AN1754 APPLICATION NOTE

DATA LOGGING PROGRAM FOR TESTING ST7 APPLICATIONS VIA ICC

by Microcontroller Division Application Team

INTRODUCTION

Data logging is the process of recording data. It is required during the course of application development in order to test application robustness and reliability.

The purpose of this application note is to show how to implement a data logging system based on the ICC protocol[1].

Over a specified time period, the data logging system records each and every value of a particular variable or register used by the application. The advantage of using this ICC-based data logging package is that your application runs on the ST7 in its target environment, with the same hardware configuration and settings and with minimal added software.

An ST7 application software example and the PC side executable are provided with this application note. The PC software uses the STVP7[2] DLLs for communicating via the ICC Protocol between a PC-based data logging system and the user application. It can be used for ST7 devices supported by the STICK, i.e. ST7 devices supporting ICC protocol except the USB family devices. The ST7 software provided is an example which can be modified and used, or a completely new software may be developed by the user.

[1] The ICC protocol (In-Circuit Communication) is used to connect ST7 micro controllers with an external controller such as a flash programmer or in-circuit debugger. It is described in detail in the ST7 ICC Protocol Reference Manual.

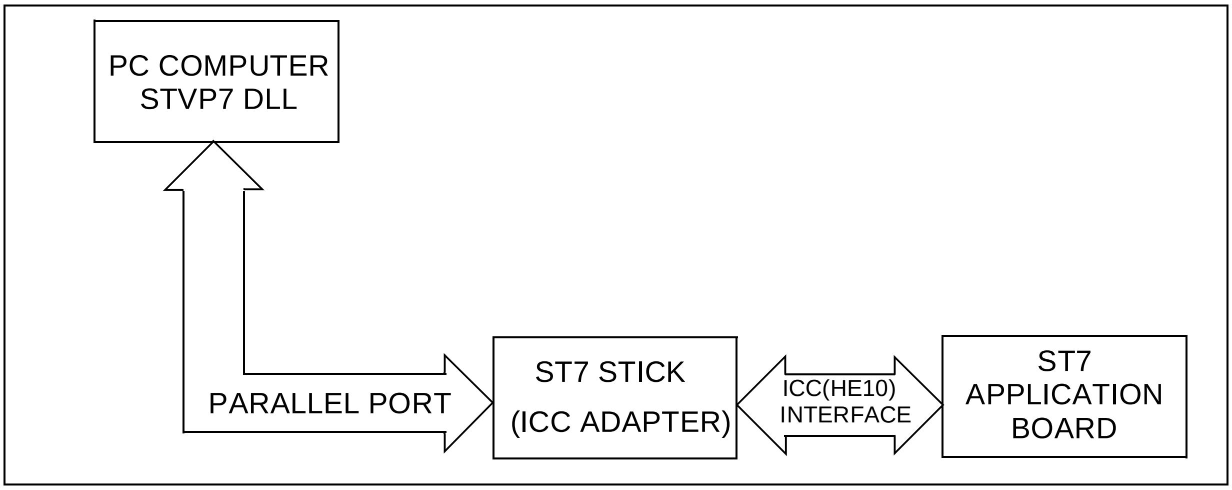
[2] STVP7 (ST7 Visual Programmer) is the Windows software interface for ST7 Flash Programming Tools (ST7 EPB's and ST7 STICK). For more information on ST7 Development Tools refer to http://mcu.st.com.

Rev. 1.0

1 SYSTEM HARDWARE AND SOFTWARE REQUIREMENTS

The hardware interface between the parallel port and the ICC (HE10) connector is the ST7 STICK. A block diagram of the set-up is shown in Figure 1.

Figure 1. Data Logging hardware setup



The PC software has been developed using the Microsoft Visual C++ 6.0 environment and the ST7 software example is compatible with both Cosmic and Metrowerks C compilers. The software has been tested with the A/D converter application on the ST72F264 and ST72F521. The ICC monitor embedded in the ST72F264 is the advanced variant (it has additional commands), the ICC monitor embedded in ST72F521 is the basic variant. The software example works with both variants.

The process of data logging developed in this application takes advantage of the fact that even when the ST7 is in ICC mode, it can execute the user code programmed in Flash memory as well as the ICC commands embedded in BootROM/Sysmem.

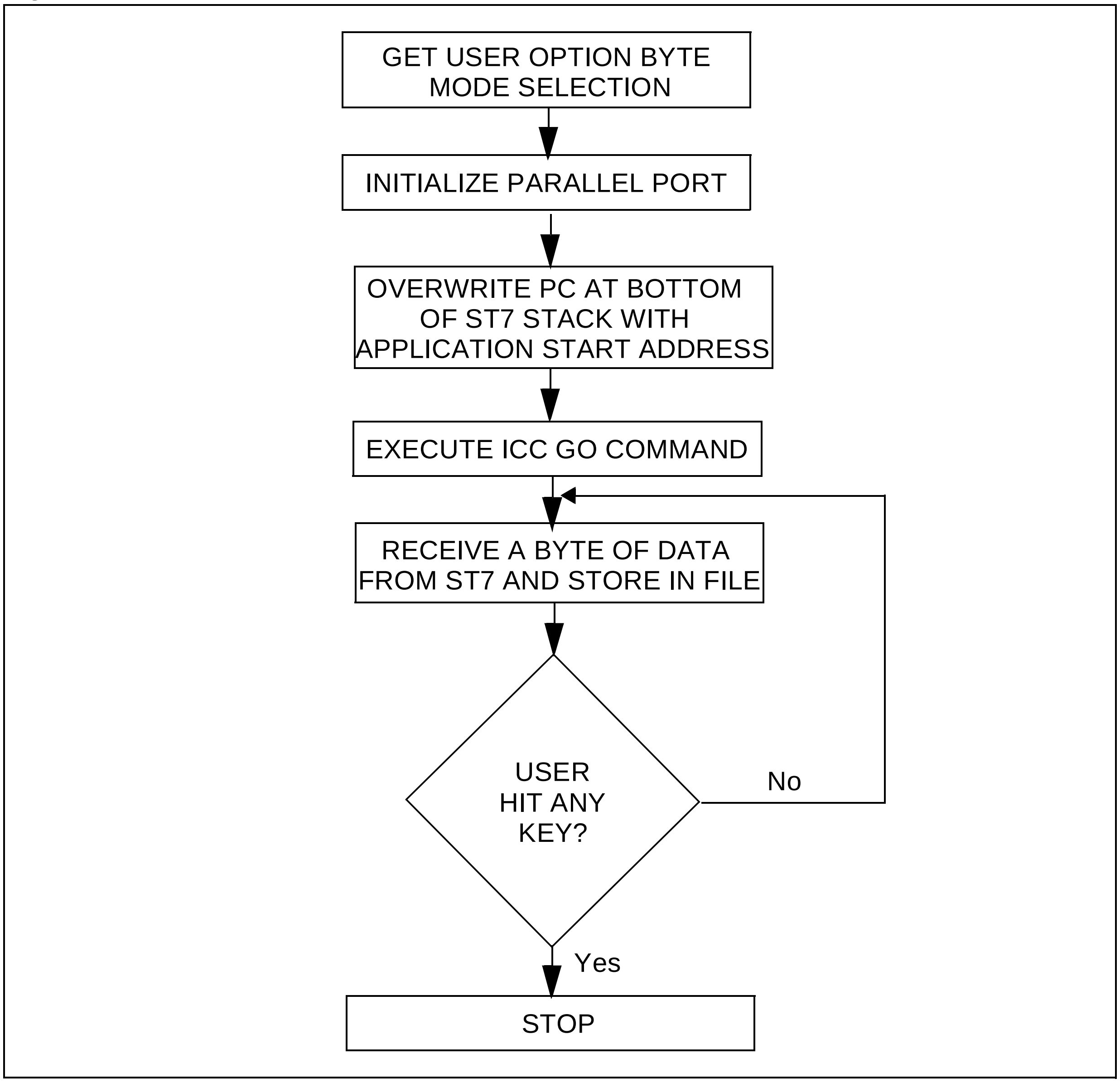
2 PC SOFTWARE

The software on the PC side has been created in Microsoft Visual C++ 6.0 re-using DLLs from the STVP7 software. It can handle all the ST7 devices supporting ICC protocol, except the USB family devices. Prior to running the PC software, you must install STVP7 on your PC and program your device with your application code and the option bytes. The executable for the PC software has been provided. When you execute this file, you will be prompted for certain parameters. Section 4 of this application note describes these parameters, two of which determine whether the data logging process is to be performed with the option bytes enabled or disabled. Make sure that the ST7 is driven by the clock source corresponding to this selection.

Please note that this package is compatible with STVP7 1.9.0 and uses the system drivers corresponding to this version. In case the version of STVP7 installed on your system is a different one, please replace the dll files with the corresponding ones from the STVP7 folder(..\stm\st7toolchain\stvp7).

The PC software flowchart is given in Figure 2.

Figure 2. PC software flowchart


GET USER OPTION BYTE MODE SELECTION
INITIALIZE PARALLEL PORT
OVERWRITE PC AT BOTTOM OF ST7 STACK WITH APPLICATION START ADDRESS
EXECUTE ICC GO COMMAND
RECEIVE A BYTE OF DATA FROM ST7 AND STORE IN FILE
USER HIT ANY KEY?
No
Yes
STOP

After entering ICC mode, the PC software modifies the ST7 stack so that the position corresponding to the Program Counter contains the address of the user application. Hence, the execution of the Go command has the effect of jumping to the user application and executing it. The external controller software then loops to receive bytes till the keyboard is hit. The bytes received are stored in the file “Datafile.doc” in the PC_application folder.

3 ST7 SOFTWARE

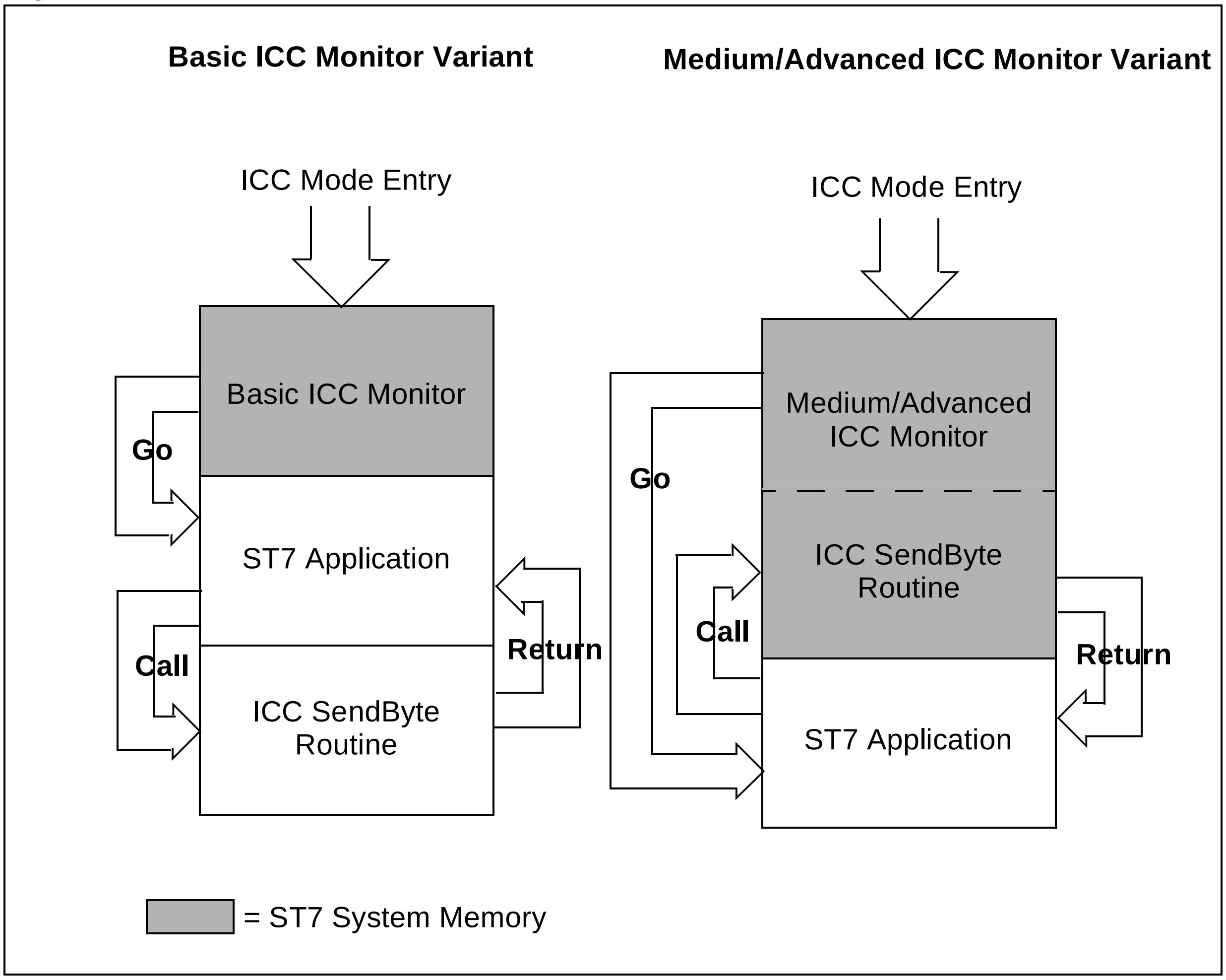
The PC application performs the initialization and starts execution of the ST7 application. At this point, your ST7 application has to send the data bytes to the PC. The method you use depends on the variant of the ICC monitor in the ST7 device because some ICC commands are available only in the medium or extended variant and not in the basic variant. Please refer to theST7 ICC Protocol Reference manual for the table listing ST7 devices with the ICC monitor variant embedded in each type.

If the device chosen has a medium or advanced variant ICC monitor, you can just call the ICC_Send_Byte routine at the address provided in the ICC Protocol Reference manual. If the device has a basic ICC monitor, the send byte routine needs to be coded as part of your application. The sample program provided with this application note includes a send byte routine which you can use.

The software provided can be configured to support devices with any ICC monitor variant.

The ST7 software execution is given in Figure 3.

Figure 3. ST7 Software Execution



Basically, you can run an ST7 application and call the Send byte routine whenever you want to “note” a particular variable/register. The PC receives the data and stores it in a file named Datafile.doc whose size is only limited by the amount of PC memory. This method can be used to store data over long periods of time to be examined and analysed later.

Essentially, the ST7 software is synchronized with the external controller using the ICC protocol. Once the user stops the external controller, the device stops sending bytes since it does not get the desired response from the external controller.

4 HOW TO USE THE DATA LOGGING SOFTWARE PACKAGE

This section explains the exact changes that you need to make to adapt the package for a specific ST7 device.

On the PC side, you only have to execute the APIDatalog.exe file. You will be prompted to enter certain parameters which are explained in Section 4.1.

On the ST7 side, the parameters to be changed have been grouped into the “main.h” file. Hence, all changes and selections are to be made in the main.h, unless mentioned otherwise.These parameters are explained in Section 4.2.

Before you start, you have to install STVP7 and program the ST7 flash with your user application and option bytes. An example user application is provided with the package (userappli.s19).

4.1 USING THE PC SOFTWARE

When you run APIDatalog.exe, you will be prompted for some inputs. These inputs will set certain parameters which can be split into two categories:

- **Device specific parameters:** These parameters have to be set to the values specified in the datasheet (Stack top address) and ST7 ICC Protocol Reference manual (Settings for ICC mode entry). In case of ICC mode entry settings, they also have to match the option byte settings in the ST7 device, so there is no conflict when the ST7 tries to detect the clock.
- **Application specific parameters:** These parameters have to match the application programmed in the ST7, like the application start address and the timeout parameter.

A detailed explanation of these parameters follows:

4.1.1 Number of Pulses

This input selects the number of pulses to be sent to the device to enter ICC mode. The number of pulses used to enter ICC mode determines whether the option byte configuration programmed in the device is used or ignored. Hence, this is to be used to select the clock source of the ST7.

Case 1: User chooses to ignore the option bytes - The ST7 must then be driven by an external clock which in this case, is provided by the STICK. In this configuration, pin 9 of the ICC (HE10) connector on the application board must be connected to the OSCIN pin of the microcontroller.

Case 2: User chooses to use the option bytes - The clock has to be provided on the application board.

4.1.2 Enable STICK to provide external clock

This input decides whether the STICK ICCOSC buffer is enabled or disabled. If enabled, then the clock provided by the STICK is available on pin 9 of the ICC(HE10) connector of the STICK.

4.1.3 User application MSB and LSB

You have to provide the MSB and the LSB of the start address of your user application. These inputs are used to modify the micro controller stack to jump to the required location in the device Flash memory. They have to be entered in the format: e0 etc. and not 0xe0.

4.1.4 STACK_TOP

You have to enter the stack top address of the micro controller you are using.This input has to be entered in the format: 17f etc. and not 0x17f.

4.1.5 Timeout in milliseconds

This is an important parameter which has to be modified by the user to ensure synchronization. It defines the maximum time that the PC software will wait to receive a byte, before timing out. Hence, you need to fix this parameter to the maximum time that may elapse between two consecutive bytes sent by your micro controller application.

The parameters entered by you will be stored in the Parameters.ini file so that you can choose to set new parameters or use the settings of your last session. The package as provided, has these parameters set to communicate with the ST72F264 device in ICC mode with option bytes ignored and the user application starting at 0xe000.

4.2 ADAPTING THE ST7 SOFTWARE

In this package, tested workspaces are provided for implementing a data logging system for ST72F521 and ST72F264 devices using both Metrowerks and Cosmic toolchains. The workspaces have been named ADC_HIW_521, ADC_CSMC_521, ADC_HIW_264 and ADC_CSMC_264 according to the combination of device and toolchain supported. All the workspaces use different toolchain and configuration settings for the same source code. This source code implements an application running the ADC to perform conversions continuously and sending back the contents of ADCDRH to the PC.

The ST7_application, as delivered, is configured for the ST72F264 device. In order to migrate from one device to another, certain changes have to be made. All the following changes are to be made in main.h, except for the change described in Section 4.2.2.

4.2.1 Compiler path

Please check paths in the configuration files for the compiler being used.

4.2.2 Microcontroller Selection

You have to select the appropriate device in the ST7lib_config.h file and provide the corresponding peripheral registers and configuration files.

4.2.3 ICC Monitor Variant

The ICC monitor on the ST7 micro controller may be a Basic, Medium or Advanced variant. The variant of the monitor determines the ICC commands supported by it. The different variants and the ICC commands supported by them are summarized in Table 1 ICC Monitor Variant.

Table 1. ICC Monitor Variant

	Name	ICC Monitor Variant		
		Basic	**Medium**	**Advanced**
ICC Command	Write Memory	X	X	X
	Go	X	X	X
	Go New Context			X
	Read memory		X	X
Automatic Context Saving				X

The variant of ICC monitor determines whether you have to provide the ICC Send Byte routine or not.

Case: Medium or Advanced variants - You must update the address of the ICC Send Byte routine according to the addresses specified in the ICC Protocol Reference manual.

Case: Basic variant - You call a user-programmed Send Byte routine, just like calling any other user specified function. In this case, you also have to update the ICCPort_xxx register references and the ICCCLK & ICCDATA pin references accordingly.

Note: If you use the Cosmic C Compiler to generate code for devices with medium and advanced ICC monitor, you have to modify the address of the send byte routine in the “DATA_Logging” function in the main.c file of the ST7_application workspace.

4.2.4 Application specific parameters

Finally, if you are using the example ST7 application provided with the package, you have to change the OutPort_xxx register details and the ANALOG_CHANNEL number before you can use it.

To use the send byte routine provided with the package, you have to assign the data to be logged to USER_Data and call the DATA_Logging function with USER_Data as the parameter.

The ST7 application provided with this package is only a sample package which supports ST72F264 and ST72F521 devices. If you want to use a device other than these two, you can either choose to write the corresponding ST72Fxxx_periph.h, ST72Fxxx_reg.c and ST72Fxxx_reg.h files or you can make a completely new application. Please note that in case of devices with basic ICC monitor, you need to provide and call a routine like the Send Byte routine provided in this package.

5 CONSTRAINTS

5.1 SYSTEM CONSTRAINTS

- You must not execute STVP7 and APIDatalog.exe at the same time since the DLLs access common resources.

5.2 DEVICE RESOURCE CONSTRAINTS

- You must not use the ICCCLK and ICCDATA port pins in your application software.

5.3 TIMING CONSTRAINTS

- Any data logging system will work, subject to the constraint that the time between two consecutive data “logs” has to be greater than the time required to call and execute the send byte routine.
  The execution time of the asm ICC send byte routine as provided in the ICC Protocol Reference manual is 78 memory cycles and that of the ‘C’ routine provided with this package is 123 memory cycles. In both cases, the calculated time excludes the time required to call the function. In case of the ‘C’ routine, it must be noted that this is only the execution time of the Send_Byte routine itself which is called by the DATA_Logging Function.
  Note: The number of cycles required to execute the routines are given as best case figures, when the micro controller does not have to loop while waiting for a response from the external controller, but finds the line released.
- In the ST7 application provided with this package, the SendByte routine does not time out. Hence the ST7 device may remain waiting for a few hundred microseconds during WIndows background activities.

6 CONCLUSION

The example data logging package provided with this application note is intended to be adapted to a user application for the purpose of receiving and storing bytes on the PC. It is up to you to modify the example to suit your needs. For instance, you can extend it to store 10-bit ADC results or to log any number of different variables, with each variable being stored in its own respective file. The possibilities are numerous.

7 ST7 SOFTWARE

7.1 MAIN.H

```
/
*********************************************************************
COPYRIGHT 2003 STMicroelectronics
Source File Name : main.h
Group           : IPSW,CMG - IPDF
Author          : MCD Application Team
Date First Issued: 24/09/2003
***************************Documentation****************************
General Purpose - This file is the header of the main module of ST7
software for Data logging. User needs to make certain changes in this
file for device compatibility.
**************************Revision History**************************
Date:24/09/2003      Release:1.0
********************************************************************/

#include "ST7lib_config.h"          /* select appropriate device  */

/****Select appropriate monitor according to the device selected****/

//#define BASIC_monitor
//#define MEDIUM_monitor
#define ADVANCED_monitor

/* If selected micro controller has medium or advanced monitor, ICC
send byte routine is used. Address of the routine for different de-
vices is provided in the ICC Protocol manual. In case of basic mon-
itor, a routine has to be as part of the user code. */

#ifdef MEDIUM_monitor
```

```
#define Send_Byte 0xDF00;       /* ICC_Send_Byte for ST72F264*/
#endif

#ifdef ADVANCED_monitor
#define Send_Byte 0xDF00
#endif

unsigned char USER_Data;/*USER_Data is the data that is being logged*/

/*User has to change the following section according to registers of
selected device*/
/*************264 register settings*********/

/*Output port to display data being transmitted*/
#define OutputPort_DDR PBDDR
#define OutputPort_OR PBOR
#define OutputPort_DR PBDR

/*To define ICCCLK and ICCDATA in case user defined Send_Byte routine
is used*/
#define ICCCLK 0
#define ICCDATA 1

#define ICCPort_DDR PADDR
#define ICCPort_DR PADR

#define ANALOG_CHANNEL 5

/*************521 register settings*********/
```

```
//#define OutputPort_DR PADR
//#define OutputPort_DDR PADDR
//#define OutputPort_OR PAOR

//#define ICCPort_DR PCDR
//#define ICCPort_DDR PCDDR

//#define ICCCLK 6
//#define ICCDATA 4

//#define ANALOG_CHANNEL 0
```

7.2 MAIN.C

```
/*
*******************************************************************
COPYRIGHT 2003 STMicroelectronics
Source File Name: main.c
Group      : IPSW,CMG-IPDF
Author      : MCD Application Team
Date First Issued: 24/09/2003
**************************Documentation***************************
General Purpose - This file is the main module of ST7 application for Data
                                  logging.
*************************Revision History*************************
_________________________________________________________________
Date:24/09/2003   Release:1.0
*******************************************************************/

#include "main.h"

void Configure_output_port(void);
void DATA_Logging(unsigned char);
void Send_Byte_Routine(unsigned char);

void main (void)
```

```
{
      int i;
      Configure_output_port();

       ADC_Init(ADC_DEFAULT);      /* Setting ADC at default value    */

       ADC_Select_Channel(ANALOG_CHANNEL); /*Select channel for conver-
sion*/

       ADC_Enable();          /* Start conversion i.e. ADON bit is set  */

       while(1)
      {
                  while(ADC_Test_Conversn_Complete() == FALSE);
                  OutputPort_DR = ADCDRH;      /*Display result on port*/

                  USER_Data = ADCDRH;
                  DATA_Logging(USER_Data);          /*Send data to PC*/

      }
}

void Configure_output_port() /*Initializes OutputPort as Output Push-
pull*/
{
      OutputPort_DDR = 0xff;
      OutputPort_OR = 0xff;
}

void DATA_Logging(unsigned char USER_Data)
{
      /*In case of basic monitor, user defined send byte routine called*/
      #ifdef BASIC_monitor
                  Send_Byte_Routine(USER_Data);
      #else
                  #ifdef _HIWARE_
                       #asm
                            clr A
                            mul X,A
                            ld A,USER_Data
                            call Send_Byte
```

```
                              ret
                         #endasm
                    #else
                    #ifdef _COSMIC_
                         #asm
                              clr A
                              mul X,A
                              ld A,_USER_Data
                              call 0xdf00//COSMIC:User has to fill ICC
send byte address
                              ret
                         #endasm
                    #endif
                    #endif
     #endif
}

void Send_Byte_Routine(unsigned char USER_Data)
{
     volatile unsigned char BitCounter = 7;
     ICCPort_DDR |= (0x01 << ICCDATA);  /* ICCDATA made open drain*/
     do
     {
                    ICCPort_DR |= (0x01 << ICCDATA); /*Set ICCDATA()*/
                    if ( !(USER_Data & (0x01 << BitCounter)) )  /* Check for
'0' bit*/
                    {
                         ICCPort_DR &= (unsigned char)~(0x01 << ICCDA-
TA);/* Reset ICCDATA*/
                    }
                      /*Wait for 6 clock cycles to ensure ICCDATA level*/
                    #asm
                         nop
                         nop
                         nop
                    #endasm

     /*Reset ICCCLK since BSET/BRES ICCDATA may affect ICCCLK DR*/
                    ICCPort_DR &= (unsigned char)~(0x01 << ICCCLK);
                    ICCPort_DDR |= (0x01 << ICCCLK); /*=> ICCCLK output =
0*/
```

```
                         /*Wait for 12 clock cycles to ensure ICCDATA level*/
                        #asm
                               nop
                               nop
                               nop
                               nop
                               nop
                               nop
                        #endasm
                        /*    Release ICCCLK after 5 Tcpu (ie BRES duration)*/
                        ICCPort_DDR &= (unsigned char)~(0x01 << ICCCLK);
                        /*Wait for external controller to release IsICCCLK*/
                        while(!(ICCPort_DR & (0x01 << ICCCLK)));
                        --BitCounter;
        }
                        /*          Check if transmission of 8 bits are done  */
        while(BitCounter<=7);
         /*Define ICCDATA as floating input before returning*/
        ICCPort_DDR &= (unsigned char)~(0x01 << ICCDATA);

}

/***************** (c) 2003  ST Microelectronics *******************/
```