AN3209
Application note

Developing your M24LR64-R datalogger application for temperature acquisition

Introduction

The M24LR64-R is a Dual interface EEPROM. Since it has both an 13.56 MHz ISO 15693 RFID and a 400-kHz I^2C interface, the device is a good solution for RF-enabled sensors for which ST has developed a reference design. One of the main benefits brought by the M24LR64-R is that the sensor data can be accessed in read and write mode without consuming any on-board power.

This application note presents a practical useful application for the M24LR64-R datalogger. It describes an autonomous battery-powered datalogger able to record and store 64 Kbits of temperature data using the M24LR64-R Dual interface EEPROM (I^2C and RF). The datalogger microcontroller is an STM8L101K3. It communicates with the M24LR64-R using its serial interface and controls an STTS75 digital temperature sensor.

An on-board demonstration firmware, the **M24LR64-R_Datalogger_application_firmware**, stored in the STM8L101K3 memory selects and controls the temperature acquisition through a RFID reader connected by a USB cable to a PC.

The application is delivered with a PC software, the **M24LR64-R_Datalogger_application_software**, to configure and control the datalogger, as well as download and display the temperature values.

ST provides all the resources required to develop your own datalogger application and PC software:

- Source files of the data logger firmware (M24LR64-R_Datalogger_application_firmware): they allow implementing I^2C communications between the M24LR64-R, the STTS75, and the STM8L101K3.
- Source files of the PC software (M24LR64-R_Datalogger_application_software): they control RF communications between the M24LR64-R and an RFID reader.

Basic information about the M24LR64-R, STTS75, and STM8L101K3 component characteristics, as well as a description of the algorithms for the datalogger firmware and PC software are provided in this document.

Reference documents

- M24LR64-R datasheet
- “M24LR64-R tool driver install guide” user manual (UM0863)
- “Using the M24LR64-R datalogger reference design” user manual (UM0925)
- “How to manage M24LR64-R data transfers from the I^2C bus or an RF channel” application note (AN3057)
- STM8L101K3 datasheet
- STM8L101 reference manual (RM0013).
- STTS75 datasheet.

The documents are available from http://www.st.com/dualeeprom.

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1 Overview of M24LR64-R datalogger application

1.1 Board architecture

The entire circuit is implemented on a 90x50 mm PCB board which integrates the three ST components (M24LR64-R, STTS75, and STM8L101K3) plus a 20x40 mm antenna connected to the dual EEPROM RF interface. The system is supplied from a 3 V battery (BR2330) fixed on the back side of the PCB as shown in *Figure 2*.

The board is equipped with a connector which provides an easy access to the STM8L101K3 SWIM signal required to program the microcontroller and debug the firmware (see *Figure 2*). This reference board allows the SDA and the SCL I^2C signals to be probed using dedicated connectors.

Figure 1. Datalogger front side view

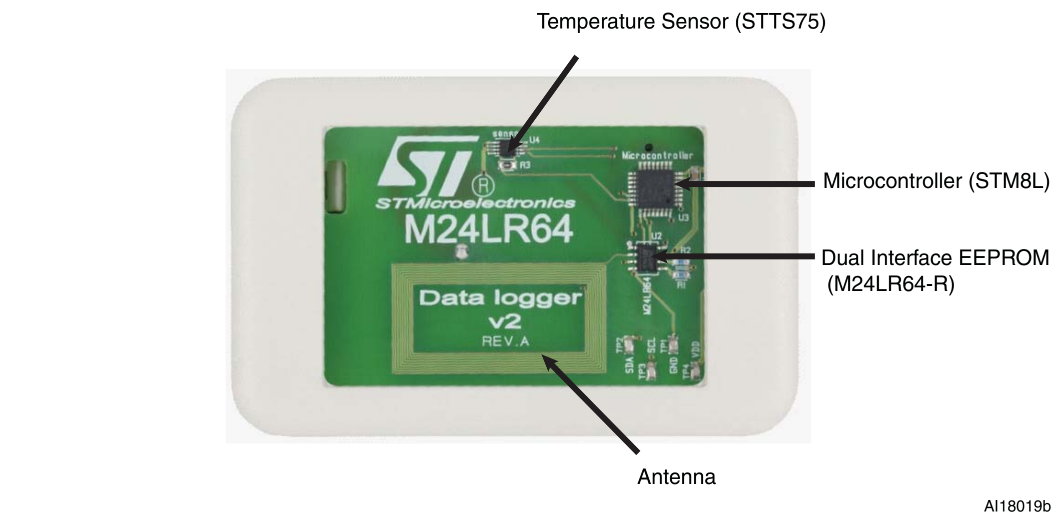
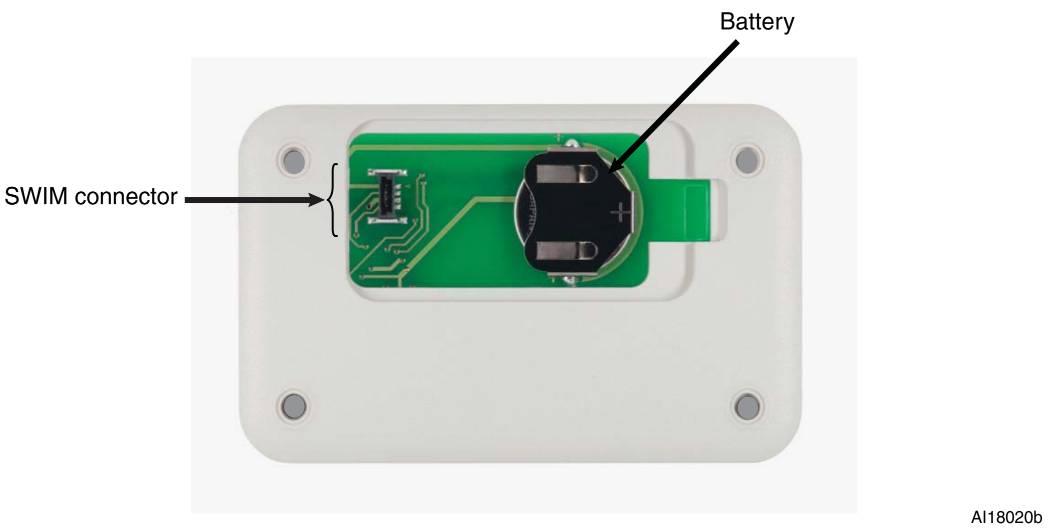


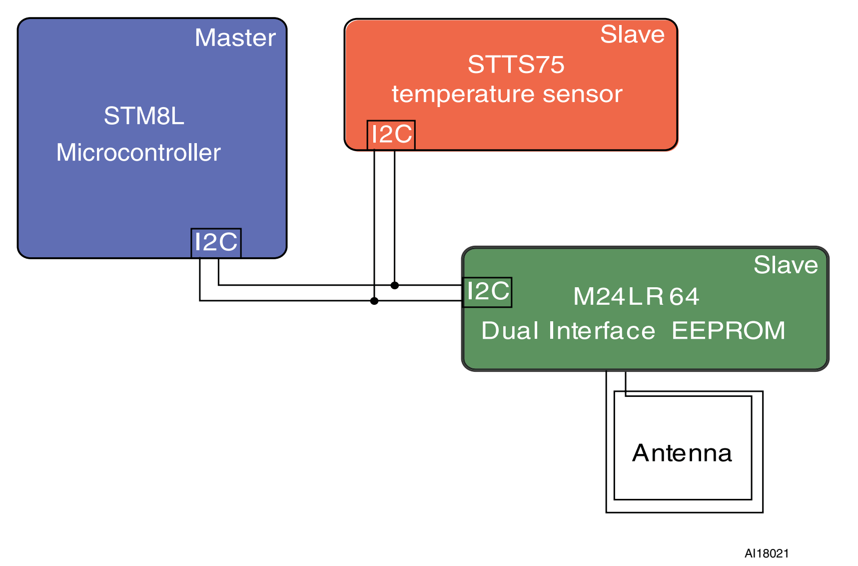
Figure 2. Datalogger back side view



1.2 Communication interfaces

The communications between the STM8L101K3, M24LR64-R, and STTS75 are performed through an I^2C bus. The STM8L101K3 acts as the I^2C master, and both the M24LR64-R and STTS75 act as slaves. The Dual interface EEPROM is also connected to an antenna to communicate with the RFID reader. Refer to *Figure 3* for an overview of the communication interfaces.

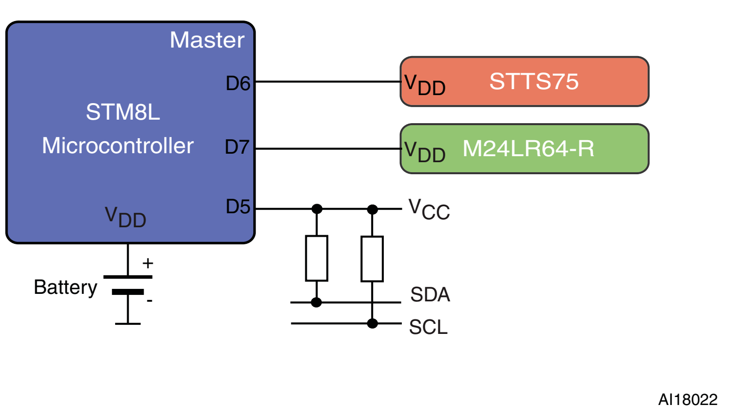
Figure 3. STM8L101K3/M24LR64-R/STTS75 communication block diagram



1.3 Power management

The datalogger is a low power application requiring a particular power management. The entire power supply is managed by the microcontroller which is the only device directly powered by the battery (see *Figure 4*). Both slave nodes and I^2C power supply (V_{CC}) are powered by the STM8L101K3 microcontroller.

Figure 4. Datalogger power management



2 Component overview

This section describes the main characteristics of the three STMicroelectronics components (M24LR64-R, STTS75, and STM8L101K3). It explains how to configure them for the temperature acquisition application, and it describes the corresponding code function and examples.

2.1 M24LR64-R Dual interface EEPROM

2.1.1 M24LR64-R main features

The M24LR64-R device is a dual-access electrically erasable programmable memory (EEPROM). It features an I^2C interface and can be operated from a V_{CC} power supply. It is also a contactless memory powered by the received carrier electromagnetic wave.

The M24LR64-R is organized as 8192x8 bits in the I^2C mode and 2048x32 bits in the ISO 15693 and ISO 18000-3 mode 1 RF mode.

Figure 5. M24LR64-R pinout

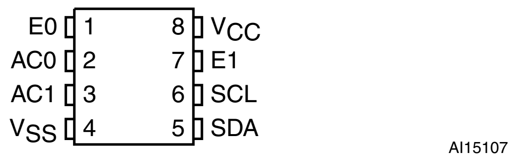


Figure 6. M24LR64-R functional block diagram

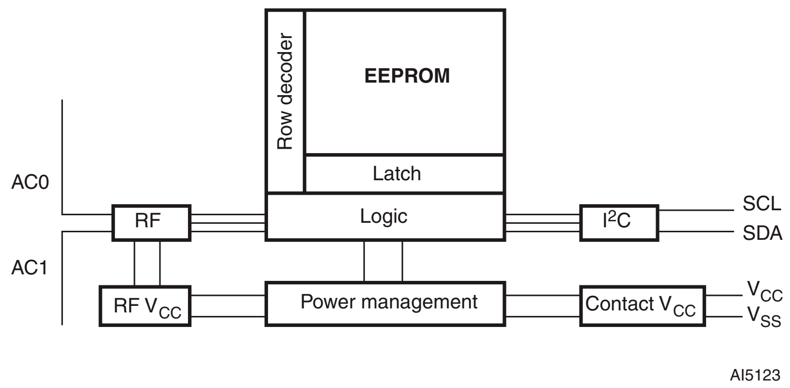


Table 1. M24LR64-R signal names

Signal name	Function	Direction
E0, E1	Chip Enable	Input
SDA	Serial Date	I/O
SCL	Serial Clock	Input

Table 1. M24LR64-R signal names (continued)

Signal name	Function	Direction
AC0, AC1	Antenna coils	I/O
V_{CC}	Supply voltage	
V_{SS}	Ground	

2.1.2 M24LR64-R I²C interface

The M24LR64-R can work both in standard and Fast I²C modes. The device carries a built-in 4-bit device type identifier code (1010b) compliant with the I²C bus definition. For the demonstration application, the STM8L101K3 master operates at a speed of 100 kHz.

The M24LR64-R behaves as a slave for the I²C protocol with all memory operations synchronized by the serial clock. The device I²C address is 1010 0000b (0xA0)

The I²C master writes and reads to/from the M24LR64-R memory. These basic operations are performed by the M24LR64-R_Datalogger_application_firmware by calling *i2c_ee.c* library functions.

Write operations

To write to the memory, the I²C master sends write commands to the M24LR64-R. The command frame must be compliant with the format described in *Figure 7*.

The M24LR64-R_Datalogger_application_firmware calls the `I2C_EE_PageWrite` function which programs a set of bytes into the EEPROM (see *Table 2* for a description and an example).

Figure 7. Write I²C frame format

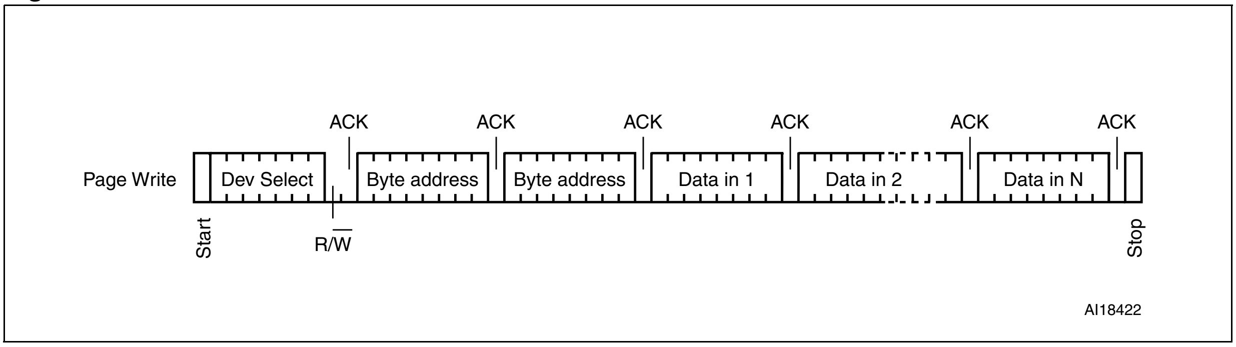


Table 2. I²C page write function

Function description	
Function name	`I2C_EE_PageWrite(uint8_t* pBuffer, uint16_t WriteAddr, uint8_t NumByteToWrite)`
Parameters	**pBuffer**: pointer to the buffer containing the data to be written to the EEPROM. **WriteAddr**: internal address of the EEPROM where the data must be written. **NumByteToWrite**: number of bytes to be written into the EEPROM.
Return value	**ErrorStatus:** SUCCEEDED FAILED
Example	`I2C_EE_PageWrite(s_data, 0x0002, 0x01)` writes the content of the buffer pointed by sedate at address 0x01.

To read from the memory, the I²C master can send read commands to the M24LR64-R. The command frame must be compliant with the format described in *Figure 8*.

The M24LR64-R_Datalogger_application_firmware calls the `I2C_EE_BufferRead` function which reads a set of bytes from the EEPROM (see *Table 3* for a description and an example).

Figure 8. Read I²C frame format

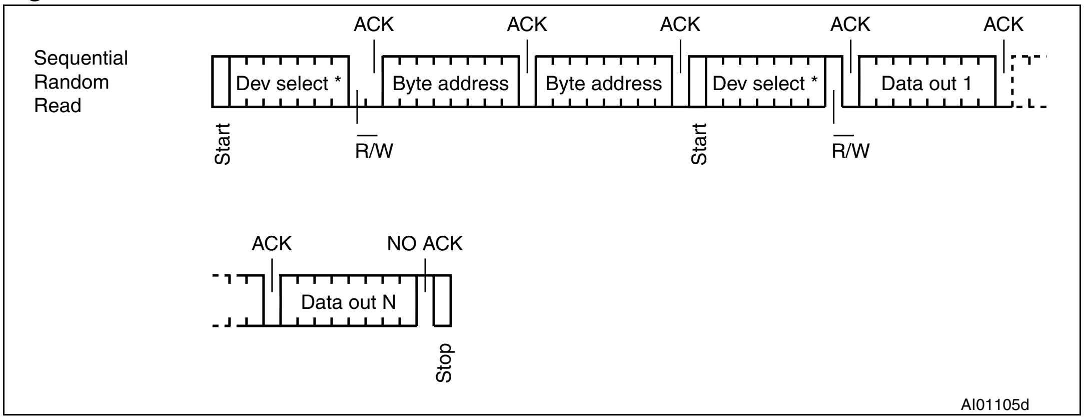


Table 3. I²C buffer read function

Function description	
Function name	`I2C_EE_BufferRead(uint8_t* pBuffer, uint16_t ReadAddr, uint8_t NumByteToRead)`
Parameters	**pBuffer**: pointer to the buffer where the data read from the EEPROM are stored. **ReadAddr**:internal EEPROM address from which the read operation is performed. **NumByteToRead**: number of bytes to read from the EEPROM.
Return value	**ErrorStatus:** SUCCEEDED FAILED
Example	`I2C_EE_BufferRead (s_data, 0x0002, 0x01)` reads one byte from memory address 0x01, and stores the value in the buffer pointed by *s_data* points.

2.1.3 M24LR64-R RF Interface

In ISO 15693/ISO 18000-3 1 RF mode, the M24LR64-R is accessible via the 13.56 MHz carrier electromagnetic wave. Incoming data are demodulated from the received signal amplitude modulation (ASK: amplitude shift keying). The received ASK wave is 10% or 100% modulated with a data rate of 1.6 Kbit/s using the 1/256 pulse coding mode, or 26 Kbit/s using the 1/4 pulse coding mode.

Outgoing data are generated by the M24LR64-R load variation using Manchester coding with one or two subcarrier frequencies at 423 kHz and 484 kHz. Data are transferred from the M24LR64-R at 6.6 Kbit/s in low data rate mode and 26 Kbit/s high data rate mode. The M24LR64-R supports the 53 Kbit/s in high data rate mode in one subcarrier frequency at 423 kHz. The M24LR64-R follows the ISO 15693/ISO 18000-3 mode 1 recommendation for radio-frequency power and signal interface

RF commands are sent and decoded by the RFID reader. The demonstration application can operate with FEIG and estar USB readers, for compliance with the available M24LR64-R kits:

- Development kit: FEIG reader
- Demonstration kit: FEIG reader
- Starter kit: estar reader

The commands depend on the type of reader.

The PC M24LR64-R_Datalogger_application_software is developed in Visual Basic. It includes functions allowing to operate the datalogger with both FEIG and estar readers:

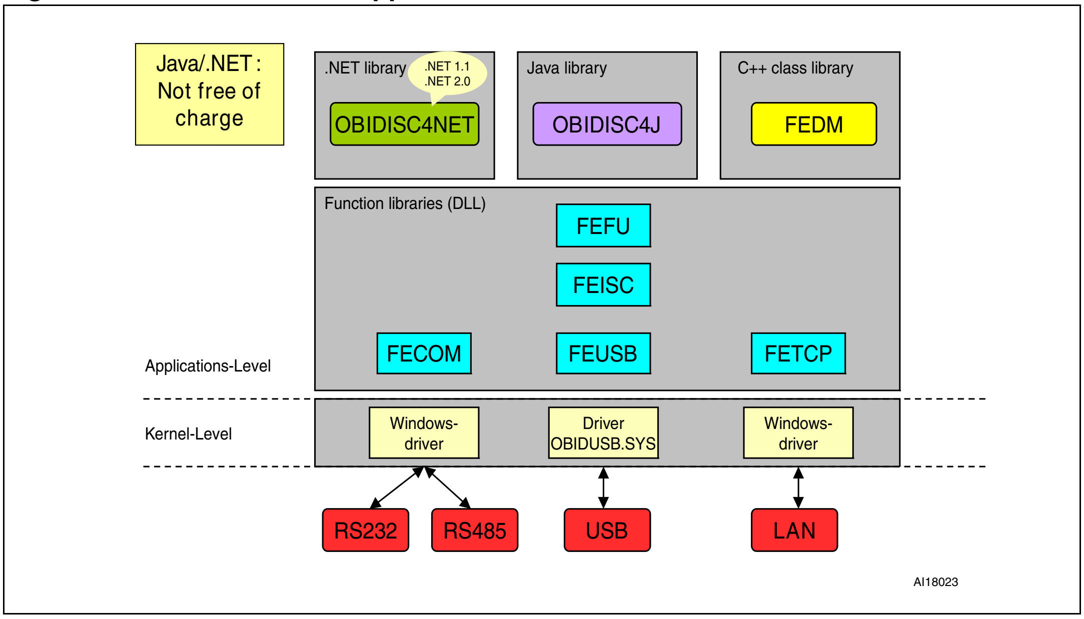
- Inventory
- Reset To Ready
- Read Single Block
- Write Single Block
- Read Multiple Block

Refer to *Appendix B: M24LR64-R RF commands* for a detailed description of these functions.

FEIG commands

FEIG readers are delivered with a package to develop and program application software in AINSI-C/C++, and Visual Basic (see *Figure 9*).

Figure 9. FEIG software support for windows



Estar commands

Estar readers are delivered with a package to develop and program application software in ANSI-C/C++, and Visual Basic. The following dll files are provided:

- For Visual Basic: HIDdll.bas
- For C/C++: HIDdll.h, HIDdll.lib

2.1.4 Datalogger memory mapping

The M24LR64-R memory is used as described in *Table 4*. The first two blocks of sector 0 contain critical system parameters, and application data.

Table 4. M24LR64-R-R memory organization

Sector number	RF block address	i^2C byte address	bit [31:24]	bit [23:16]	bit [15:8]	bit [7:0]
0	0	0	RFU	Delay	Overwrite	Status
0	1	4	RFU	RFU	Nb Temp[1]	Nb Temp[0]
0	2	8	Temp2 [1]	Temp2 [0]	Temp1 [1]	Temp1 [0]
0	3	12	Temp4 [1]	Temp4 [0]	Temp3 [1]	Temp3 [0]
0	4	16	Temp6 [1]	Temp6 [0]	Temp5 [1]	Temp5 [0]
0	5	20	Temp8 [1]	Temp8 [0]	Temp7 [1]	Temp7 [0]

Table 4. M24LR64-R-R memory organization

Sector number	RF block address	i^2C byte address	bit [31:24]	bit [23:16]	bit [15:8]	bit [7:0]
...	...	...	...	...	...	...
63	2016	8064	Temp4092 [1]	Temp4092 [0]	Temp4091 [1]	Temp4091 [0]

System bytes

- Status byte

  The Status byte shows the current application state. Refer to *Table 5* for the meaning of each possible value.

Table 5. Status byte values

Status byte value	Description
0x11	START
0X22	PAUSED
0x33	RUNNING
0x44	STOPPED
0x55	UPDATE
0x66	OTHER

- Overwrite byte

  During the acquisition, the temperature values are stored in the memory. When the memory is full, the application can either stop or rewrite data starting from the first address, depending on the value of the Overwrite byte (see *Table 6*).

Table 6. Overwrite byte values

Overwrite byte value	Description
0x11	Overwrite authorized
Any other values	Overwrite non authorized

- Delay byte

  The Delay byte contains the value of the acquisition rate (see *Table 7*):

Table 7. Delay byte values

Delay byte value	Description (s)	Comment
0x0D	1	Temperature measured and saved every second
0x10	30	Temperature measured and saved every 30 seconds

- Nb Temp bytes

  NbTemp bytes contains the number of temperature values stored in the memory. It consists in two hexadecimal-coded bytes. The number of temperature values is the concatenation of Nb Temp[1] and Nb Temp[0] where Nb Temp[0] is the LSB and Nb

Temp [1] is the MSB. For example, if Nb Temp [0] equals 0xF3 and Nb Temp [1] equals 0x02, then the number of acquired temperature values is 0x02F3 (755d).

Application data

- Temp bytes

  Tempx[0] and Tempx[1] contain the raw temperature (see *Table 4*), x ranging from 1 to 4092. For example if Tempx[0] = 0x1E and Tempx[1] is 0x80, the concatenation of these two bytes gives the temperature value that is 0x1E80 corresponding to 30.5 °C (according to the temperature sensor format).

  The temperature format conversion is performed by issuing the following Visual Basic command:

```
function convert_temp (TempToConvert As String) As Single
```

2.2 STM8L101K3 8-bit low power microcontroller

2.2.1 STM8L101K3 overview

The STM8L101K3 (part number STM8L101K3T6) 8-bit low power microcontroller features an enhanced STM8 CPU core which provides an increased processing power (up to 16 MIPS at 16 MHz) while maintaining the advantages of a CISC architecture of improved code density, 24-bit linear addressing space and an optimized architecture for low power operations (see *Figure 10* and *Figure 11*).

For more details refer to the STM8L101K3 datasheet and to the STM8L101xx reference manual (RM0013).

Figure 10. STM8L101K3 32-pin package pinout

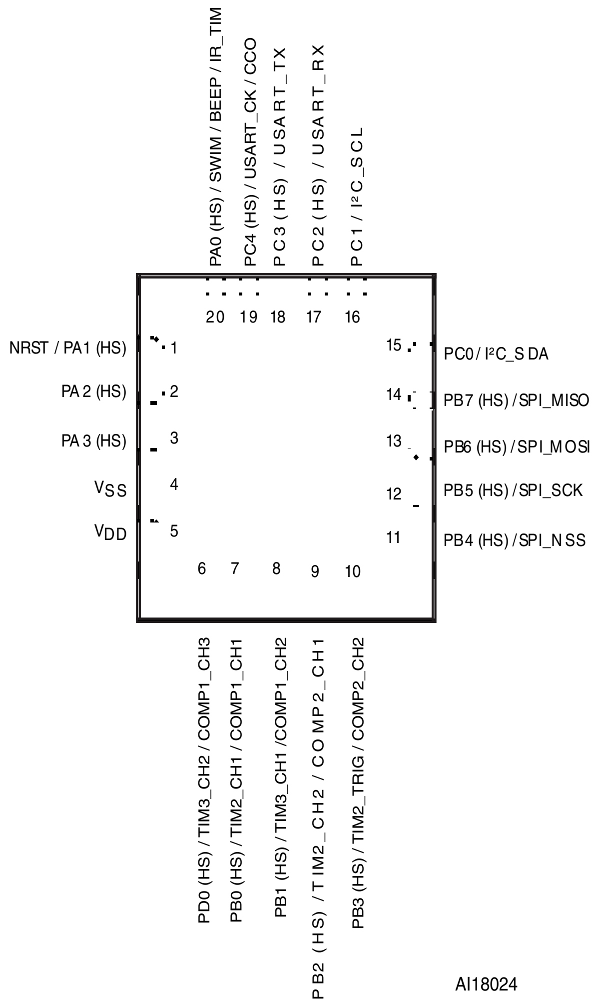
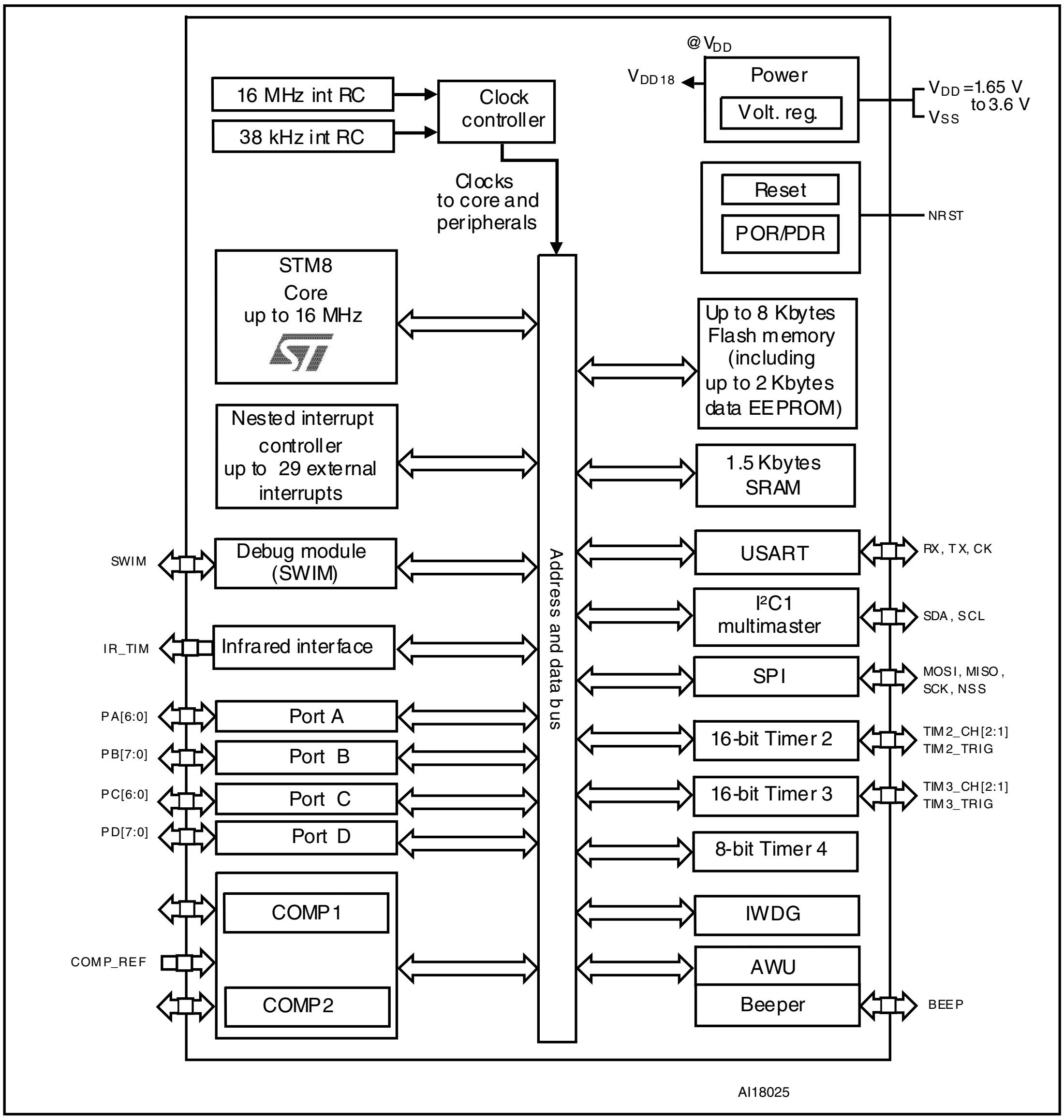


Figure 11. STM8L101K3 functional block diagram



2.2.2 STM8L101K3 I²C interface

The STM8L101K3 I²C peripheral allows multimaster and slave communications with bus error management in standard (up to 100 kHz) or fast (up to 400 kHz) mode. In the demonstration datalogger application, only the single master mode is used.

I²C synchronous communications require only two signals: SCL (Serial clock line) and SDA (Serial data line). The corresponding port pins must be configured as floating inputs. Refer to the STM8L101K3 datasheet for additional details.

To manage errors resulting from I²C and RF arbitration, an error management mode has been implemented in the I²C library, *i2c_ee.c*, called by the M24LR64-R_Datalogger_application_firmware (see AN3057 for details).

2.2.3 STM8L101K3 configuration

Clock configuration

The STM8L101K3 microcontroller is configured as follows for the demonstration M24LR64-R_Datalogger_application_firmware:

- Master clock set to 2 MHz (minimum)
- I2C, timer 2 (TIM2), Auto wakeup clocks enabled.

This is done by calling the following functions of the STM8L101 firmware library:

```
CLK_MasterPrescalerConfig(CLK_MasterPrescaler_HSIDiv8);
CLK_PeripheralClockConfig(CLK_Peripheral_I2C, ENABLE);
CLK_PeripheralClockConfig(CLK_Peripheral_TIM2, ENABLE);
CLK_PeripheralClockConfig(CLK_Peripheral_AWU, ENABLE);
```

I/O configuration

Three dedicated pins are set in output mode to power the Dual interface EEPROM, the temperature sensor, and the I^2C bus. This is done by using the following STM8L101 firmware library function**:**

```
GPIO_Init (GPIOD,GPIO_Pin_5 • GPIO_Pin_6 • GPIO_Pin_7,
GPIO_Mode_Out_PP_Low_Fast);
```

This example is illustrated in *Figure 4*.

Note: It is recommended to set unused pins in input mode to minimize power consumption.

Auto wakeup configuration

The Auto wakeup (AWU) provides an internal wakeup timebase that can be used when the microcontroller enters Active-halt power saving mode. This timebase is clocked by the low speed internal (LSI) RC oscillator clock.

To ensure the best possible accuracy when using the LSI clock, its frequency can be measured with TIM2 timer input capture 1, by calling the `AWU_AutoLSICalibration` functions of the STM8L101 firmware library (see code example below):

```
AWU_AutoLSICalibration ();
AWU_Init (AWU_Timebase_1s);
AWU_Cmd (ENABLE);

/*The datalogger FW then issues the HALT instruction to switch the
microcontroller to Active-halt low power mode. In the following
function, command3 will automatically be executed 1second after
command2 according to the previous configuration */
void function (void)
  {
  command1 ;
  command2 ;
  halt ;
  command3 ;
  }
```

2.3 Digital temperature sensor

2.3.1 STTS75 main features

The STTS75 is a high-precision CMOS digital temperature sensor IC with a programmable 9- to 12-bit analog-to-digital (ADC) converter and an I^2C-compatible serial digital interface..

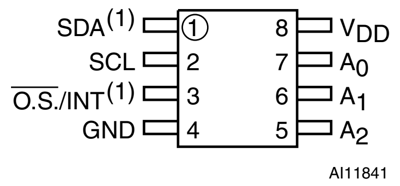
The STTS75 typically accuracy is ±3 °C over the full temperature measurement range of –55 to 125 °C, and ±2°C in the –25 to 100°C range.

It operates from a 2.7 to 5.5 V supply voltage, with a typical supply current of 75 µA at 3.3 V.

For the demonstration datalogger application, the sensor is configured to the default resolution settings that is 9 bits, to achieve a temperature resolution of 0.5 °C.

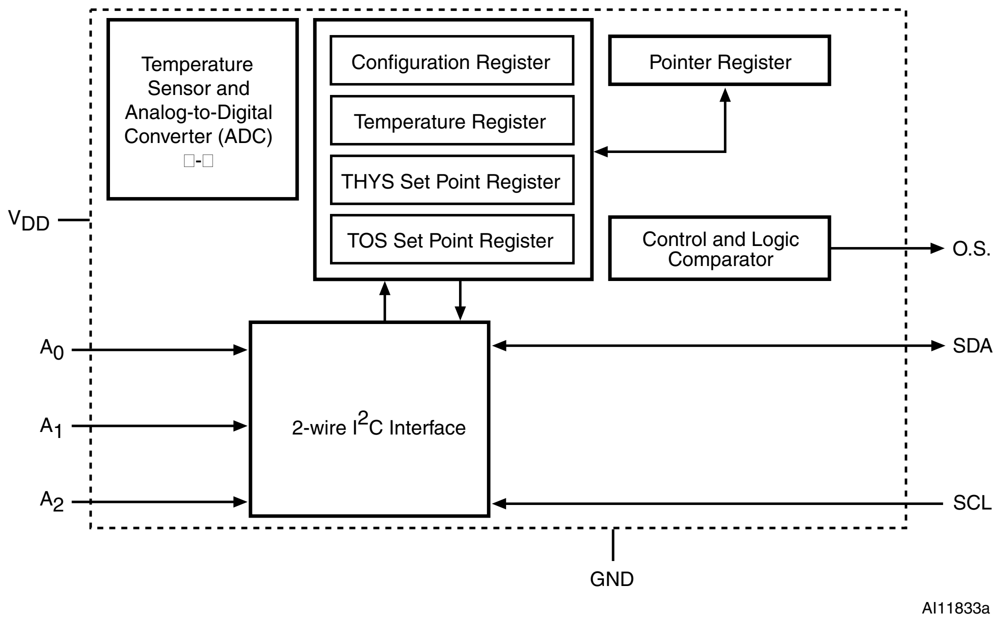
The STTS75 is factory-calibrated and requires no external components to measure temperature.

Figure 12. STTS75 temperature sensor pinout



1. SDA and OS/INT are open drain.

Figure 13. STTS75 temperature sensor block diagram



2.3.2 STTS75 I²C interface

The STTS75 has a simple 2-wire I²C-compatible digital serial interface which allows to access the data stored in the temperature register at any time.

It communicates via the serial interface with a master controller which operates at speeds up to 400 kHz. However, for the demonstration datalogger application the master operates at a speed of 100 kHz.

A0, A1, and A2 pins select the address and allow to connect to up to 8 devices on the same bus without address conflict. For the demonstration application, A0, A1 and A2 are connected to ground.

STTS75 I²C device address is 1001 0000b (0x90).

2.3.3 STTS75 I²C commands

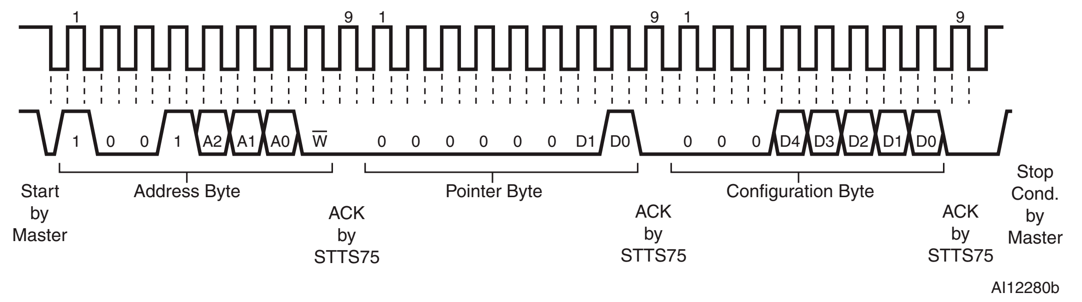
The I²C master requests the sensor to acquire a temperature value and read the data from the sensor register. These operations are performed by calling functions of the I²C library, *i2c_ee.c*. Refer to *Appendix C: STTS75 I2C commands* for a detailed description of these STTS75 functions.

Acquire temperature

To configure the temperature sensor in temperature acquisition mode, the I²C master sends a Pointer Set Configuration Register Write frame as shown in *Figure 14*.

This is done by calling the `I2C_SS_Config (uint16_t ConfigBytes)` function.

Figure 14. Typical Pointer Set Configuration Register Write

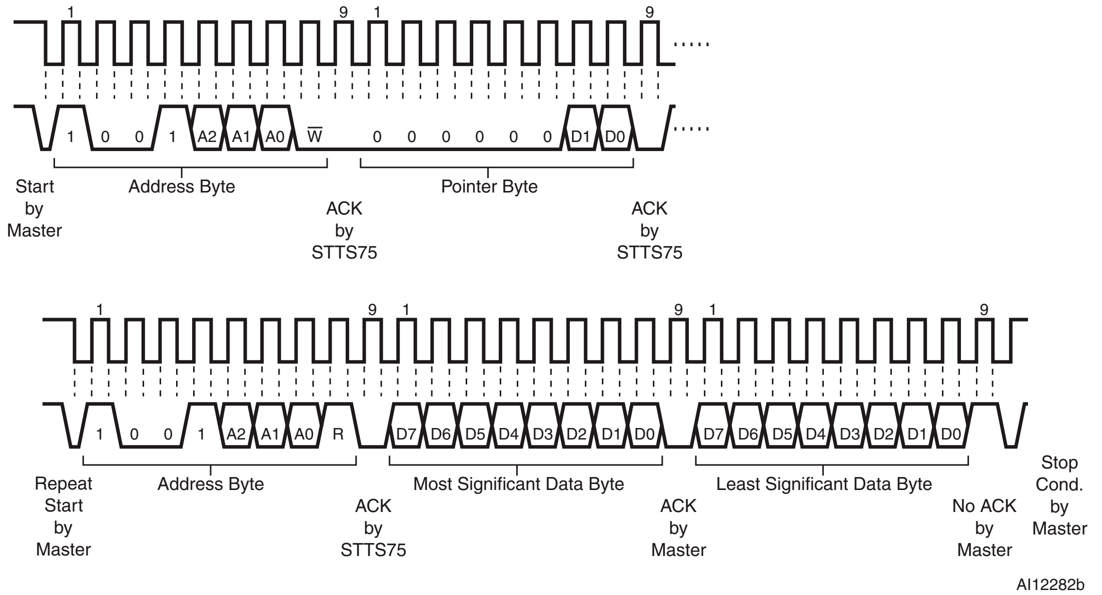


Read acquired temperature

To read the 2 bytes temperature register, the I^2C master must send a Pointer Set Configuration Register Write frame followed by a 2-byte read frame (see *Figure 15*).

This operation is managed by calling the `I2C_SS_BufferRead(unit8_t* pBuffer, unit16_t ReadAddr, unit8_t NumberByteToRead)` function.

Figure 15. Typical pointer set followed by a READ for 2-byte register



2.3.4 Temperature format

Table 8 shows the relationship between the output digital data and the external temperature for 9 to 12-bit resolution. The left-most bit in the output data stream controls temperature polarity information for each conversion. If the sign bit is '0', the temperature is positive and of the sign bit is '1', the temperature is negative.

Table 8. Relationship between temperature and digital output

Temperature (°C)	Sign	Number of bits used by conversion resolution		9	10	11	12	Always zero	Digital output (Hex)
	12-bit resolution							0000	
	11-bit resolution						0	0000	
	10-bit resolution					0	0	0000	
	9-bit resolution				0	0	0	0000	
+125	0	111	1101	0	0	0	0	0000	7D00
+25.0625	0	001	1001	0	0	0	1	0000	1910
+10.125	0	000	1010	0	0	1	0	0000	0A20
+0.5	0	000	0000	1	0	0	0	0000	0080

Table 8. Relationship between temperature and digital output (continued)

Temperature (°C)	Sign	Number of bits used by conversion resolution		9	10	11	12	Always zero	Digital output (Hex)
0	0	000	0000	0	0	0	0	0000	0000
–0.5	1	111	1111	1	0	0	0	0000	FF80
–10.25	1	111	0101	1	1	1	0	0000	F5E0
–25.0625	1	110	0110	1	1	1	1	0000	E6F0

3 Installing the datalogger package on your computer

To install the datalogger package on your computer:

1. Execute the *setup.exe* file available from http://www.st.com/dualeeprom to install the **M24LR64-R_Datalogger_application_software** and copies the following folders on your computer (see *Figure 16*):
   – USB driver
   – .dll files
   – Source code of the M24LR64-R_Datalogger_application_firmware

   The RFID reader must not be connected to your PC.
2. When the installation is complete, connect the reader to the PC through an USB cable.
3. To install the USB driver, follow the steps described in section 31. of user manual UM0863 section 3.1.

Figure 16. M24LR64-R_Datalogger_Application_Software folder structure

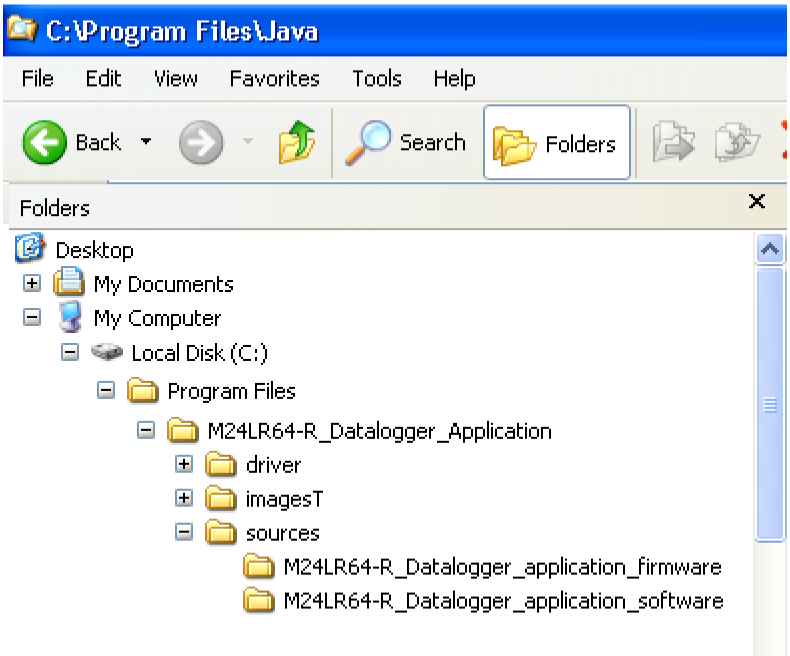
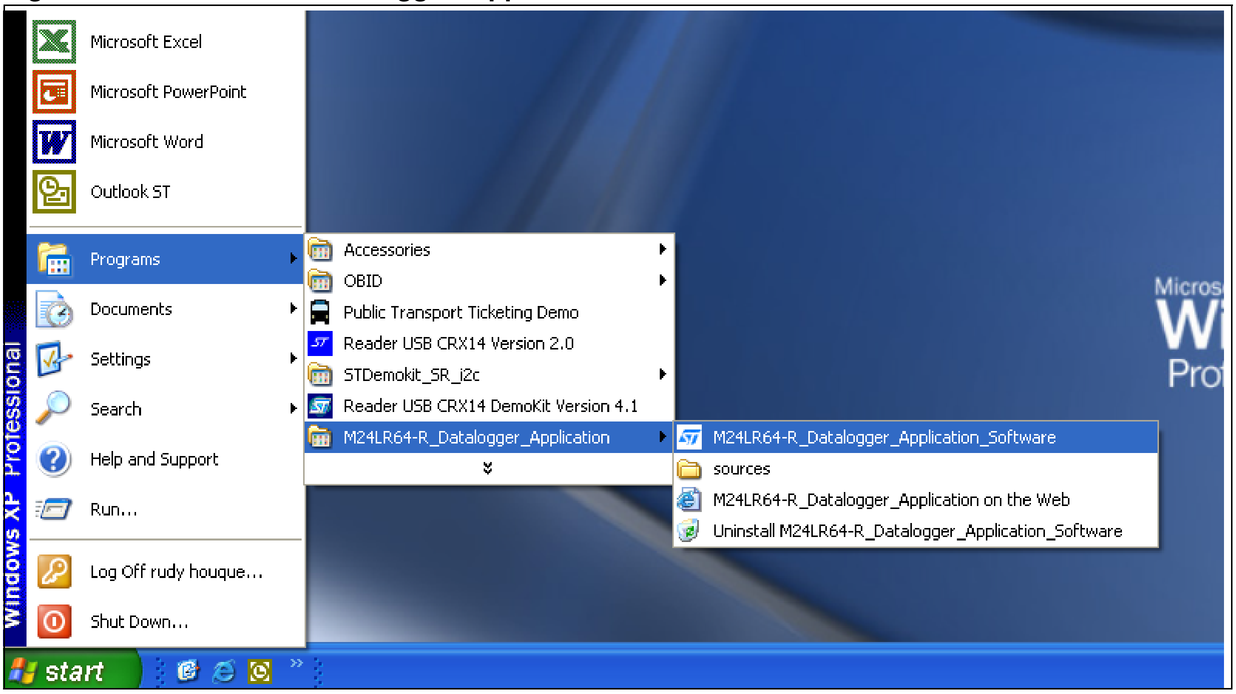


Figure 17. M24LR64-R_Datalogger_Application_Software start menu



4 Developing, compiling and debugging your datalogger firmware

4.1 Installing the datalogger application firmware

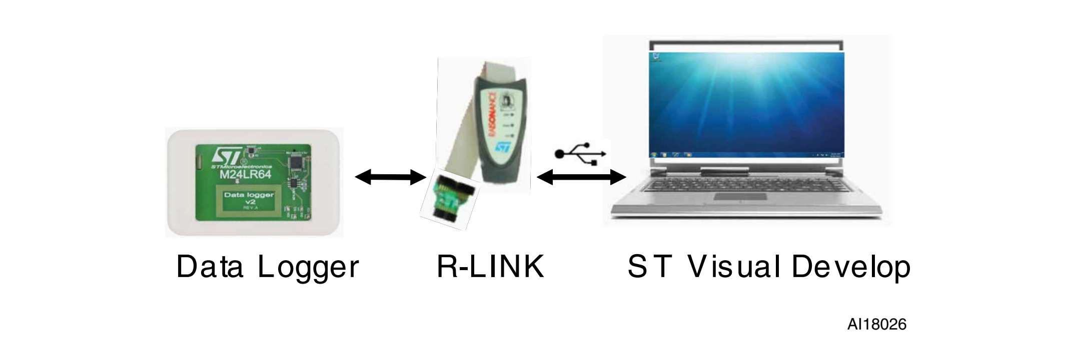
The source code of the demonstration M24LR64-R_Datalogger_application_firmware is then available under **C:\Program Files\M24LR64-R_Datalogger_Application\sources\M24LR64-R_Datalogger_application_firmware** (see *Figure 16*) or by clicking **Start > M24LR64-R_Datalogger_Application > M24LR64-R_Datalogger_application_firmware**.

4.2 Software tool-chain overview

To develop, compile and run an application software on an STM8L101K3 microcontroller, the following software tool-chain components are required (see *Figure 18*):

- Integrated development environment (IDE) composed of the ST Visual Develop (STDV) and the ST Visual programmer software interface (STVP).
- A C complier
- The R-LINK hardware

Figure 18. Needed material to compile and run an application on STM8L101K3



4.2.1 ST Visual Develop (STDV)

STVD is a full-featured development environment. It is a seamless integration of the Cosmic and Raisonance C compilers for STM8 microcontroller family. STDV software is available at http://st.com/stonline/products/support/micro/files/sttoolset.exe.

To install STDV, download the installation software and follow each step of the installation wizard. When the installation is complete, the executable is available under **START>Programs>ST Toolset > Development Tools> ST Visual Develop**.

4.2.2 C compilers

The C compilers are integrated into the STDV development environment. They allow to directly configure and control the building of your application through an easy-to-use graphical interface. The demonstration application uses STM8 Cosmic C compiler (free version up to 16 KBytes of code).

Cosmic compiler is available with the related documentation at http://www.cosmicsoftware.com/download_stm8_16k.php.

Note: 1 *You have to request a free license to use the compiler.*

2 *Refer to http://www.cosmic-software.com and http://www.raisonance.com for more information on complier download, installation and configuration.*

4.3 Description of the datalogger firmware

The M24LR64-R_Datalogger_application_firmware implemented in the STM8L101K3 is low power oriented. It manages two power consumption modes:

- Active consumption mode where the operations are executed by the application.
- Low consumption mode: when no operation is ongoing, the application switches to low consumption mode for a predefined delay.

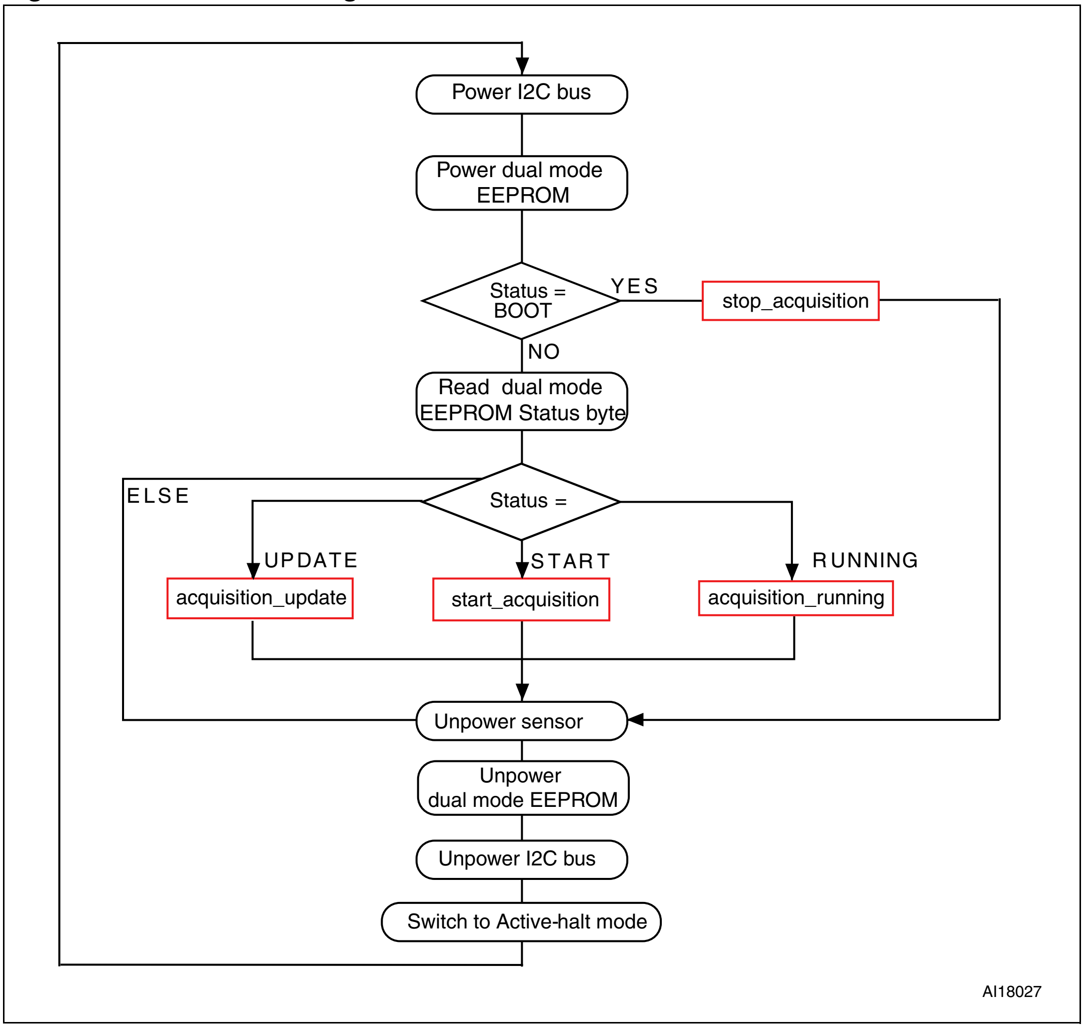
The following sections describe the main and the acquisition routines, where the red rectangles represent functions. Each function is described in details in a dedicated section.

4.3.1 Main routine

Figure 19 describes the flowchart of *main.c* file algorithm. *main.c* is located at **C:\Program Files\M24LR64-R_Datalogger_Application\sources\M24LR64-R_Datalogger_application_firmware** or by clicking **Start > M24LR64-R_Datalogger_Application > M24LR64-R_Datalogger_application_firmware**.

The datalogger firmware is based on an infinite loop. The first operation checks the status byte stored in the M24LR64-R dual mode EEPROM. This byte indicates the state of the datalogger (STARTED or STOPPED).

Figure 19. Main routine algorithm



4.3.2 Acquisition algorithm functions

Figure 20, *Figure 21*, and *Figure 23* describe the algorithms corresponding to the red-rectangle functions of the main routine (see *Figure 19*).

Figure 20. Acquisition_running algorithm

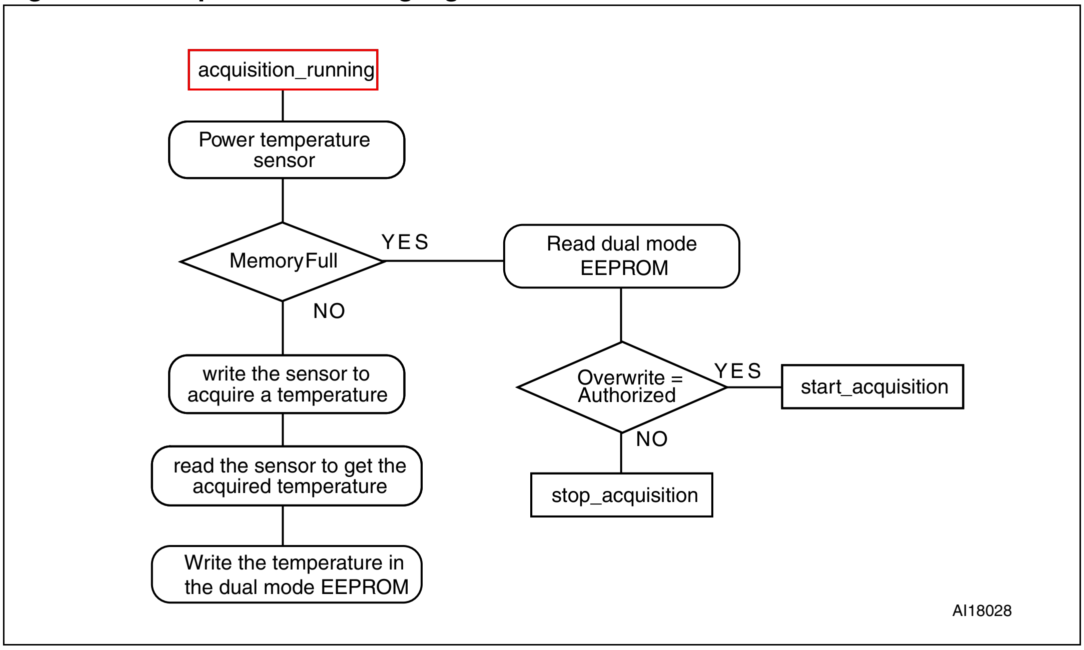
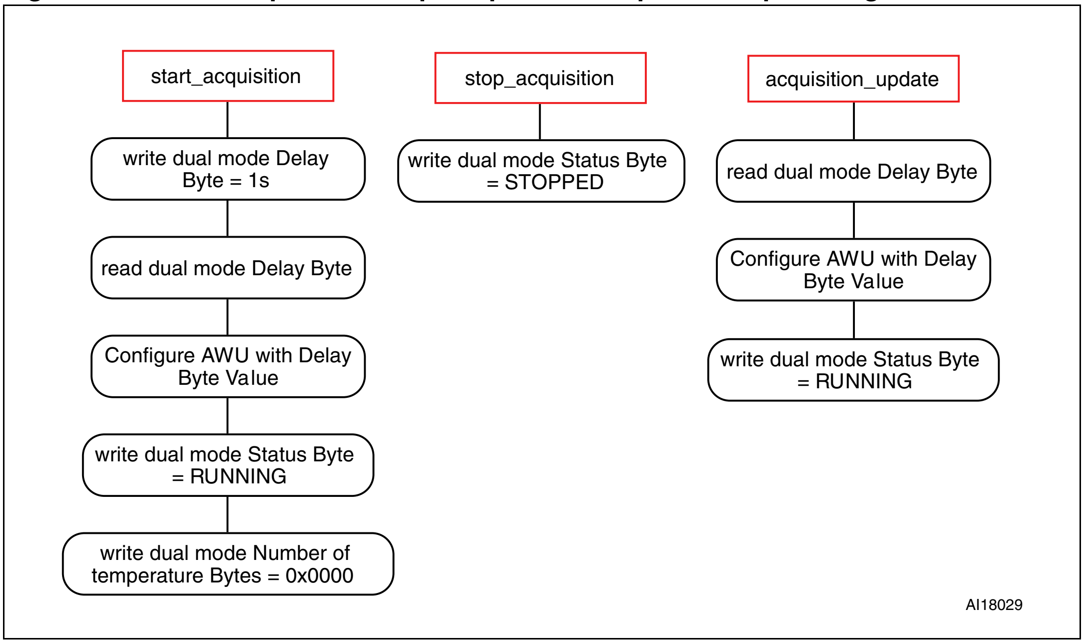


Figure 21. Start_acquisition/stop_acquisition/acquisition update algorithms



5 PC software

Once the *setup.exe* file is installed, the M24LR64-R_Datalogger_application_software project is available under **C:\Program Files\M24LR64-R_Datalogger_Application\sources\M24LR64-R_Datalogger_application_software**, or from the menu **Start > M24LR64-R_Datalogger_Application > M24LR64-R_Datalogger_application_software**.

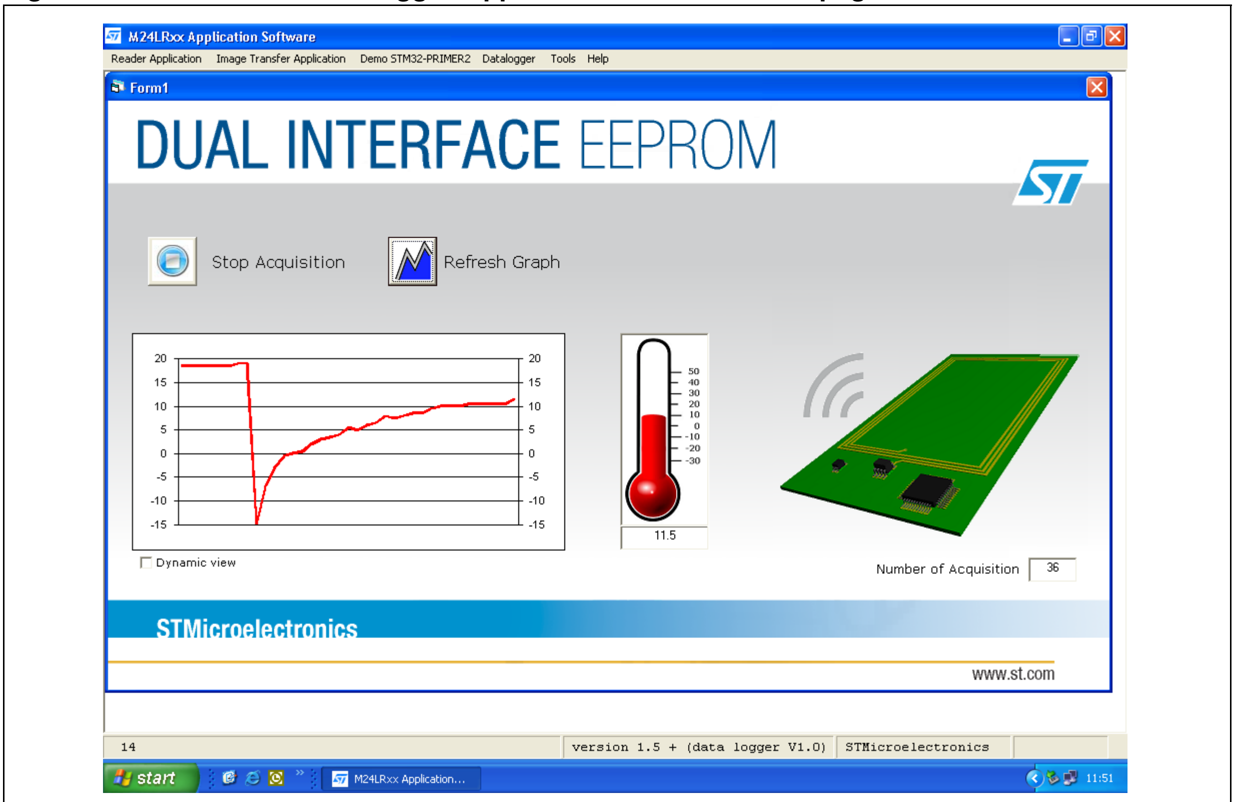
The M24LR64-R_Datalogger_application_software is developed with Visual Basic 6.0. Double click on **DATA LOGGER\source code\Software\Launch Project.vbp** to open the corresponding workspace in Visual Basic.

5.1 Description of the PC software

A user interface features all the functions and options to launch and control the temperature sensing datalogger application (see *Figure 22*):

- **START/STOP** button (see *Section 5.1.1*)
- **STOP** button (see *Section 5.1.2*)
- **TRACE GRAPH** button (see *Section 5.1.3*)
- Dynamic view checkbox (see *Section 5.1.4*)

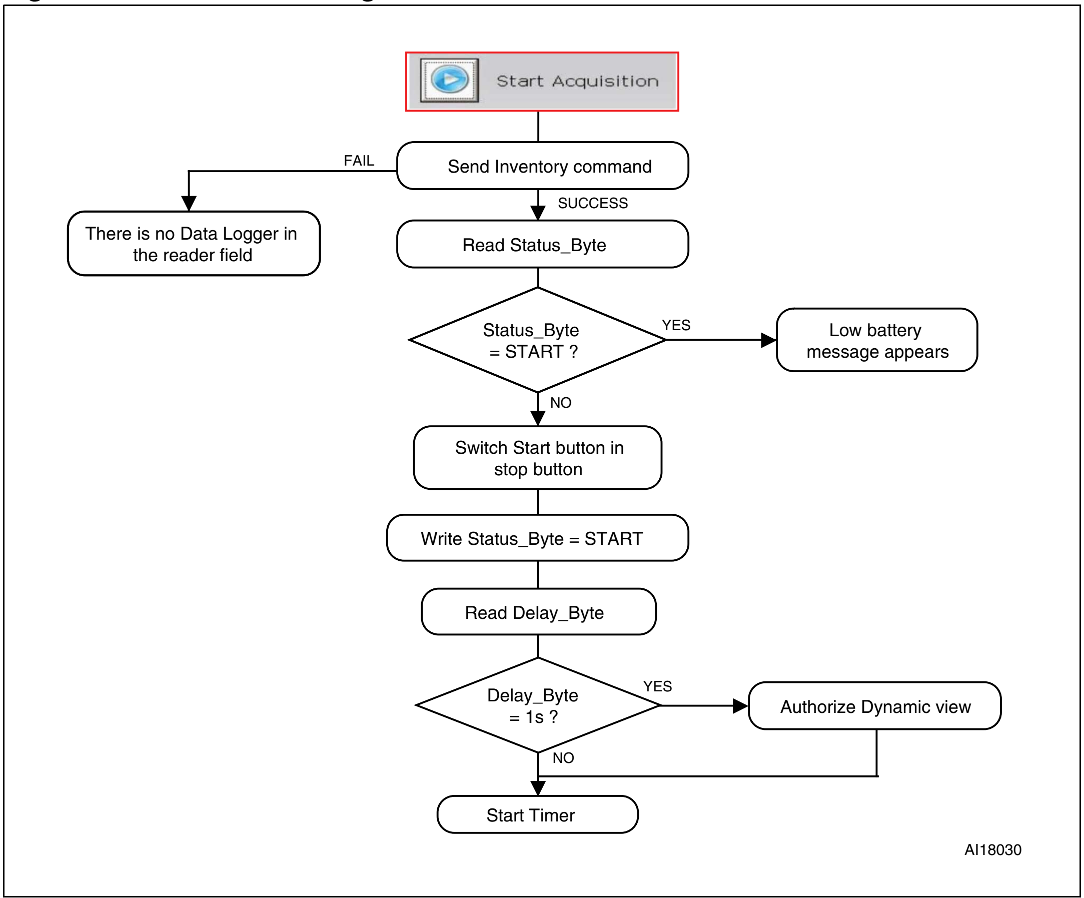
Figure 22. M24LR64-R_Datalogger_application_software home page



5.1.1 START button algorithm

In data acquisition mode, clicking the START button from the menu writes the START value in the Status byte (see *Section : System bytes*) via the RF interface and starts data acquisition. *Figure 23* shows the START button algorithm.

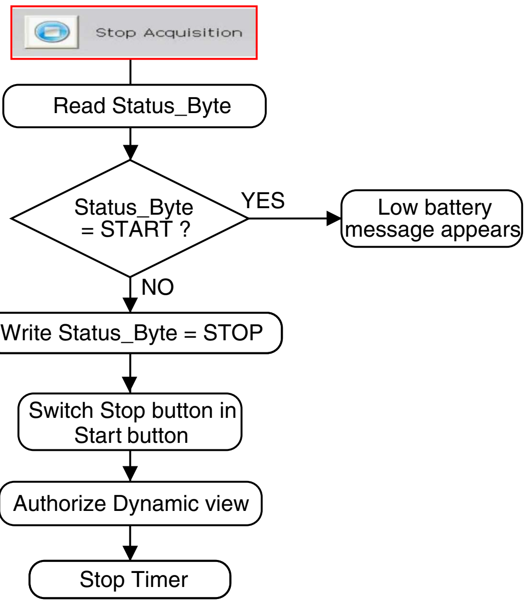
Figure 23. START button algorithm



5.1.2 STOP button algorithm

In data acquisition mode, clicking the STOP button from the menu writes the STOP value in the application Status byte (see *Section : System bytes*) via the RF interface and stops data acquisition. *Figure 24* shows the STOP button algorithm.

Figure 24. STOP button algorithm

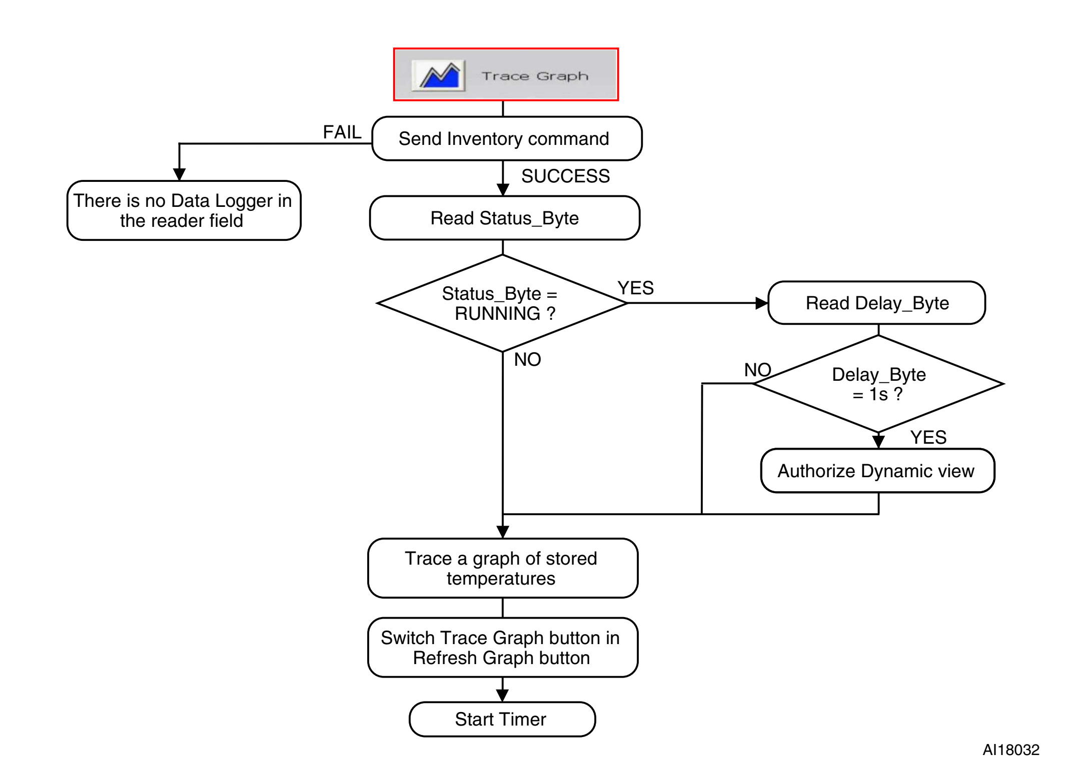


5.1.3 TRACE GRAPH button algorithm

Clicking the **TRACE GRAPH** button from the menu downloads all the acquired temperature values stored in the M24LR64-R memory through the RF interface, and displays a graphical representation of these data. When the delay is set to 1 s, the window displays a checkbox that allows the user to activate a dynamic view.

Figure 25 shows the TRACE GRAPH algorithm.

Figure 25. TRACE GRAPH algorithm



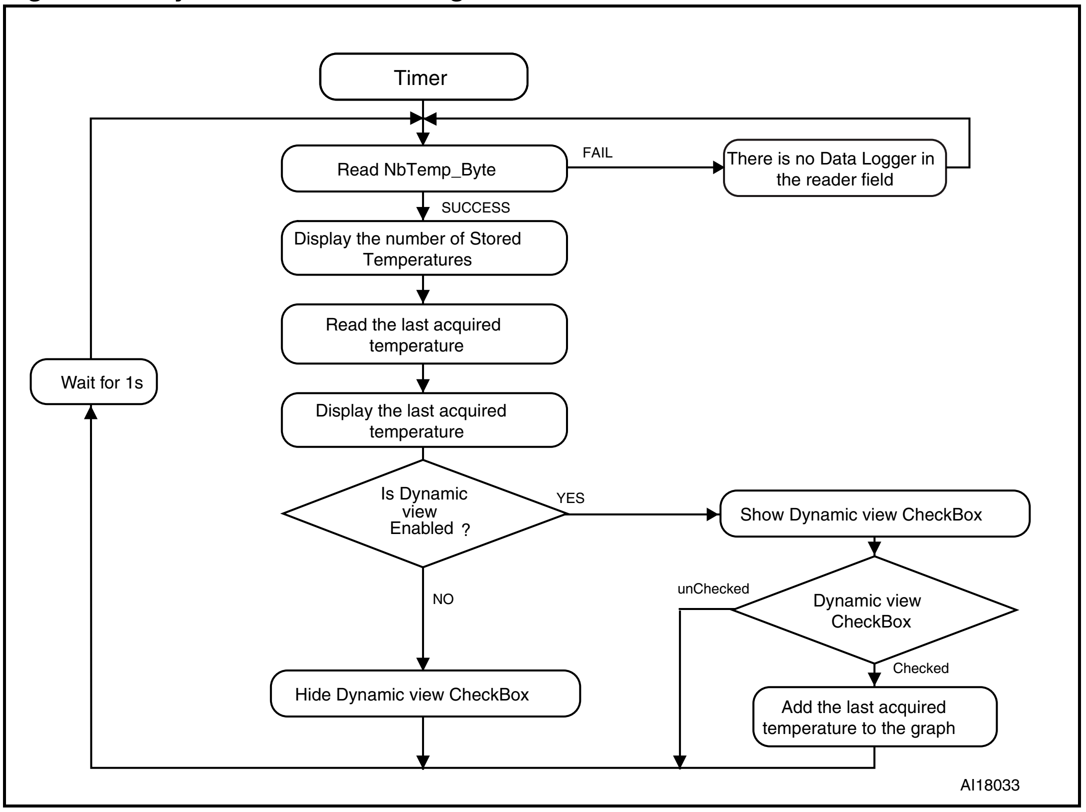
5.1.4 Timer management

When the timer function is enabled, it is executed once per second. This function is used for graphic animations such as dynamic view, periodic thermometer refresh, display of the number of acquisition values, and meteorological pictogram.

As an example, when the **Dynamic view** option box is checked and as long as the datalogger stays in the reader field, the acquired temperature values are automatically added to the graph each second (see *Figure 26* for a description of the Timer function used in conjunction with the Dynamic view).

Refer to UM0925 for a description of the other animations.

Figure 26. Dynamic view - timer algorithm



Appendix A Temperature acquisition datalogger schematics

Figure 27 and *Table 9* describe the electrical schematics of the datalogger for temperature acquisition.

Figure 27. Temperature acquisition datalogger schematics

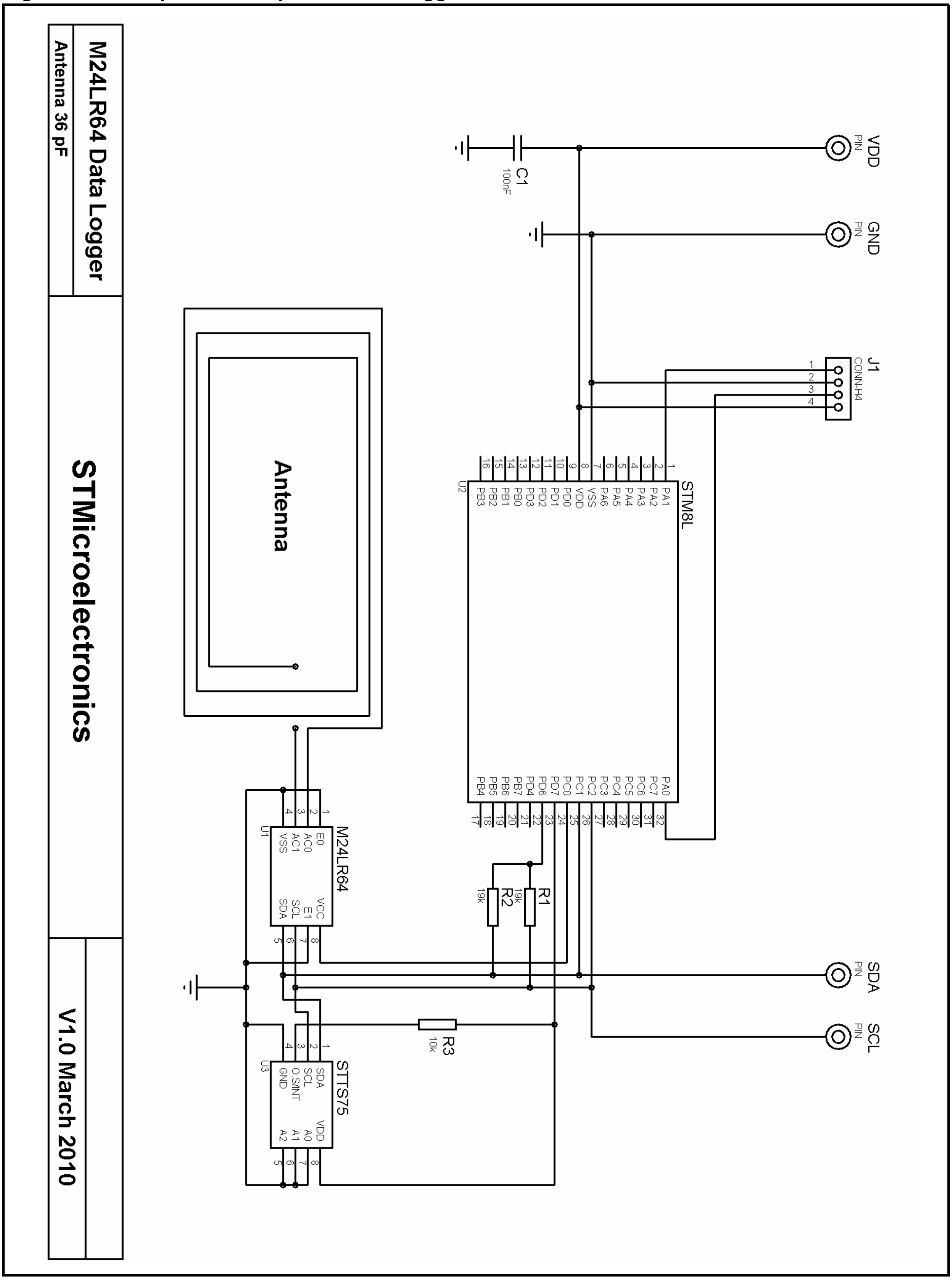


Table 9. Component values for schematics

Component	Quantity	Description
U1	1	M24LR64-R
U2	1	STM8L101K3
U3	1	STTS75
R1 & R2	2	19 kΩ
R3	1	10 kΩ
C1	1	100 nF
J1	1	Connector

Appendix B M24LR64-R RF commands

The M24LR64-R_Datalogger_application_software uses the USB driver library to control RFID readers. The library is written in Visual Basic. It is available under **C:\Program Files\M24LR64-R_Datalogger_Application\sources\M24LR64-R_Datalogger_application_software** or from **Start** > **M24LR64-R_Datalogger_Application** > **M24LR64-R_Datalogger_application_software**.

B.1 Inventory

The ISO 15693 inventory command is performed by calling the `Inventory_DataLogger()` function:

```
Function Inventory_DataLogger() As Integer
```

Table 10. Inventory_DataLogger()

Function description	
Prototype	`Inventory_DataLogger()`
Parameters	None
Returned value	**i_Result**: Function status SUCCEDDED FAILED

B.2 Reset to Ready

The Reset to Ready ISO 15693 command is performed by calling ResetToReadyRF_DataLogger() function:

```
Function ResetToReadyRF_DataLogger() As Integer
```

Table 11. ResetToReadyRF_DataLogger()

Function description	
Prototype	`ResetToReadyRF_DataLogger()`
Parameters	None
Returned value	**i_Result**: Function status SUCCEDDED FAILED

B.3 Read single block

The Read Single Block ISO 15693 command is performed by calling the ReadRF_single_DataLogger() function.

Table 12. ReadRF_single_DataLogger()

Function description	
Prototype	`Function ReadRF_single_DataLogger (lngAddLow As Long, lngDataSize As Long, lngNbByteAddress As Long) As String`
Parameters	**lngAddLow**: address the read operation starts from **lngDataSize**: number of data bytes to be read **lngNbByteAddress**: number of bytes used to code the address
Returned value	String
Example	ReadRF_single_DataLogger(0, 4, 2) returns the 4 bytes read from address 0 coded on 2 bytes.

B.4 Read Multiple Block

The Read Multiple Block ISO 15693 command is performed by calling the ReadRF_multiple_DataLogger() function:

Table 13. ReadRF_multiple_DataLogger()

Function description	
Prototype	`Function ReadRF_multiple_DataLogger (lngAddLow As Long, lngRowNumber As Long, lngDataSize As Long, lngNbByteAddress As Long) As String`
Parameters	**lngAddLow:** address the read operation starts from **lngRowNumber**: number of blocks to be read (maximum 32) **lngDataSize**: number of bytes per block **lngNbByteAddress:** number of bytes used to code the address
Returned value	String
Example	ReadRF_multiple_DataLogger(0,32,4,2) returns in 32*4 bytes read from the address 0 coded on 2 bytes.

B.5 Write single block

The Write Single Block ISO 15693 command is performed calling the ReadRF_multiple_DataLogger() function WriteSingleBlockRF_DataLogger() function:

Table 14. WriteSingleBlockRF_DataLogger()

Function description	
Prototype	`Function WriteSingleBlockRF_DataLogger(lngadd As Long, strData As String, lngDataSize As Long, lngNbBytesAddress As Byte) As Integer`
Parameters	**lngadd**: address where the data must be written **strData:** String containing the data to be written **lngDataSize:**number of data bytes to be written **lngNbBytesAddress**: number of bytes used to code the address
Returned value	**ErrorStatus:** SUCCEEDED FAILED
Example	WriteSingleBlockRF_DataLogger(0, Data_To_Send, 4, 2) returns SUCCEEDED if the data write has succeeded, FAILED otherwise.

B.6 estar commands

All previous Visual Basic functions are compatible with estar readers.

Appendix C STTS75 I^2C commands

The M24LR64-R_Datalogger_application_firmware uses the *i2c_ee.c* C library to interface with the STTS75 temperature sensor. The library is available under **C:\Program Files\M24LR64-R_Datalogger_Application\sources\M24LR64-R_Datalogger_application_firmware** or from **Start > M24LR64-R_Datalogger_Application > M24LR64-R_Datalogger_application_firmware**.

The address Byte defines the address of the STTS75 on the I^2C bus. It is defined by the `SENSOR_ADDRESS` global variable of the *i2c_ee.c*

```
#define SENSOR_ADDRESS  0x90
```

C.1 Acquire temperature

The I2C_SS_Config() function configures the STTS75 in temperature acquisition mode. Refer to the STTS75 datasheet for a detailed description of the pointer byte and of the corresponding registers.

Table 15. I2C_SS_Config()

Function description	
Prototype	`I2C_SS_Config (uint16_t ConfigBytes)`
Parameters	**ConfigBytes**: 2 bytes resulting from the concatenation of the Pointer byte and Configuration byte. Pointer byte: Bits P2 to P7 must always be set to 0. Bits P0 and P1 define the pointer value corresponding to the register to be configured. Configuration byte: Value to be programmed in the Configuration register. It is the last byte of the Pointer Set Configuration Register Write frame. (see *Section : Acquire temperature*). Default value is 0x00.
Returned value	**ErrorStatus:** SUCCEEDED FAILED

Example

`I2C_SS_Config (0x0183)` configures the STTS75 to perform one temperature acquisition with a resolution of 9 bits and store the value in the 16 bits temperature register. where

Pointer byte = 0x01

Configuration byte = 0x83

ConfigBytes = 0x0183.

C.2 Read acquired Temperature

The I2C_SS_BufferRead() function allows to read a temperature acquisition value.

Table 16. I2C_SS_Config()

Function description	
Prototype	`I2C_SS_BufferRead(unit8_t* pBuffer, unit16_t ReadAddr, unit8_t NumberByteToRead)`
Parameters	**pBuffer**: pointer to the buffer containing the 2-bytes temperature data This buffer contains the acquired temperature coded on 2 bytes (refer to *Table 8: Relationship between temperature and digital output*). pBuffer[1] and pBuffer[2] are the MSB and the LSB, respectively. **ReadAddr**: Pointer byte. The Pointer byte must be set to 0x00 to access the temperature register. **NumberByteToRead**: Number of bytes to read.
Returned value	**ErrorStatus:** SUCCEEDED FAILED

Example

`I2C_SS_BufferRead(pBuffer, 0x00, 0x02)` accesses the sensor temperature register and stores the read value in pBuffer.

6 Revision history

Table 17. Document revision history

Date	Revision	Changes
08-Jun-2010	1	Initial release.