UM0690
User manual

STEVAL-IFS012V1 demonstration board for multiple temperature sensors

Introduction

This user manual explains the functions of the multi-device temperature sensor demonstration board which is based on a motherboard and daughter card approach. The complete system consists of the motherboard with an ST72F651 microcontroller and daughter cards with temperature sensors. The temperature sensors supported by this system are:

- STLM20
- STTS424E02
- STTS75
- STDS75
- STLM75
- STCN75

This board can operate in 2 modes:

- Standalone / external-power mode
- USB-powered mode / full-featured mode

The board's configuration and operation in both modes is explained in different sections. To select the desired mode, there is a power selection switch (SW5) on the board which enables the appropriate selection. When this board is connected to a computer through the USB cable then it also behaves as a mass storage device. The default state of the board (with USB connection) is mass storage mode. It switches to temperature-sensor mode using a graphical user interface (GUI).

Figure 1. Multi-device temperature-sensor demonstration board

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1.1 Package contents

The multi-device temperature-sensor demonstration board includes the following items:

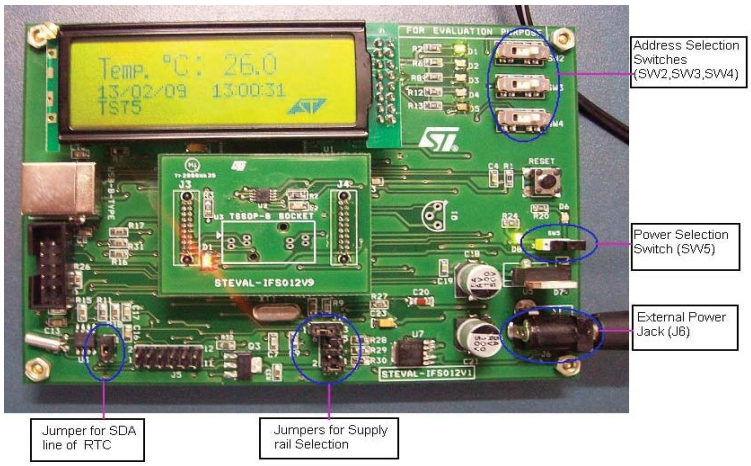
- Hardware content:
  - One motherboard
  - Two daughter cards (STTS75 - TSSOP8 package and STLM20 - UDFN package)

Daughter cards for all sensors can be ordered individually.

- Documentation:
  - User manual
  - Quick reference manual
- GUI installation file

1.2 Hardware description

Figure 2. Hardware description of demonstration board



1.2.1 On-board components

Major blocks present on the board are:

- Microcontroller
- 64 MB NAND flash
- RTC
- Graphic LCD (122 X 32)
- 3 V button battery
- Power jack for external power supply
- USB jacket for USB connection
- Switches SW2, SW3 and SW4 to configure the address of the temperature sensor
- Power selection switch (SW5) to select between external-power and USB-power

1.2.2 Power supply selection

The board can work in two different power supply modes.

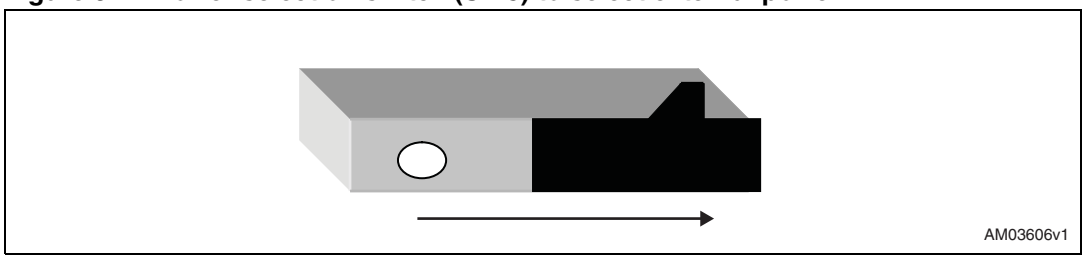
- External power mode
- USB-powered mode

Selection of required power mode is done through the SW5 switch.

2 External power mode selection

To select the external supply mode position the switch (SW5) as shown in *Figure 3*. Then plug in the DC adapter (8 V - 20 V,1 A and center positive) with a female connector to the power jacket (J6) and the green colored LED (D8) turns on.

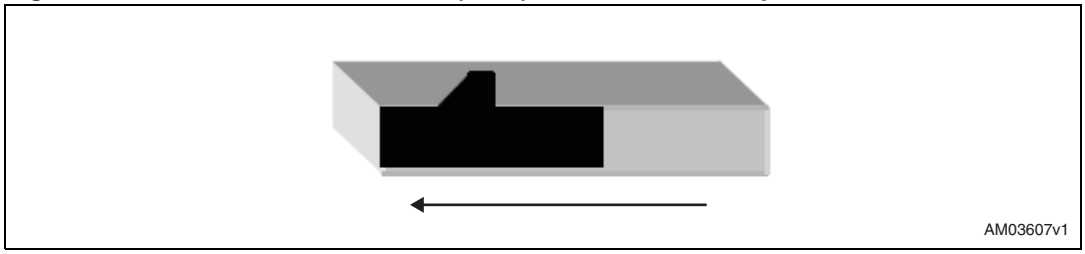
Figure 3. Power selection switch (SW5) to select external power



3 USB-powered mode selection

To select USB-powered mode unplug the external power supply and then position the power switch, as shown in *Figure 4*. Then plug the USB cable into the USB socket (J2) on the board. A red colored LED (D6) turns on and the board is powered up through USB-power.

Figure 4. Power selection switch (SW5) to select for USB-power



Note: At any time only one power supply should be plugged in (either USB or external power adapter). The power LED (green (D8) for external supply and red (D6) for USB supply) turns on as soon as the power is plugged in but the power is connected to the board only by appropriate switch settings as shown in Figure 3 and Figure 4.

4 External power mode of board

This mode is also called the standalone mode of board. In this mode the board is supplied by an external power supply and continuously displays the time and temperature on the LCD. A computer interface is not needed for this mode.

4.1 Powering of the board

The motherboard can be powered to 5 V using an external supply or a USB supply whereas daughter cards can be powered to one of 1.8 V/2.5 V/3.3 V/5.0 V using the J16 and JP1 jumpers on the motherboard.

The procedure for powering the board is explained below.

- Steps:
  - Select the power selection switch (SW5) as external power mode as explained in *Figure 3*
  - Place the jumper on J16
  - To supply the temperature-sensor daughter card with 5 V, place the jumper on pin 1 and pin 2 of J16. If the daughter card is to be supplied with alternate voltage (1.8 V/2.5 V/3.3 V) then place the jumper on pin 2 and pin 3 of J16
  - To supply the daughter card with 3.3 V, place the jumper on pin 1 and pin 2 of JP1 or to select 2.5 V, place the jumper on pin 3 and pin 4 of JP1, or for 1.8 V place the jumper on pin 5 and pin 6 of JP1. Refer to table 1 for daughter card powering.

Table 1. Power selection for daughter card

Needed voltage	Jumpers	
	J16	JP1
5 V	Pins 1 and 2	n/a
3.3 V	Pins 2 and 3	Pins 1 and 2
2.5 V		Pins 3 and 4
1.8 V		Pins 5 and 6

Note: At any time only one jumper should be present on JP1

- Plug in the DC power supply through the adapter (8 V - 20 V, 1 A output). As soon as power is plugged in, the green colored LED (D8) turns on.

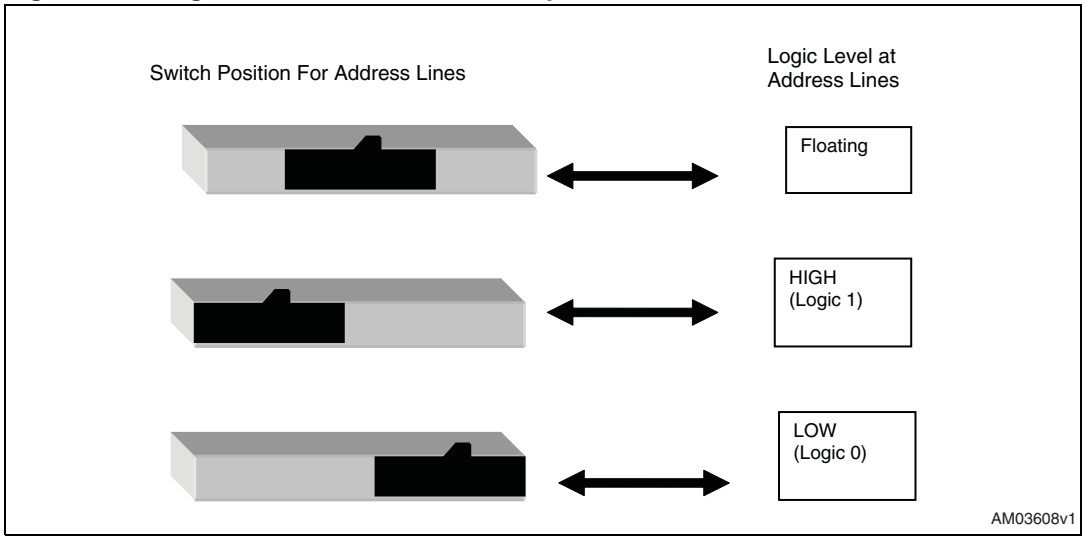
Note: This LED (D8) shows only whether power is connected or not. Power to the board is selected through the power selection switch (SW5).

4.2 Address selection on the board

This evaluation board supports different temperature sensors which are present on different daughter cards. Address lines of digital sensors are configured using the switches (SW2, SW3, SW4) present on the motherboard.

Logic level is assigned to the address line using the address selection switches. *Figure 5* shows the position of the switch and the respective logic level assigned by that switch.

Figure 5. Logic level and relative switch positions



4.2.1 Address configuration of different sensors using the switches

The following are the steps for configuring the address lines of different sensors

STTS75,STDS75,STLM75 and STCN75

STTS75, STDS75, STLM75 and STCN75 all are digital temperature sensors with 3 address lines. There are 8 possible addresses for these sensors.

SW2 corresponds to A0, SW3 corresponds to A1 and SW4 corresponds to A2 address lines of the sensors.

Listed below are the allowed addresses and their settings for STTS75, STDS75, STLM75 and STCN75:

- Address 1 = 0x90, => SW4 = 0, SW3 = 0, SW2 = 0
- Address 2 = 0x92, => SW4 = 0, SW3 = 0, SW2 = 1
- Address 3 = 0x94, => SW4 = 0, SW3 = 1, SW2 = 0
- Address 4 = 0x96, => SW4 = 0, SW3 = 1, SW2 = 1
- Address 5 = 0x98, => SW4 = 1, SW3 = 0, SW2 = 0
- Address 6 = 0x9A, => SW4 = 1, SW3 = 0, SW2 = 1
- Address 7 = 0x9C, => SW4 = 1, SW3 = 1, SW2 = 0
- Address 8 = 0x9E, => SW4 = 1, SW3 = 1, SW2 = 1

Table 2. Switch settings for selecting different addresses of STT75/STLM75/STDS75/STCN75

Address line	Address 1 (0x90)	Address 2 (0x92)	Address 3(0x94)	Address 4 (0x96)	Address 5 (0x98)	Address 6 (0x9A)	Address 7 (0x9C)	Address 8 (0x9E)
SW2 (A0)								
SW3 (A1)								
SW4 (A2)								

STTS424E02

STTS424E02 is also a digital temperature sensor with 3 address lines. There are 8 possible addresses for this sensor.

SW2 corresponds to A0, SW3 corresponds to A1and SW4 corresponds to A2 address lines of the sensors.

Listed below are the allowed addresses and there settings for the STTS424E02 sensor:

- Address 1 = 0x30, => SW4 = 0, SW3 = 0, SW2 = 0
- Address 2 = 0x32, => SW4 = 0, SW3 = 0, SW2 = 1
- Address 3 = 0x34, => SW4 = 0, SW3 = 1, SW2 = 0
- Address 4 = 0x36, => SW4 = 0, SW3 = 1, SW2 = 1
- Address 5 = 0x38, => SW4 = 1, SW3 = 0, SW2 = 0
- Address 6 = 0x3A, => SW4 = 1, SW3 = 0, SW2 = 1
- Address 7 = 0x3C, => SW4 = 1, SW3 = 1, SW2 = 0
- Address 8 = 0x3E, => SW4 = 1, SW3 = 1, SW2 = 1

Table 3. Switch settings for selecting different addresses of the STTS424E02

Address line	Address 1 (0x30)	Address 2 (0x32)	Address 3 (0x34)	Address 4 (0x36)	Address 5 (0x38)	Address 6 (0x3A)	Address 7 (0x3C)	Address 8 (0x3E)
SW2 (A0)								
SW3 (A1)								
SW4 (A2)								

STLM20

STLM20 is an analog temperature sensor with no address lines.

After setting the address press the reset button (RESET) present on the board.

Then the board starts to function, showing the temperature and the time and sensor name on the LCD.

Note: The jumper for the SDA line of RTC (J2) should be connected before pressing the RESET button on the board.

4.3 Value of temperature-sensor registers in a standalone case

4.3.1 STTS75, STLM75, STDS75 and STCN75

Table 4. Default values of sensor registers

Register name	Value
Over saturation (Tos)	35 Degree Centigrade
Hysteresis (Thys)	15 Degree Centigrade
Configuration (Tconfig)	0x00

4.3.2 STTS424E02

Table 5. Default values of sensor registers

Register name	Value
Configuration	0x00,0x08 (alarm enabled)
Alarm temperature lower boundary trip	15 Degree Centigrade
Alarm temperature upper boundary trip	30 Degree Centigrade
Critical temperature trip	35 Degree Centigrade

4.3.3 STLM20

STLM20 is an analog sensor and therefore there is no register configuration for it. Also there is no alert output from the sensor.

4.4 Sequence for operation of board in a standalone case

- Steps for standalone mode:
  - Plug the temperature-sensor daughter card into the motherboard
  - Accordingly, configure the address lines of the sensor using the SW2, SW3, and SW4 switches, as explained in *Section 4.2*
  - Move the power selection switch (SW5) to select the external power supply as explained in *Figure 3*
  - Put the jumper on the SDA line of the RTC (J2)
  - Plug the power adapter into the board and switch on the supply
  - Press the reset button (RESET) present on the board
  - The application starts running. Temperature and time are displayed on the LCD.

Note: To change the address of the sensor, switch off the supply, configure the new address and again plug in the supply, the application starts with a new address configuration.

5 USB-power/GUI mode of board

The second mode of operation of this multi-device temperature-sensor board is with a graphical user interface (GUI) through a USB connection.

In this mode, if the GUI is not connected then the board behaves as a mass storage device and is seen as a removable drive on the computer.

To use the board in temperature-sensor mode, connect it to the computer using a USB cable and communicate with the GUI using the USB communication protocol. The GUI is used to configure the temperature-sensor registers and to explore all the features of the temperature sensor.

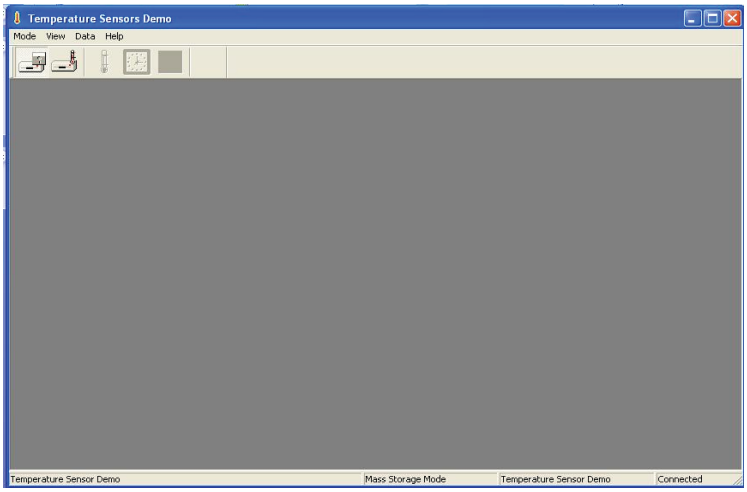
5.1 Getting started

Double click on the setup of the .exe file to install the GUI on the host system.

To install the GUI, the user should have administrative rights, as the set-up overwrites files (.dll) in the system folder that are protected using administrative rights. If the user does not have administrative rights, this GUI can not be installed (error message: 0x80040707 appears).

Then open up the temperature-sensor GUI by clicking on the GUI icon. The GUI window, as shown in *Figure 6*, opens.

Figure 6. GUI window on startup



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5.2 Powering of board in GUI mode

The steps for powering the board in GUI mode follow.

- Steps:
  - Select the power selection switch (SW5) to USB-power mode as explained in *Figure 4*
  - Place the jumper on J16.

To supply the daughter card with 5 V, place the jumper on pin 1 and pin 2 of J16. If the daughter card is to be supplied with alternate voltage (1.8 V/2.5 V/3.3 V) then:

- Place jumper on pin 2 and pin 3 of J16
- To supply the daughter card with 3.3 V, place the jumper on pin 1 and pin 2 of the JP1 or to select for 2.5 V place the jumper on pin 3 and pin 4 of the JP1 or for 1.8 V place the jumper on pin 5 and pin 6 of the JP1. Refer to *Table 1*.

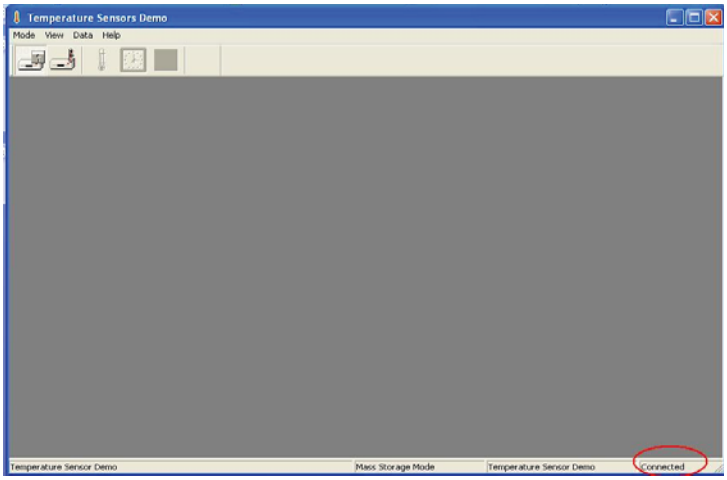
Note: (At any time only one jumper should be present on JP1).

- Plug the USB cable into the USB socket on the board. As soon as the USB cable is plugged in the red colored led (D6) turns on.

Note: This LED (D6) shows only whether the USB is connected or not. Power to board is selected through the power selection switch (SW5).

- After plugging in the USB cable, and if the power switch is selected correctly, the status bar of the GUI changes to Connected as shown in *Figure 7*.

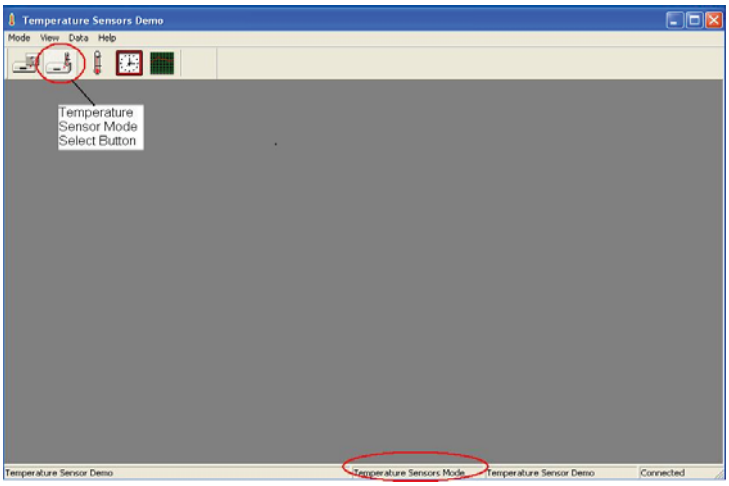
Figure 7. Board connected to GUI and status changed to connected in status bar



5.3 Switching to temperature-sensor mode

By default the board is in mass storage mode and when the GUI is opened it shows the mass storage mode in the status bar. Once the board is connected to the GUI and the status changes to Connected in the status bar, press the temperature-sensor mode selection button in the toolbar to switch to temperature-sensor mode. As the GUI goes into temperature-sensor mode, all the 3 icons of the temperature sensor, clock and plotter become active. The GUI appears as shown in *Figure 8*.

Figure 8. Temperature-sensor mode selected

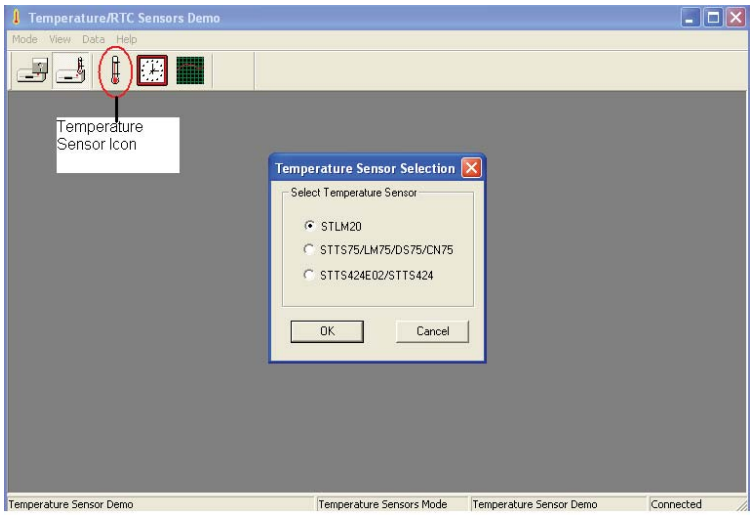


In this mode the LCD shows:

- Temperature and °C written in the first row
- Date and time in the second row

Select the temperature-sensor icon from the tool bar, it opens the list of sensors on the GUI as shown in *Figure 9*. Click on the desired sensor and press the OK button on the GUI. If the sensor present on the board is different to the one selected on the GUI, an error message pops up on the GUI showing the wrong selection of the sensor. In the case of an error message, re-select the correct sensor from the GUI and press the OK button. When the correct sensor is selected, the window opens in the GUI.

Figure 9. Temperature-sensor child Window



There are 6 sensors supported by the motherboard and there are 3 different GUI windows to support all the sensors. The GUI child window is for the:

- STTS75/STLM75/STDS75/STCN75
- STTS424E02
- STLM20

5.3.1 The GUI window for STTS75, STLM75, STDS75, STCN75 sensors

The STTS75, STLM75, STDS75, and STCN75 sensors are supported by a single GUI window, as shown in *Figure 10*. There are radio buttons for selecting one of four possible sensors (STTS75, STLM75, STDS75, and STCN75). The LCD display shows TS75 for all of the STTS/LM//DS/CN temperature sensors.

Below are the steps for operating these sensors using the GUI:

- Select one of the radio buttons present in the Select the Temperature Sensor area on the GUI. This enables the GUI for one of the selected sensors (STTS75/STLM75/STDS75/STCN75)
- Choose the address from the drop down menu of the Choose Address block. If the address selected from the GUI is the same as configured on the board (as described in *Section 4.2.1*), the remaining part of the GUI is enabled or else an error message shows up on the GUI as shown in *Figure 11*
- In the case of an error message, check the correct address from the GUI
- Configure the different sensor registers and observe the behavior on the GUI and on the board.

Figure 10. GUI child window for STTS75/STDS75/STLM75/STCN75

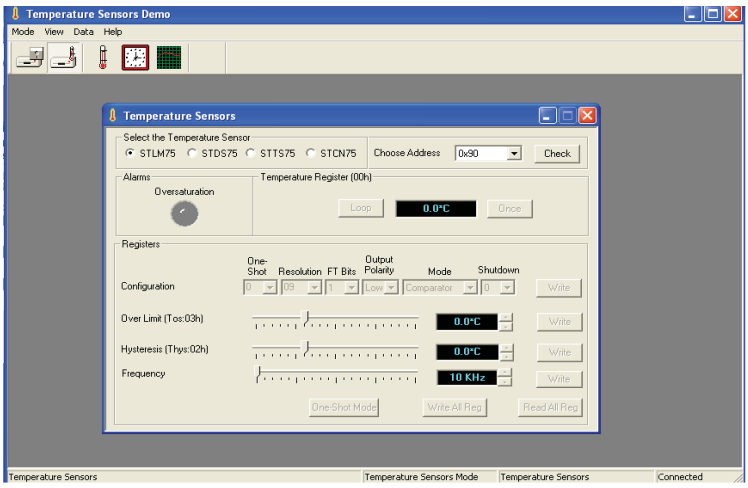


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Figure 11. Address error-message display on the GUI

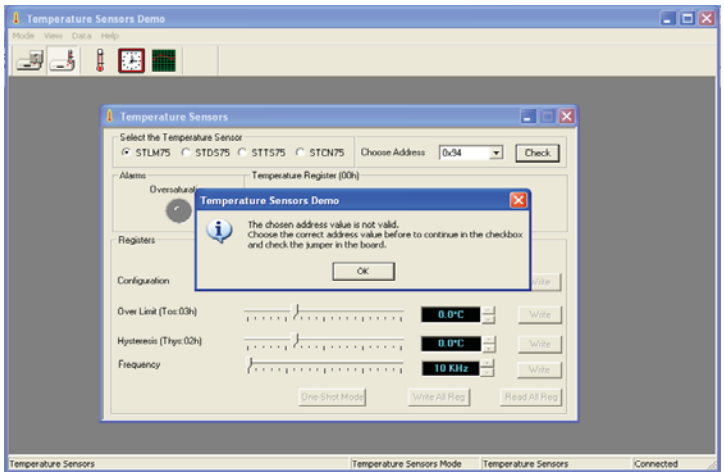

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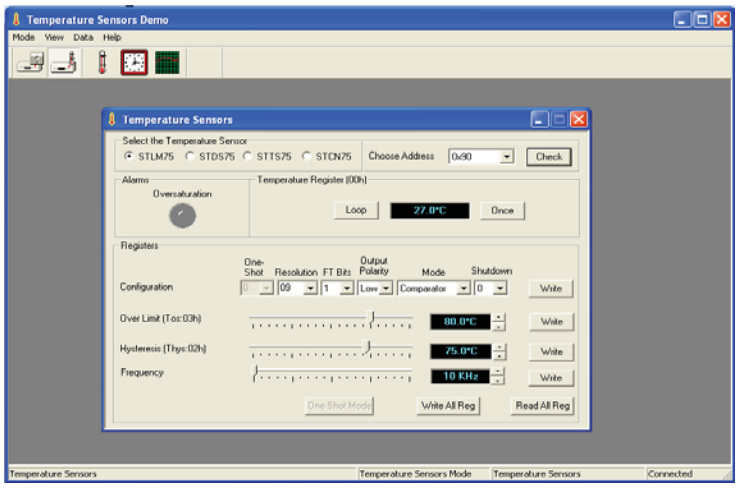
Figure 12. Active temperature-sensor child window



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Register configuration for STTS75,STLM75,STDS75, and STCN75 sensors

There are 4 different registers for each sensor.

These registers are:

- 8-bit configuration register
- 16-bit over saturation (Tos) register
- 16-bit hysteresis (Thys) register
- 16- bit read-only temperature register

The GUI has a register section to configure these registers.

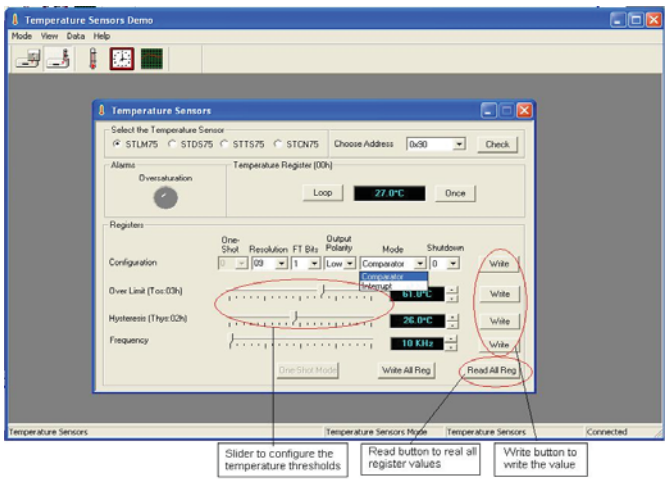
1. Configuration register:
   - The GUI has the drop down buttons for bits of the configuration register. Select for the desired bits in the configuration register
   - Select the Write button to program the sensor with the selected value
   - One-Shot is enabled only for the STTS75 sensor
2. Over saturation register (Tos):
   - This register is used to enter the Over saturation temperature
   - Enter the desired temperature using the slider or the up/down button
   - Select the Write button to program the sensor with the selected temperature
   - Setting configuration is shown in *Figure 13*
3. Hysteresis register (Thys):
   - This register is used to enter the hysteresis temperature
   - Enter the desired Hysteresis temperature using the slider or the up/down button
   - Press the Write button to program the sensor with the hysteresis value
   - Setting configuration is shown in *Figure 13*
4. Temperature register:
   - This register is used to show the temperature measured by the sensor.
   - The Once button is used to read the temperature at any one instant.
   - The Loop button is used to continuously measure and display the temperature.
   - An alarm is seen on the GUI only when the Once or Loop button is pressed. Pressing Once reads the instantaneous temperature value and latches the instantaneous alarm condition on the GUI. The Loop button, pressed continuously, monitors the temperature and alarm condition and displays the same on the GUI. Stopping the loop button latches the last measured value of temperature and the last alarm condition on the GUI.

The read button is used for reading the values back from the sensor present on the board. As soon as the address is checked the sensor registers show the default settings of the registers in this window.

There is a one shot mode button present on the GUI which functions only for the STTS75 sensor. One shot mode puts the sensor in shutdown mode and then reads temperature register. After one shot mode, the shutdown pin of the configuration register sets to '1'. To bring the sensor to normal mode, write the shutdown bit to '0'.

There is a slider for the frequency setting for I^2C communication with sensor. This is default fixed to 10 kHz. In order to avoid the disruption of sensor communication with the microcontroller, this frequency slider does not affect the sensor I^2C communication frequency.

Figure 13. Temperature-sensor register settings



Alarm in STTS75,STLM75,STDS75,STCN75 sensors

Alarm status can be observed in Once or Loop condition. On pressing the Once button, the instantaneous alarm condition is latched on the GUI whereas in Loop condition, the alarm condition is monitored continuously and is displayed on the GUI. When the Loop condition is stopped, the last alarm status is latched and shown on the GUI.

This alarm is used to indicate the behavior of the OS pin output of the temperature sensor.

- Default state: alarm OFF
- Temperature reaches above over saturation temperature (Tos): alarm LIGHTS UP
- Temperature reaches below Thys: alarm OFF

On the motherboard this alarm signal is shown by the D5 LED. This is a RED colored LED which turns on whenever there is an alert signal from the sensor and turns off when the alert is not present.

5.3.2 GUI Window for STTS424E02 sensor

STTS424E02 is a simple digital temperature sensor also having on chip 2 Kb EEPROM. The GUI for STTS424E02 also has an option for supporting the STTS424 without EEPROM.

Below are the steps to operate the STTS424E02 sensor in GUI mode:

- Plug the daughter card of the STTS424E02 into the motherboard
- Select for STTS424/STTS424E02 sensor option from the GUI as shown in *Figure 9*
- Select STTS424E02 sensor radio button from sensor options in Select the Temperature Sensor area in the GUI. On selecting the STTS424E02 sensor, the Edit EEPROM option also gets enabled on the GUI
- Check the address from Choose Address area. If the address configured on the board (explained in *Section 4.2.1*) is different from the address selected from the GUI, an

error message appears on the GUI. In case of error, re-check the address with the correct option.

- All the registers show the default readings at first selection
- Press the Loop button to continuously read the temperature on the GUI
- Configure the different registers through the GUI and observe the behavior of the sensor

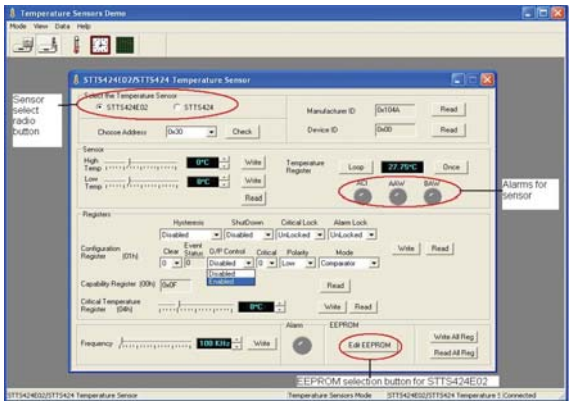
Register configuration for the STTS424E02 sensor

There are 4 read/write registers in the STTS424E02 temperature sensor:

1. Configuration register:
   - The GUI has drop down buttons for bits of the configuration register. Select for the desired bits in the configuration register
   - Press the Write button to program the sensor with the selected value. *Figure 14* shows the settings
2. Upper temp register:
   - This register is used to enter the alarm temperature upper boundary settings for the sensor
   - Enter the desired temperature using the slider or through the up/down button
   - Press the Write button to program the sensor with the selected temperature. *Figure 14* shows the settings
3. Lower temp register:
   - This register is used to enter the alarm temperature lower boundary settings for the sensor
   - Enter the desired temperature setting using the slider or the up/down button
   - Press the Write button to program the sensor with this value. *Figure 14* shows the settings
4. Critical temperature register:
   - This register is used to enter the critical temperature settings for the sensor
   - Enter the desired temperature setting using the slider or the up/down button
   - Press the Write button to program the sensor with this value. *Figure 14* shows the settings
5. Temperature register (read only):
   - This register is used to show the temperature measured by the sensor
   - The Once button is used to read the temperature at any one instant
   - The Loop button is used to continuously measure and display the temperature.

There is a slider for setting the frequency of I^2C communication for sensor communication and it is fixed to default 100 kHz. In order to avoid communication failure, this slider does not affect the frequency in the sensor.

Figure 14. Configuration of the STTS424/STTS424E02 sensor



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Alarm setting for the STTS424/STTS424E02 sensor

There are 3 alarms in the STTS424E02 sensor:

1. Below Alarm Window (BAW):

This alarm occurs when the measured temperature goes below the temperature setting in the alarm temperature lower boundary register (lower temp register). This alarm lights up as the BAW alarm on the GUI. As the measured temperature becomes greater than the below alarm window setting the alarm switches off.

2. Above Alarm Window (AAW):

This alarm occurs when the measured temperature goes above the temperature setting in the alarm temperature upper boundary register (upper temp register). This alarm lights up as the AAW alarm on the GUI. As the measured temperature becomes lower than the above alarm window setting the alarm switches off.

3. Above Critical Temperature (ACI):

This alarm occurs when the measured temperature goes above the temperature setting in the critical temperature register. This alarm lights up as the ACI alarm on the GUI. As the measured temperature becomes lower than the critical alarm setting the alarm switches off.

Note: The Alarm icon lights up on the GUI only when the O/P Control bit is enabled in the configuration register and one of the above mentioned alarms has occurred, and then only the alarm LED on the board (D5) turns on.

BAW, AAW, ACI alarms status can be seen on the GUI either in Once or Loop mode. Pressing of the Once button shows the instantaneous alarm conditions and latches the same on the GUI. This condition is refreshed by again pressing the Once button. The Loop button pressed continuously monitors the alarm condition and displays it on the GUI. Stopping the Loop button latches the last condition of the alarm over the GUI. These are refreshed by again using the Loop or Once read button. For the first time address check, the default state of the upper temp register, lower temp register and critical temp register is 0x00, therefore alarm conditions for the AAW and ACI are met and so these are seen as turning on the GUI.

Note: The alarm is observed only when the register settings follow this order: Critical temperature > above alarm window temperature > below alarm window temperature.

Note: To observe the alarms occurring on the board, the O/P control bit should be enabled in the configuration register.

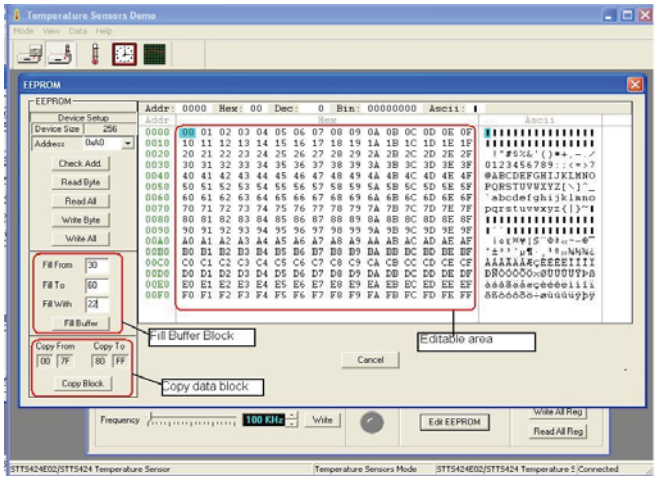
EEPROM setting for the STTS424E02 sensor

The STTS424E02 sensor has on chip EEPROM of 2 Kb size. For the STTS424E02 sensor selected on the GUI, the Edit EEPROM button is enabled. The EEPROM window opens by clicking this edit EEPROM button.

Below are the steps for using the EEPROM for the STTS424E02 sensor:

- Check the eeprom address. The last three bits of the eeprom address are derived from the last 3 bits of the temperature-sensor address.
- For correct address checked, the GUI for eeprom gets enabled with an editable area for 256 bytes.
- To read the data byte at any specific location, select the location in the editable window and press the read byte button, it reads the selected location data from the sensor eeprom and displays at the location in the editable area on the GUI.
- The Read All button reads all the 256 bytes from sensor eeprom and displays it in the editable area
- To write a single byte at a specific location, change the byte value by typing and press the enter button on the computer. Then press the write byte to write the data into eeprom.
- To write all the 256 bytes of eeprom, press the Write All button on the GUI. This writes the bytes as seen in the editable box. To change the bytes in the editable box, type the new value and press enter and then go to type a new value to other location. After all the values are changed according to the requirement, press Write All to program the values in eeprom.
- Fill Buffer is used to fill the area of eeprom with the same data byte. Type the memory location from where the data is to be written and also the destination memory location address. Then enter the data byte in fill with area. Pressing the fill buffer button programs the eeprom selected area with the selected data byte. This data byte can be seen on the GUI by pressing the read all button.
- Copy block is used to copy the data from memory location 0x00 -0x7F to location 0x80-0xFF. Therefore both upper and lower 1 Kb data is similar after the copy block command. Settings for eeprom on the STTS424E02 sensor is shown in *Figure 15*.

Figure 15. EEPROM setting for STTS424E02



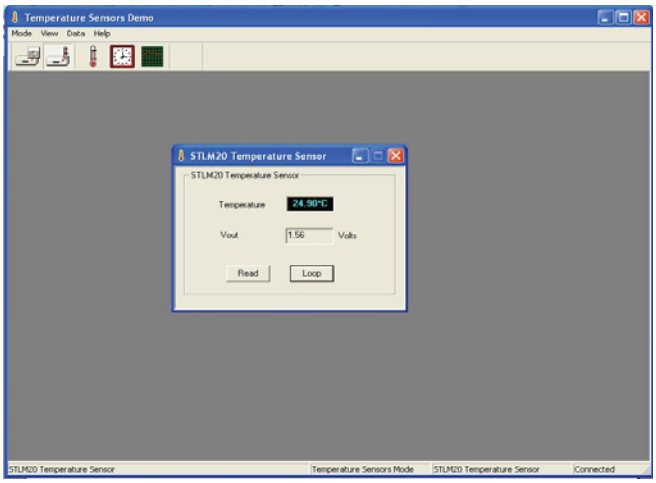
AM03618v1

5.3.3 GUI Window for the STLM20 sensor

The STLM20 is an analog temperature sensor. Below are the steps for using the GUI for the STLM20:

- Plug the STLM20 daughter card into the motherboard
- Select the STLM20 sensor on the GUI as seen in *Figure 16*
- The Once button reads the voltage output value from the sensor and displays the respective temperature on the GUI
- The Loop button continuously reads the voltage from the STLM20 and displays the corresponding temperature

Figure 16. GUI Window for STLM20 temperature sensor



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5.4 RTC mode of GUI

On powering up the board, the RTC clock is seen as halted and shows the time at which the power was put down. The clock starts running only after resetting the HT bit in the RTC GUI window. In standalone case, the HT bit is handled in firmware.

RTC date and time setting

Click on the Clock icon in the toolbar of the GUI. The RTC selection radio button appears on the GUI as shown in *Figure 17*.

- Select for RTC M41T81s and the RTC child window opens, as shown in *Figure 18*
- The Update button is used to enable the configuration of the RTC. Pressing the Update button enables the GUI window for RTC configuration. It also reads the RTC registers from the on-board RTC and displays the same on the GUI
- After pressing the Update button, reset the HT bit to see the clock ticking on the display.
- The user can configure the RTC Date and Time by clicking on the Set Time button on the GUI. It programs the on-board RTC with the system date and time
- CEB, Stop Bit, OFIE Bit are check boxes to enable or disable the respective bit in the RTC. Checking the box and then pressing the Write button sets the bits and un-checking them and clicking on Write button resets the bits
- The Program button configures the RTC with the current settings visible over the GUI
- The RTC Reg button shows the RTC registers and the values present in those registers, as shown in *Figure 19*.

Figure 17. RTC selection Window

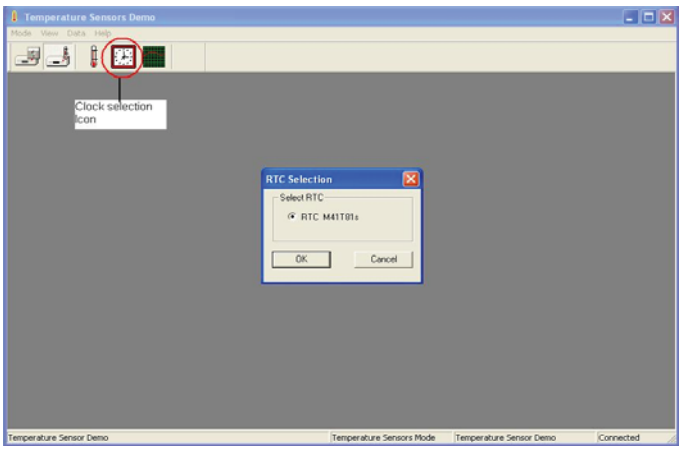

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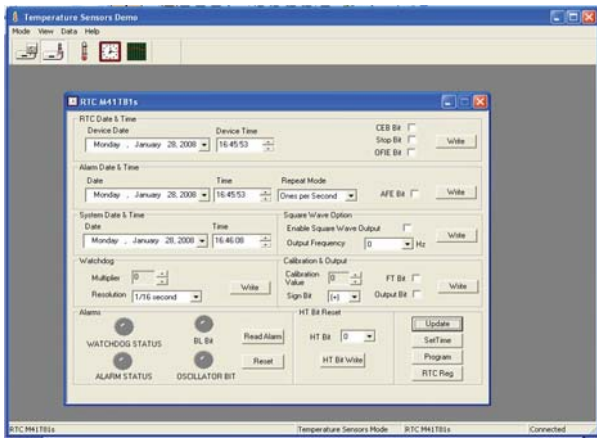
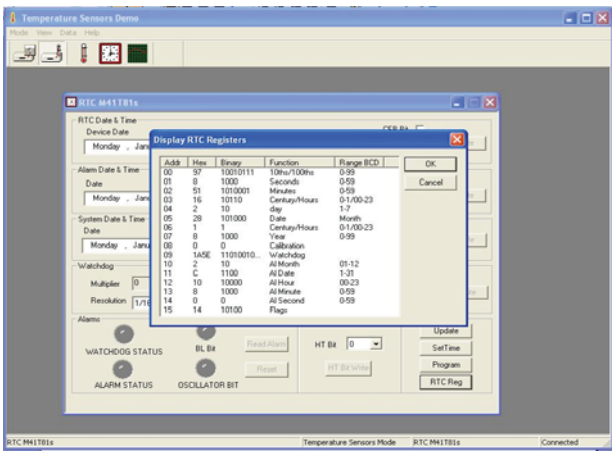
Figure 18. GUI window for RTC



AM03621v1

Figure 19. RTC register



AM03622v1

5.4.1 RTC alarm setting

- Set the alarm date and time using the alarm section in the RTC GUI window
- Check the AFE bit to observe the alarm output on the IRQ pin of the RTC on the board. If the AFE bit is not set then in alarm condition, the alarm flag is set in FLAG REGISTER of RTC but LED D3 on the board does not turn on as there is no active signal on the IRQ pin.
- Press the Write button to enter these alarm settings in the RTC present on the board. Repeat Mode setting is for setting the repetitive alarm.
- Alarm status can be seen on the GUI by pressing the Read Alarm button. Pressing the Read alarm button again clears the alarm register of the RTC and its new status is shown on the GUI.
- The Reset button is used to reset the “OF” (oscillator failure) bit in the alarm register and correspondingly the oscillator bit alarm is also cleared by the reset button.

5.4.2 WATCHDOG

- Watchdog of the RTC is enabled by configuring the Multiplier and Resolution settings and pressing the Write button
- The time period for watchdog is calculated by resolution x multiplier value. This value is in seconds
- The watchdog alarm occurs when the time set in the watchdog register is lapsed
- The status of the watchdog alarm can be seen only by pressing the Read Alarm button. Pressing again clears the WDG flag in the alarm register of the RTC and its status is shown on the GUI

5.4.3 Square wave option

- Square wave of the RTC is configured by setting the frequency in square wave registers.
- Set the output frequency from the drop down menu and check the Enable Square Wave Output check box to observe the square wave on the IRQ pin of the RTC.
- Alarm LED D3 lights up on the board for the square wave output on the IRQ pin.

Note: If the enable square wave output check box is not checked then there is no square wave at the IRQ pin of the RTC and hence the alarm LED D3 does not light up on the board.

5.4.4 Calibration and output

- Enter the calibration value between 0-31 in the calibration register.
- Select the positive or negative calibration by selecting the sign in the Sign Bit drop down menu.
- Press the Write button to configure the RTC calibration register with the selected settings.

5.4.5 HT bit reset

At every power down the HT bit is set and re-powering the RTC has HT bit set. To start the display of the clock on consecutive powering, HT bit should be reset each time.

- HT bit set and reset option is selected from the drop down menu
- Setting the HT bit halts the clock display of the RTC
- Resting the HT bit resumes the clock display of the RTC.

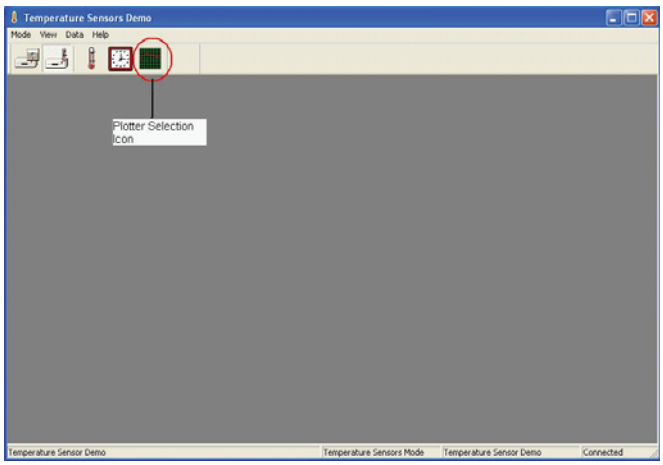
5.4.6 FT bit and output bit

- FT bit is a check box, if none of the RTC interrupt functions (alarm/WDG/SQW) are selected then checking this box selects the frequency test function of the RTC and it is displayed by the D3 LED lighting up. Resetting the bit switches off the frequency test function
- The Output Bit check box is used to demonstrate the output driver function of the RTC. If none of the alarm functions (alarm/WDG/SQW/FT) are selected then checking this bit gives high level on the IRQ pin of the RTC and therefore the D3 LED does not turn on whereas resetting the check box results in the turning on of the D3 LED on the motherboard.

5.5 Plotter mode

There is a plotter icon in the toolbar, as shown in *Figure 20*. Click on this icon to open the plotter application on the GUI. This plotter can be used to plot the temperature variation with respect to time in real time (dynamic mode) or the temperature data can be stored on the board NAND flash and then can be plotted at latter times (NAND mode).

Figure 20. Plotter selection Window



5.5.1 Dynamic mode

Dynamic mode of the plotter is used to plot the real time temperature variation with respect to time. In this mode the sensor measures the temperature at selected frequency and, in parallel, plots that temperature on the graph.

Steps to be followed to plot the graph in dynamic mode:

- Select the dynamic mode from the mode selection drop down menu in the plotter window
- Select the desired frequency (200 millisecond/500millisecond/1 second /10 second) from the Time Interval drop down menu. This frequency denotes the timing interval after which the next reading is taken and plotted on the graph.
- Click on the play button in the toolbar. It opens the plotter and starts plotting the graph, as shown in *Figure 21*.
- To stop the plotting, click on the stop button located in the toolbar.
- Use the toolbar present on the graph window to expand or compress the scale on the graph. This is shown in *Figure 22*.
- To store the image of the graph on computer, click on the floppy icon in the toolbar of the plotter window. It stores the graph as a .tsg format.
- To store the graph data as text format in an excel sheet, click on the excel sheet icon in the toolbar. It saves the temperature readings in an excel format.
- In order to see the previously stored graphs, click on the folder icon in the toolbar and open the .tsg file.

Figure 21. Plotter window for dynamic mode

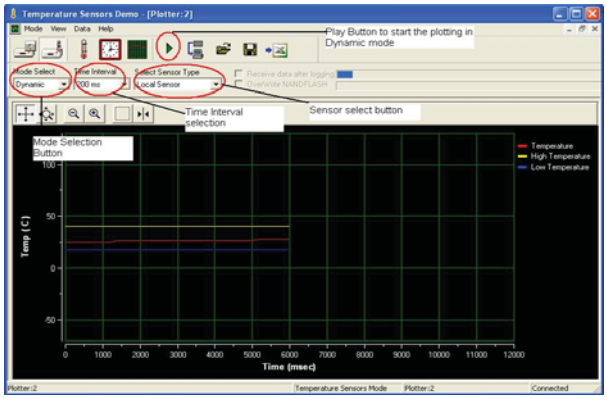
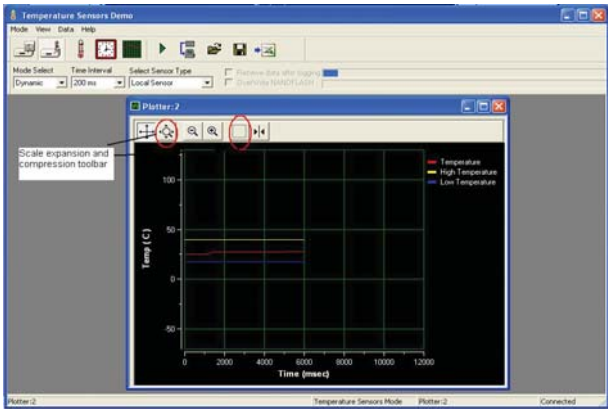


Figure 22. Plotter window with dynamic mode graph



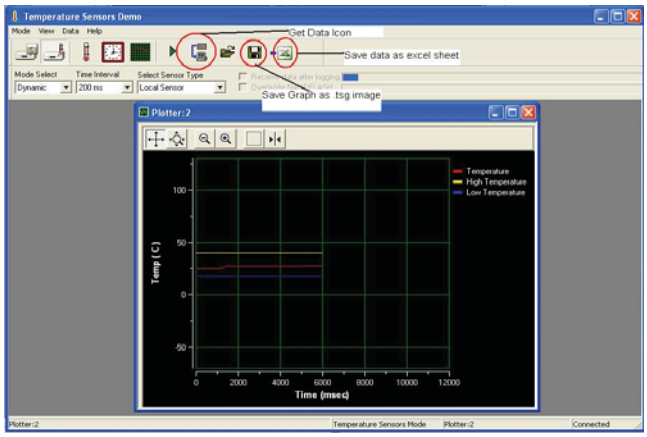
5.5.2 NAND mode

- This mode is used for logging the temperature data in the NAND flash present on the board. This logged data can be viewed at latter times in the graphical format in this window
- Select the NAND mode from the mode selection drop down menu in the plotter window
- Select for the desired frequency (200 millisecond/500 millisecond/1 second /10 second) from the Time Interval drop down menu. This frequency denotes the timing interval after which the next reading is taken and stored in the NAND flash
- Click on the Play Button in the toolbar. It starts logging the data in the NAND flash present on the board. A total of 100 Kb of NAND flash is used for data logging. The percentage of NAND filled is shown by the status bar in the toolbar of the plotter

window. The first status bar shows that data is being logged while the second status bar shows the percentage of data logged

- To stop the data logging click on the stop button in the toolbar
- To read the logged data from the on-board NAND, click on the Get Data icon in the toolbar. It reads the data form board and then plots the graph of temperature versus time. This is shown in *Figure 23*
- Use the toolbar present on the graph window to expand or compress the scale on the graph
- To store the image of the graph on computer, click on the floppy icon in the toolbar of the plotter window. It stores the graph as .tsg format
- To store the graph data as text format in an excel sheet, click on the excel sheet icon in the toolbar. It saves the temperature readings in excel format
- In order to see the previously stored graphs, click on the folder icon in the toolbar and open the .tsg file
- If the user wants that the graph should be plotted as soon as the data logging is stopped, then the check box Receive Data After Logging should be checked before starting the data logging (i.e. before clicking the PLAY button)
- Checking the Overwrite NAND FLASH overwrites the data in NAND flash in case the whole of the 100 Kb gets filled. Therefore in this case the user looses the previously stored data.

Figure 23. Plotter window with NAND mode



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Note: At each logging of data in the NAND flash, previously stored data is lost and the NAND flash is overwritten starting with new data.

5.6 Application LED's

There are 5 application specific LED's on the board:

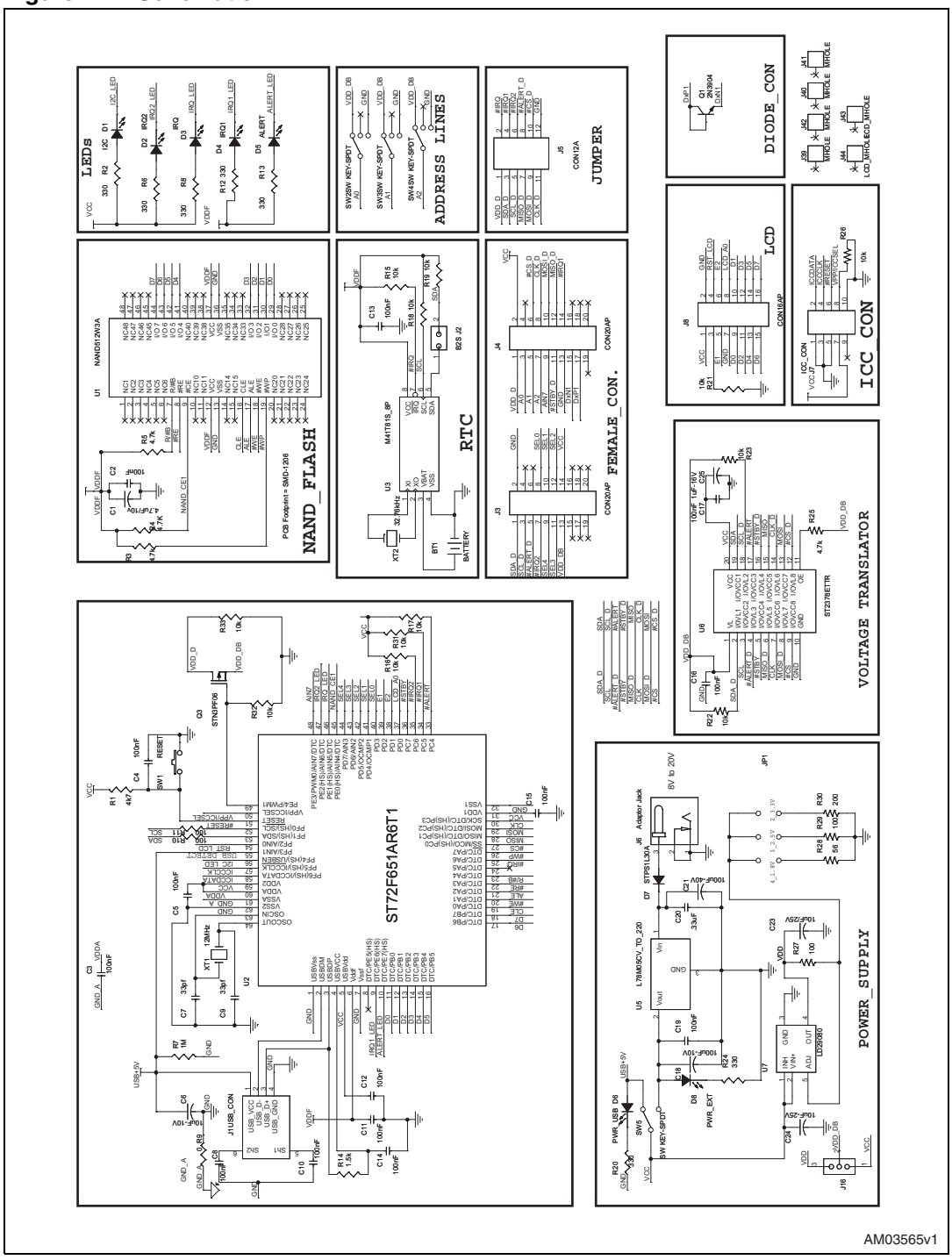
- I^2C LED: This is a green colored LED (D1) which blinks whenever there is an I^2C communication occurring in the application
- IRQ LED: This is a red colored LED (D3) which turns on in accordance to the signal status on the IRQ pin of the RTC
- Alarm LED: This is a red colored LED (D5) which turns on in accordance with the alarm output signal of sensors
- Power_USB LED: This is a red colored LED (D6) which turns on as soon as the USB cable is plugged in
- Power_EXT LED: This is a green colored LED (D8) which turns on as soon as an external adapter is plugged into the DC adapter jack.

Appendix A Schematic and bill of material

A.1 Schematic

This is a schematic for the motherboard.

Figure 24. Schematic



A.2 Bill of material

Table 6. BOM

Ref. designator	Component description	Package	Manuf.	Manufacturer's ordering code / orderable part number	Supplier	Supplier ordering code	Comment
U1	NAND FLASH	TSOP48	Numonyx	NAND512W3 A2BN6E	Farnell	1224401	
U2	Microcontroller	TQFP64	ST	ST72F651AR 6T1E			
U3	RTC	SO8	ST	M41T81SM6E			
U5	Voltage regulator	TO-220	ST	L7805CV			
U6	Voltage translator	TSSOP20	ST	ST2378ETTR			Not mounted
U7	Voltage regulator	PPAK	ST	LD29080PT			
Q3	PMOS	SOT-223	ST	STN5PF02V			STN5PF02 is in MAT50 status. We can replace it with STN3PF06
D7	Schottky diode	SMA	ST	STPS1L30A			
Q1	npn transistor	Through hole	Any	2N3906			
XT1	Crysal 12 MHz	Through hole	Any				
XT2	32.768 kHz	Through hole	Any				
RESET	Push button	Push button	Any				
J1	USB connector	Through hole	Any				
J2,J3	Daughter card connector	Through hole	Sametec	TFC110X1-L-D	Integrated Electronics	TFC110X1-L-D	
J5	SIP-10 (berg strip)	2 x SIP6	Any				
J6	Adapter Jack	Through hole	Any				
J7	Header 5X2	IDC-10B	Any				

Table 6. BOM (continued)

Ref. designator	Component description	Package	Manuf.	Manufacturer 's ordering code / orderable part number	Supplier	Supplier ordering code	Comment
J8	LCD Connector	SIP-16 (berg strip)					
D2,D3,D4, D6	Red LED	LED-3 mm	Any				
D1,D8	Green LED	LED-3 mm	Any				
D5	Blue LED	LED-3 mm	Any				
C1	Capacitor(electrolytic)/4.7 µF	SMD	Any				
C2,C3,C4, C5, C8,C10, C111, C12,C13, C14,C15, C16,C17, C19	100 nF	SMD0805	Any				
C6	Electrolytic (10 µF/10 V)	SMD	Any				
C7,C9	33 pF	SMD0805	Any				
C18	Electrolytic (100 µF/ 10 V)	SMD	Any				
C20	0.33 µF	SMD0805	Any				
C21	100 µF/40 V	SMD	Any				
C23	10 µF	SMD	Any				
C24	10 µF/50 V	SMD	Any				
R1,R3,R4, R5,R25	4.7 kΩ	SMD0805	Any				
R2,R6,R8, R12,R13, R20,R24	330 Ω	SMD0805	Any				
R7	1 MΩ	SMD0805	Any				
R9	0 Ω	SMD0805	Any				
R10,R11	100 Ω	SMD0805	Any				
R14	1.5 kΩ	SMD0805	Any				

Table 6. BOM (continued)

Ref. designator	Component description	Package	Manuf.	Manufacturer 's ordering code / orderable part number	Supplier	Supplier ordering code	Comment
R15,R16, R17,R18, R19,R21, R22,R23, R26,R31	10 kΩ	SMD0805	Any				
R27,R29	100 Ω	SMD0805	Any				
R28	200 Ω	SMD0805	Any				
R30	56 Ω	SMD0805	Any				
R32	100 kΩ	SMD0805	Any				
LCD	Graphical LCD		Techstar	TS12232C	Techstar	TS12232C	
SW2,SW3, SW4	DP3T switches	Through hole	ALPS	1123868	Farnell	STSSS2121	
SW5	SPDT switch	Through hole	EAO	674345	Farnell	09-03290-01	
BT1	Battery connector + battery (3 V)	Through hole	Any				

Appendix B Abbreviations

Table 7. Abbreviations

Abbreviation	Term
GUI	Graphical user interface
LCD	Liquid crystal display
USB	Universal serial bus
RTC	Real time clock
°C	Degree centigrade
EEPROM	Electrically erasable programmable read only memory
Kb	1024

Revision history

Table 8. Document revision history

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

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