 00	00 00 00	00 00 00	00 00 00	00 00 00		~

Registers —			- <u>-</u> ×
Name	Value	Extended	~
ACC	00		
В	00		
SP	07	00	
DPTR	00	58	
PC	02		
PSW	00		
IE	00		
IP	00		
RO	00	00	
R1	00	00	
R2	00		
R3	00		
R4	00		
R5	00		
R6	00		
R7	00		
Port0	FF		
Port1	FE		
Port2	FF		
Port3	FF		
PCON	00		
SBUF	00		
SCON	00		
TCON	00		
TMOD	00		
то	00		~
T1	00		

All the standard 8051 registers are simulated and viewed on the Register window. To see the remainder of the registers, scroll down the Register window. Note that at program startup, ports are all 0xFF, which means that all the Port pins are high logic level.

Press F11 one more time. You will notice that the current execution line (green bar) has advanced to the next line:

tes	st.asm* test.lst	
		1 .area HOME (CODE) 2 .area CSEG (CODE) 3 4
	0000	5 LABEL1:
	0000 00	7 ; Do nothing - NOP command 8 NOP 9
		10 ; Put your code here
⇔	0001 C2 90	12 clr P1.0
	0003 00 00 ASxxxx Assembler V01.70	13 14 ; Jump to LABEL1 in endless loop 15 AJMP LABEL1 + NoICE + SDCC mods + Flat24 Feb-1999 (Intel 8051), page 1.
	Symbol Table	
	A 2 Aŝtestŝ12 2 Aŝtestŝ15	00D6 0001 GR 0003 GR

Press F11 one more time. You will notice that the current execution line (green bar) has advanced to the next line:

te	st.asm [*] test.lst		
		1 .area HOME (CODE) 2 .area CSEG (CODE) 3	
	0000	Š LABEL1: 6	
	0000 00	7 ; Do nothing - NOP command 8 NOP 9	
		10 ; Put your code here	
	0001 C2 90	12 clr P1.0 13	
7	0000 00 00	14 ; Jump to LABEL1 in endless loop	
52	UUU3 UU UU LASyyyyy Assembler	IS AJMP LABELL 11 70 + NoICE + SDCC mods + Flat24 Feb-1999 (Intel 8051) page	• 1
	Symbol Table		
	A 2 A\$test\$12 2 A\$test\$15	00D6 0001 GR 0003 GR	

This means that the current line

clr P1.0

has already executed. In the Register window, Port1 will change from 0xFF to 0xFE indicating that bit 0 (P1.0) has been reset.

If you continue to press F11, the program execution will loop to the beginning and start over because **AJMP LABEL1** statement (jump to LABEL1). To stop debugging, select Debug menu and select Stop Debugging. Or click the Stop Debugging button:



When debugging is stopped, all debugging related windows such as Register window, Memory window and Variable window are automatically closed.

You can obtain more detailed help on how to use Micro-IDE by selecting Help Topics and Help Pages on the Web under the Help menu.

Appendix A: 8051 Assembly Language Instructions

Transfer (Move) Instructions

Syntax:

MOV destination, source destination = source

There are 6 basic types:

Instruction	Description
MOV A, byte	Move byte to accumulator
MOV byte, A	Move accumulator to byte
MOV Rn, byte	Move byte to register of current bank
MOV direct, byte	Move byte to internal RAM
MOV @Rn, byte	Move byte to internal RAM with address contained in Rn
MOV DPTR, data16	Move 16-bit data into data pointer

Stack Instructions

Instruction	Description
PUSH byte	Increment stack pointer, move byte on stack
POP byte	Move from stack to byte, decrement stack pointer

Exchange Instructions

Instruction	Description
XCH A, byte	Exchange accumulator and byte
XCHD A, byte	Exchange low nibbles of accumulator and byte

Arithmetic Instructions

Instruction	Description
ADD A, byte	Add accumulator to byte, put result in accumulator
ADDC A, byte	Add with carry
SUBB A, byte	Subtract with borrow
INC A	Increment accumulator
INC byte	Increment byte in memory
INC DPTR	Increment data pointer
DEC A	Decrement accumulator
DEC byte	Decrement byte in memory
MUL AB	Multiply accumulator by b register
DIV AB	Divide accumulator by b register
DAA	Decimally adjust the accumulator

Logic Instructions

Instruction	Description
ANL A, byte	AND accumulator with byte, put result in accumulator
ANL byte, A	AND byte with accumulator, put result in byte
ANL byte, #constant	AND byte with constant, put result in byte
ANL C, bit	AND carry with bit, put result in carry
ORL A, byte	OR accumulator with byte, put result in accumulator
ORL byte, A	OR byte with accumulator, put result in byte
ORL byte, #constant	OR byte with constant, put result in byte
ORL C, bit	OR carry with bit, put result in carry
XRL A, byte	XOR accumulator with byte, put result in accumulator
XRL byte, A	XOR byte with accumulator, put result in byte
XRL byte, #constant	XOR byte with constant, put result in byte

Bit Manipulation Instructions

Instruction	Description
CLR A	Clear all bits of accumulator
CLR byte	Clear all bits of byte
CLR Rn	Clear all bits of register in current bank
CLR @Ri	Clear all bits of byte pointed to by register
CLR C	Clear carry bit
CLR bit	Clear a bit-addressable RAM location or SFR
RL A	Rotate left accumulator
RLC A	Rotate left accumulator through carry
RR A	Rotate right accumulator
RRC A	Rotate right accumulator through carry
SWAP A	Swap the nibbles of accumulator
CPL C	Complement carry bit
CPL bit	Complement a bit-addressable RAM location or SFR
CPL A	2's complement A
SETB C	Set carry bit
SETB bit	Set a bit-addressable RAM location or SFR

Jump Instructions

Instruction	Description
SJMP <relative addr=""></relative>	Short jump up to 127 bytes forward or 128 bytes back
LJMP <address 16=""></address>	Long jump to a 16-bit address
AJMP <address 11=""></address>	Absolute jump to within 2K of program memory
JMP @A + DPTR	Long indexed jump

Conditional Jump Instructions

Instruction	Description
JZ <relative addr=""></relative>	Jump if accumulator is zero
JNZ <relative addr=""></relative>	Jump if accumulator is non-zero
JC <relative addr=""></relative>	Jump if carry is set
JNC <relative addr=""></relative>	Jump if carry is cleared
JB <bit>, <rel addr=""></rel></bit>	Jump if bit is set
JNB <bit>,<rel addr=""></rel></bit>	Jump if bit is cleared
JBC <bit>, <rel addr=""></rel></bit>	Jump if bit is set, clear bit
CJNE A, direct, <rel addr=""></rel>	Compare accumulator and memory, jump if not
	equal
CJNE A, #data <rel addr=""></rel>	Compare accumulator and data, jump if not equal
CJNE Rn, #data <rel< td=""><td>Compare Rn and data, jump if not equal</td></rel<>	Compare Rn and data, jump if not equal
addr>	
CJNE @Rn, #data <rel< td=""><td>Compare data and the byte pointed to by Rn, jump</td></rel<>	Compare data and the byte pointed to by Rn, jump
addr>	if not equal
DJNZ Rn, <rel addr=""></rel>	Decrement Rn and jump if not zero
DJNZ direct, <rel addr=""></rel>	Decrement memory and jump if not zero

Subroutine Instructions

Instruction	Description
ACALL <address 11=""></address>	Absolute call to within 2K of program memory
LCALL <address 16=""></address>	Long call to a 16-bit address
RET	Return from subroutine
RETI	Return from interrupt