



**Set-top box front panel evaluation board based on
the STLED316S**

Introduction

This document explains the operation of the front panel evaluation board based on the STLED316S that consists of the LED driver/controller STLED316S and microcontroller ST7LITE39F2 as SPI master. The basic idea is to develop a front panel for set-top boxes which is very close to the available solutions on the market.

The objective of this evaluation board is to display the capabilities of ST's LED controller/driver STLED316S to fit the market segment of front panels for HTiB (Home Theater in a Box), set-top boxes and other applications that require a compact, integrated solution, keeping the system cost as low as possible.

The system can be operated using the various front panel keys provided on the system.

In the sections that follow the operation of the system is explained. When the board is connected to the power supply, the system gets ready to perform any operation.

At the time of manufacturing an additional board has been connected to allow in-circuit programming of the microcontroller. The two can be easily broken apart so that the front panel board can be used independently.

To summarize, the key features of the evaluation board are:

- 8-segment, 6-digit customized LED display
- 8-segment bar graph LED display
- 7 front panel keys
- 2 LEDs (green for power and red for interrupt)
- 1 potentiometer for adjusting the brightness of the display
- 1 RESET switch to reset the whole system
- DEMO mode for making the system self-performing and user independent
- Embedded in-circuit programming capability

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1 Getting started

1.1 System requirements

The system operates in standalone mode by powering externally using a power supply adaptor with a voltage range of 8 V - 19 V and current capability of at least 500 mA.

Note: Do not run the demo for a long period at higher input voltage (>12 V) due to excessive heating of the voltage regulator (U1). If required, attach a suitable heat sink.

1.2 Package content

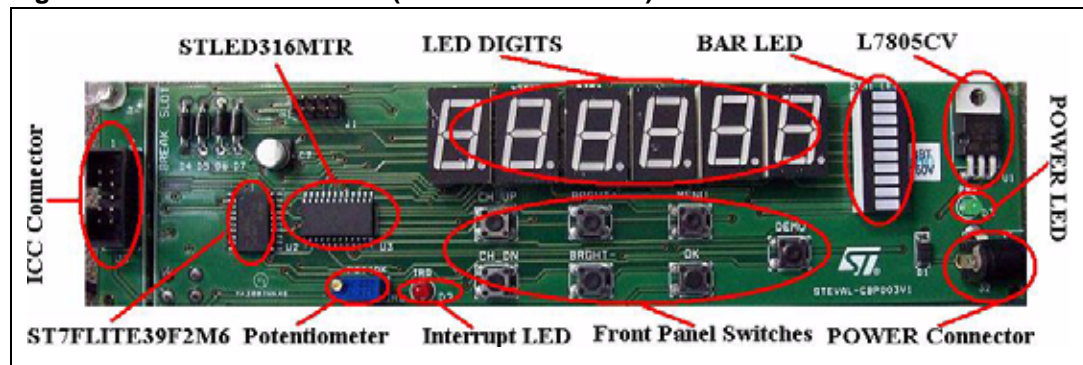
The evaluation board package includes the following:

- Hardware
 - One evaluation board
- Documentation
 - User manual

1.3 Hardware Installation

The evaluation board can be powered through an external power supply adaptor having two outputs (8 V - 19 V and GND).

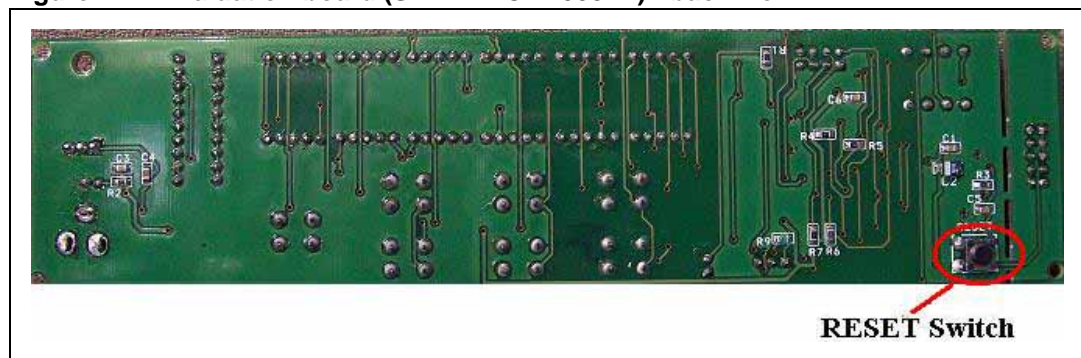
Figure 1. Evaluation board (STEVAL-CBP003V1) - front view



The major components present on the board - front view are (see [Figure 1](#)):

1. External connector for the power supply input
2. 6 common anode LED displays having 8 segments
3. 1 common anode bar graph LED having 8 segments
4. 2 status LEDs - power and IRQ
5. 7 front panel keys
6. LED controller/ driver
7. ST7 microcontroller
8. One potentiometer
9. Voltage regulator
10. Power diode
11. Normal diodes

Figure 2. Evaluation board (STEVAL-CBP003V1) - back view



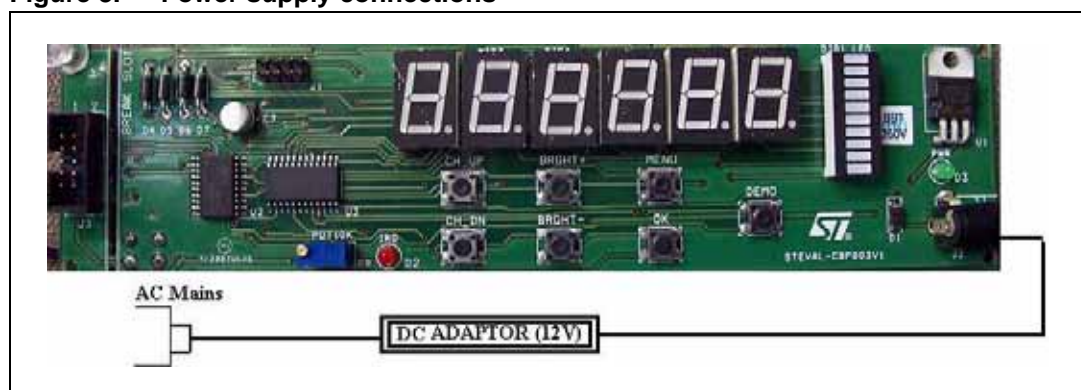
The major component present on the board - back view is (see [Figure 2](#)):

1. RESET switch

1.4 Powering on the system

This system is easy to use. As soon as the DC power supply adaptor is plugged in, the system is up and running. The power supply connections should be plugged in as shown in [Figure 3](#).

Figure 3. Power supply connections



On power-up of the system, the default display sequence is displayed with the default brightness level which is 14/16. (see [Section 1.5](#) and [1.6](#)).

The default display sequence is repeated as long as any key on the front panel is not pressed.

Note: The system is said to be stable after power-up if the default display sequence is executed at least once. As long the system is not stabilized, i.e. Default display sequence is not displayed at least once, the user should not perform any operation.

1.5 Default setting of the system

The system is programmed with following default settings:

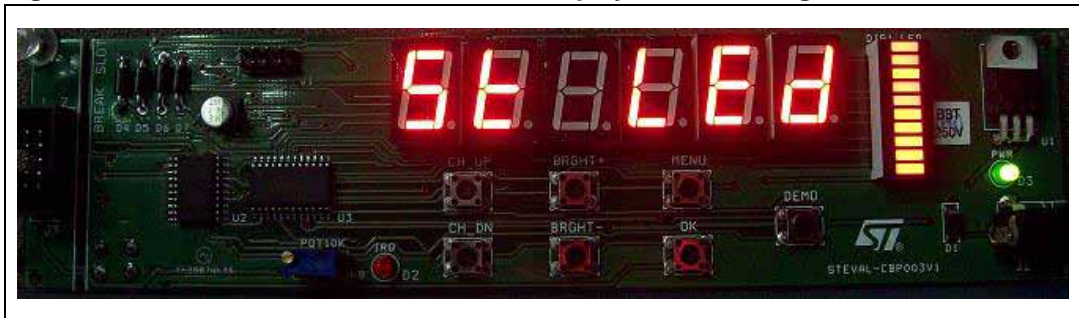
1. Brightness of LED display is set to the maximum level i.e. 14/16.
2. Channel number is set to be the lowest value i.e. channel number 000.

1.6 Default display sequence

A default display sequence has been predefined in the system. Whenever the system is not performing any operation, the system enters the default display sequence which is explained below:

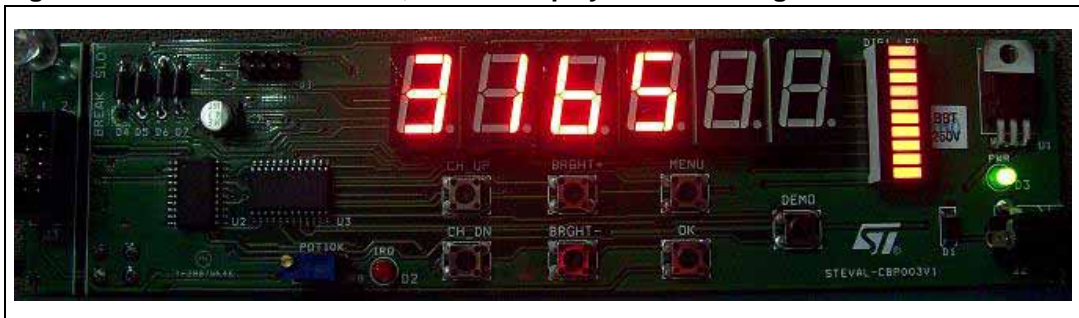
1. Firstly "St LED" appears on the LED display (see [Figure 4](#)).

Figure 4. Power-on condition, "St LED" displayed on LED segments



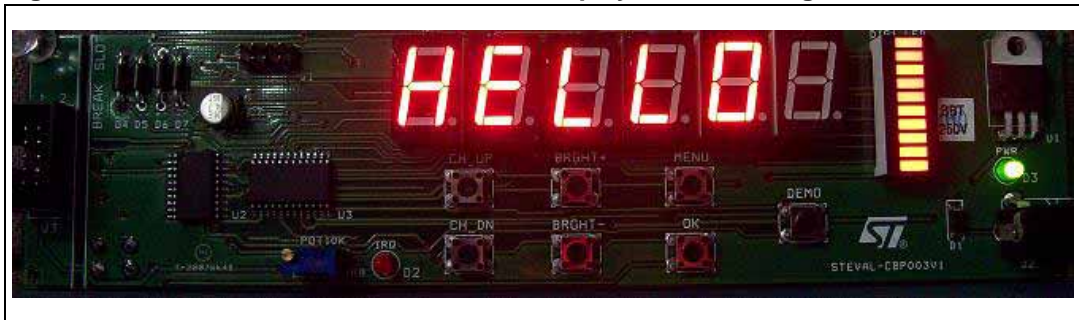
2. After approximately 4-5 seconds "316S" appears on the LED display (see [Figure 5](#)).

Figure 5. Power-on condition, "316S" displayed on LED segments



3. After approximately 4-5 seconds "HELLO" appears on the LED display (see [Figure 6](#)).

Figure 6. Power-on condition, "HELLO" displayed on LED segments



2 System features

The system has been developed to demonstrate the features of the STLED316S device and its use in the front panel of set-top boxes. The main features of the system are explained in this section.

2.1 Selection of channel numbers

The system has the capability to select and display the channel number of the system. The channel number can be changed by using the CH_UP and CH_DOWN keys of the front panel. The channel number can be selected using the 'OK' key of the front panel (see [Section 3.1](#), [3.2](#) and [3.7](#)).

- Note:*
- 1 The information of the selected channel is saved even if the power of the system is OFF. Whenever the system is powered up, the previous channel is selected.
 - 2 The default channel number in the system is 000.

2.2 Selection of brightness of display

The system has the capability to change the brightness of the LED display of the board. The brightness of the display can be varied and selected using two methods which are explained in the following subsections.

2.2.1 Using front panel keys

The brightness of the LED display can be set at any one level by using the 'BRGHT+', 'BRGHT-' and 'OK' keys. At any time any of the 8 brightness level options 1/16, 2/16, 4/16, 10/16, 11/16, 12/16, 13/16, 14/16 can be selected by using these keys.

The brightness of the display can be varied by using the 'BRGHT+' or 'BRGHT-' key of the front panel. The brightness level of the display can be selected by using the 'OK' key of the front panel. (see [Section 3.3](#), [3.4](#) and [3.7](#)).

2.2.2 Using the potentiometer

A resistance potentiometer (POT 10 k Ω , R8) has been provided on the board to vary the brightness of the LED display.

The brightness of the LED display can be decreased by rotating the knob of the potentiometer clockwise.

The brightness of the LED display can be increased by rotating the knob of the potentiometer counterclockwise.

- Note:* By using the potentiometer the brightness of the display can be set at any level irrespective of the specified brightness levels of the STLED316S.

2.3 Selection of display pattern

The system has been provided with the 4 different display pattern options. These display patterns explain the capability of the device STLED316S to control the various digits and segments independently.

The 4 display pattern options are:

- constant display - constant BAR
- variable display - constant BAR
- constant display - variable bar
- variable display - variable bar

Any of the display patterns can be selected using the 'MENU' and 'OK' keys of the front panel (see [Section 3.5](#) and [3.7](#)).

2.4 DEMO mode

To make the system user independent a 'DEMO' mode has been provided. The system can be put into the DEMO mode by pressing the 'DEMO' key of the front panel. In this mode all the display patterns and the welcome message are displayed in continuous loop. The system can be made to exit the DEMO mode by pressing the 'OK' key (see [Section 3.6](#) and [3.7](#)).

- Note:*
- 1 *When the system is in DEMO mode, all other keys except 'OK' and 'RESET' are disabled.*
 - 2 *On the press of any key (except RESET) of the front panel board, the IRQ LED (RED) blinks once indicating that a key has been pressed.*

3 Using the front panel evaluation board

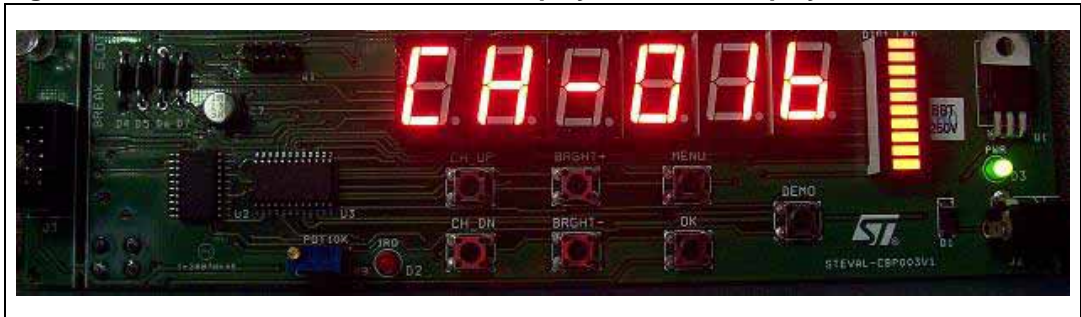
Application keys are the keys on the front panel evaluation board which allow operations to be performed. There are 4 application keys on the evaluation board.

3.1 CH_UP

On pressing the CH_UP key, the system shows the increased channel number by one value on the LED display.

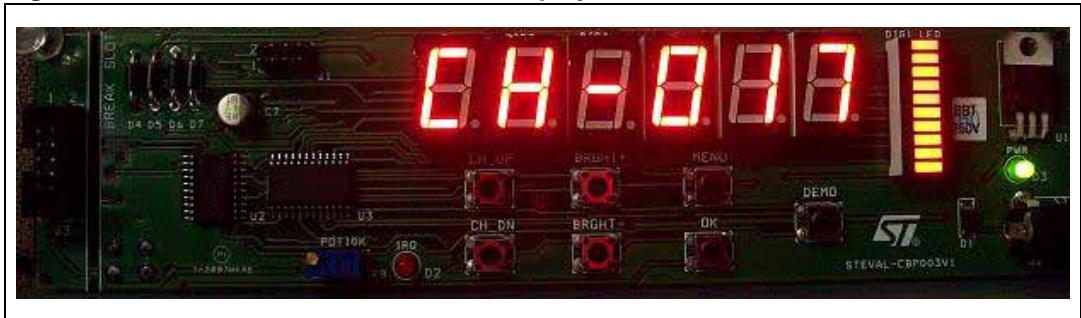
For example if the previous channel selected in the system was 015, then upon pressing the CH_UP key, the increased channel number CH - 016 appears on the LED display, as shown in [Figure 7](#).

Figure 7. Increased channel number displayed on LED display



On a subsequent press of the key, the channel value on the LED display increases, as shown in [Figure 8](#).

Figure 8. Increased channel number displayed on VFD



- Note:
- 1 The channel number increases upon every press of the CH_UP key until the channel number reaches the maximum value of 100. After that, the channel number rolls over to the value 000.
 - 2 To save the channel selected in the system, the user must press the 'OK' key of the front panel, otherwise the channel number will not be saved in the system.

3.2 CH_DOWN

The CH_DOWN is a key which can be used to decrease the channel numbers. When the key is pressed, it shows the decreased channel number by one value on the LED display, as shown in [Figure 7](#).

For example if the previous channel selected in the system was 015, then upon pressing the CH_DOWN key the decreased channel number CH - 014 appears on the LED display, as shown in [Figure 6](#).

On a subsequent press of the key, the channel value on the LED display decreases.

- Note:
- 1 The channel number decreases at every press of the CH_DOWN key until the channel number reaches the minimum value of 000. After that the channel number rolls over to the value 100.
 - 2 To save the channel selected in the system, the user must press the 'OK' key of the front panel, otherwise the channel number will not be saved in the system.

3.3 BRGHT+

On pressing the BRGHT+ key, the brightness of the LED display reaches the next increased level and the value of the brightness level appears on the LED display.

For example if the previous level of the brightness of the LED display was 11 - 16, then upon pressing the BRGHT + key, the brightness of the LED display increases and 12 - 16 appears on the LED display indicating the present brightness value of the LED display, as shown in [Figure 9](#).

Figure 9. BRGHT+ key press



On every press of the BRGHT+ key, the brightness level of the LED display increases until it reaches the maximum value of 14 - 16. If the BRGHT+ key is pressed again, then the brightness of the LED display rolls over and reaches the minimum value of 1 - 16, as shown in [Figure 10](#).

Figure 10. Brightness roll over



- Note:
- 1 By default the brightness level is set at the maximum level (14/16). The STLED316S device supports 8 levels of brightness - 1/16, 2/16, 4/16, 10/16, 11/16, 12/16, 13/16, and 14/16.
 - 2 To set the brightness of the system at any particular level the user should press the 'OK' key when that level is shown on the LED display. If 'OK' is not pressed and any other key is pressed, then the brightness level of the LED display does not change.

3.4 BRGHT-

On pressing the BRGHT- key, the brightness of the LED display reaches the next decreased level. The value of the brightness level appears on the LED display.

For example if the previous level of brightness of the LED display was 11 - 16, then upon pressing the BRGHT - key, the brightness of the LED display decreases and 10 - 16 appears indicating the present brightness value of the LED display, as shown in [Figure 11](#).

Figure 11. BRGHT - key press



On every press of the BRGHT- key, the brightness level of the LED display decreases until it reaches the minimum value of 01 - 16. If the BRGHT- key is pressed again, then the brightness of the LED display rolls over and reaches the maximum value of 14 - 16.

- Note:
- 1 By default the brightness level is set at the maximum level (14/16). The STLED316S device supports 8 levels of brightness - 1/16, 2/16, 4/16, 10/16, 11/16, 12/16, 13/16, and 14/16.
 - 2 To set the brightness of the system at any particular level, the user should press the 'OK' key when that level is shown on the LED display. If 'OK' is not pressed and any other key is pressed, then the brightness level of the LED display does not change.

3.5 MENU

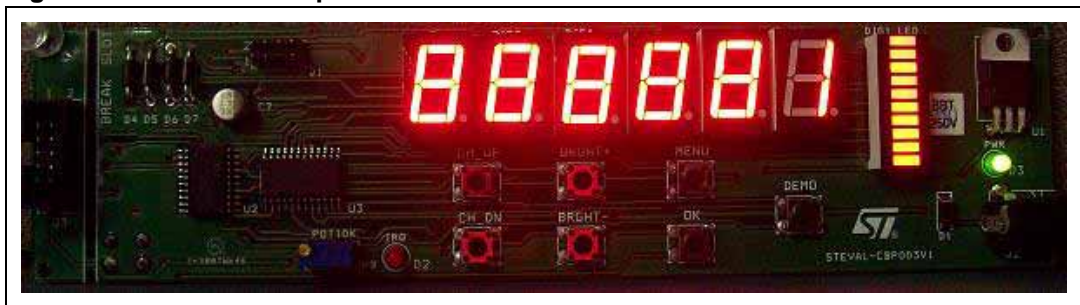
The system has been provided with a MENU key to select one of the various display options supported by the device STLED316S. The four different display options supported by the system are explained in the following subsections.

3.5.1 Constant display - constant BAR

On pressing the MENU key once, the first MENU option is displayed. In this option all the 6-digit LED displays (DIG2 - DIG7) and all the bars of the DIG1_LED have the same constant brightness level which is 14/16.

On the LED display "888881" appears which indicates that the first MENU option is displayed as shown in [Figure 12](#).

Figure 12. First menu option - "888881"



To select this display option for the system, the 'OK' key should be pressed.

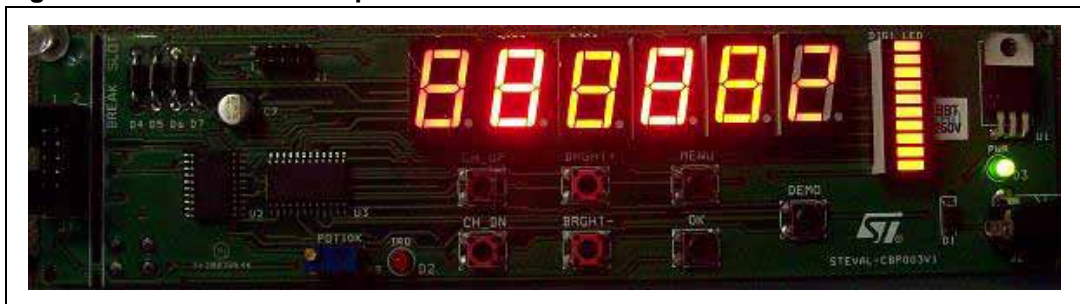
3.5.2 Variable display - constant BAR

On pressing the MENU key twice, the second MENU option is displayed. In this option all the 6-digit LED displays have different brightness levels and the different bars of the DIG1_LED have the same constant brightness level which is 14/16.

Digit LED displays (DIG2 - DIG7) have different brightness levels 1/16, 13/16, 2/16, 11/16, 4/16 and 1/6 respectively.

On the LED display "888882" appears which indicates that the second MENU option is displayed as shown in [Figure 13](#).

Figure 13. Second menu option - "888882"



To select this display option for the system, the 'OK' key should be pressed.

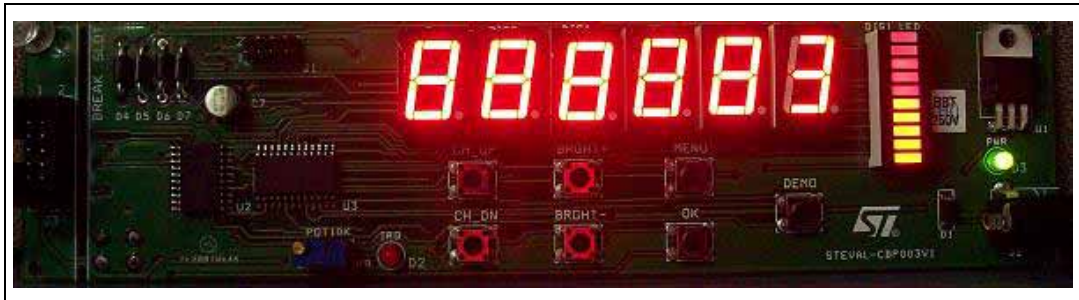
3.5.3 Constant display - variable BAR

On pressing the MENU key three times, the third MENU option is displayed. In this option all 6-digit LED displays have the same brightness level which is 14/16 and the different bars of the DIG1_LED have different brightness levels.

The 10 different bars of the LED1_DIGIT have different brightness levels 1/16, 1/16, 2/16, 4/16, 4/16, 10/16, 11/16, 12/16, 13/16 and 14/16 respectively starting from top to bottom.

On the LED display "888883" appears which indicates that the third MENU option is displayed as shown in [Figure 14](#).

Figure 14. Third menu option - "888883"



To select this display option for the system, the 'OK' key should be pressed.

3.5.4 Variable display - variable BAR

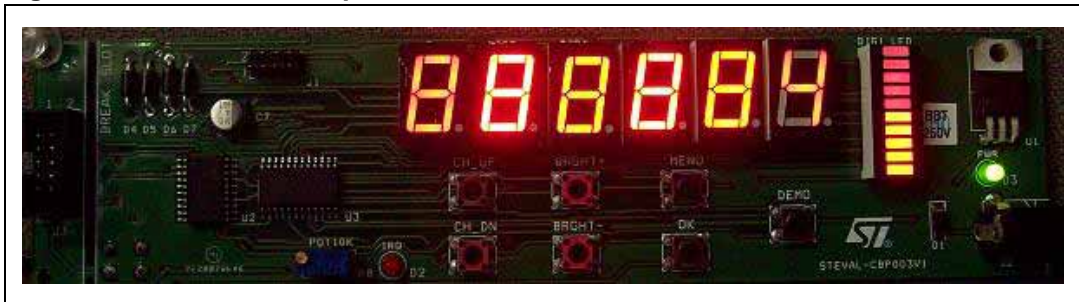
On pressing the MENU key four times, the fourth MENU option is displayed. In this option all 6-digit LED displays and the different bars of the DIG1_LED have different brightness levels.

Digit LED displays (DIG2 - DIG7) have different brightness levels 1/16, 13/16, 2/16, 11/16, 4/16 and 1/6 respectively.

The 10 different bars of the LED1_DIGIT have different brightness levels 1/16, 1/16, 2/16, 4/16, 4/16, 10/16, 11/16, 12/16, 13/16 and 14/16 respectively starting from top to bottom.

On the LED display "888884" appears which indicates that the fourth MENU option is displayed as shown in [Figure 15](#).

Figure 15. Fourth menu option - "888884"



To select this display option for the system, the 'OK' key should be pressed.

3.5.5 EXIT

On pressing the MENU key five times, the fifth option (Exit option) is displayed. In this option only one LED digit is glowing, indicating option 5 as shown in [Figure 16](#).

Figure 16. Fifth menu option - "5"



To exit from the MENU mode of the system, the 'OK' key should be pressed. The system exits with the default display pattern and with the selected brightness level. The default display sequence appears on the LED display.

Note: After the fifth MENU option, if the MENU key is pressed again, the system rolls over to the MENU option one.

3.6 DEMO mode

To show the various display options of the system and, in turn, of the device STLED316S, a DEMO mode key has been provided on the evaluation board.

On pressing the DEMO key, the system enters into a predefined display sequence as explained below:

- MENU option one (see [Figure 12](#))
- Delay
- MENU option two (see [Figure 13](#))
- Delay
- MENU option three (see [Figure 14](#))
- Delay
- MENU option four (see [Figure 15](#))
- Delay
- Default display sequence in the selected MENU option / brightness level

The system remains in the above sequence until the 'OK' key is pressed. The system exits the DEMO mode only when the 'OK' key is pressed.

Note: All keys other than 'OK' and RESET are disabled when the system is in DEMO mode.

3.7 OK

'OK' is a special key on the board which is used to select the various functions and settings of the display. On pressing the 'OK' key, the action performed depends on the previous key pressed which is described in detail in the following subsections.

3.7.1 CHANNEL selection

If the previous key pressed is CH_UP or CH_DOWN, then on pressing the 'OK' key, the displayed channel number on the LED display is selected in the system. The channel number blinks three times indicating the selection of the channel number as shown in [Figure 7](#).

After selection of the channel number the system enters into the default display sequence.

- Note:
- 1 'OK' must be pressed to select the channel number in the system.
 - 2 After pressing the 'OK' key the channel number is stored in the system and on the next power-up of the system, the same channel number is selected.

3.7.2 BRIGHTNESS selection

If the previous key pressed is 'BRGHT +' or 'BRGHT -' then on pressing the 'OK' key, the displayed brightness level on the LED display is selected for the system.

After selection of the brightness level, the system enters into the default display sequence.

- Note:
- 1 'OK' must be pressed to select the brightness level of the display of the system.
 - 2 After pressing the 'OK' key, the brightness level of the display is stored in the system and on the next power-up, the system wakes up with the same brightness level of the display.

3.7.3 Display MODE selection

If the previous key pressed is 'MENU' then on pressing the 'OK' key, the pattern on the LED display is selected for the system. The system remains in the same display pattern until some other pattern or brightness level is selected or the system is powered up again.

- Note:
- 1 'OK' must be pressed to select the display pattern of the system.
 - 2 On every power-up, the system wakes up with the default display pattern (constant display - constant BAR) and with the last selected brightness level.

3.7.4 DEMO MODE selection

When the DEMO key is pressed, the system enters the DEMO mode. The system can exit the DEMO mode only by pressing the 'OK' key.

On pressing the 'OK' key the system exits the DEMO mode and enters into the default display sequence.

- Note:
- 1 All keys except the 'OK' and 'RESET' key are disabled in the DEMO mode.
 - 2 No action is performed if the 'OK' key is pressed when the system is in default display sequence.

3.8 RESET

A 'RESET' switch is provided on the back side of the evaluation board. On pressing the 'RESET' switch all the ongoing functions are interrupted and the system starts from the initial status. The system behaves as if it has been powered up again.

Appendix A Abbreviations

Table 1. Abbreviations

No.	Acronym	Definition
1.	LED	Light emitting diode
2.	ICC	In-circuit communication
3.	GND	Ground

Appendix C Bill of materials

Table 2. BOM

Designator	Qty	Reference	Value / generic part number	Package	Manufacturer/ supplier	Manufacturer's /supplier's ordering code / orderable part number
U3	1	STLED316S LED controller	STLED316S MTR	SO - 24	STMicroelectronics	STLED316SMTR
U2	1	Microcontroller	ST7FLITE39 F2M6	SO – 20	STMicroelectronics	ST7FLITE39F2M6
U1	1	Voltage Regulator	L78M05CV	TO – 220 (A type)	STMicroelectronics	L78M05CV
D1	1	Power diode	STPS1L30A	SMA	STMicroelectronics	STPS1L30A
D4, D5, D6, D7	4	Diode	1N5817	DO41	STMicroelectronics	1N5817
DIG2, DIG3, DIG4, DIG5, DIG6, DIG7	6	7-segment LED display (common anode)	HDSP - 5501	Through hole – 14.2 mm	Agilent Technologies	HDSP - 5501 OR equivalent
DIG1_LED	1	10-segment bar graph LED	HDSP - 4830	Through hole	Hewlett Packard	HDSP - 4830 OR equivalent
SW1	1	Push-button Switches		4-leg through-hole (push-4)	Farnell	535-916
SW2	1	Push-button Switches		4-leg through-hole (push-4)	Farnell	535-916
SW3	1	Push-button Switches		4-leg through-hole (push-4)	Farnell	535-916
SW4	1	Push-button Switches		4-leg through-hole (push-4)	Farnell	535-916
SW5	1	Push-button Switches		4-leg through-hole (push-4)	Farnell	535-916
SW6	1	Push-button Switches		4-leg through-hole (push-4)	Farnell	535-916
SW7	1	Push-button Switches		4-leg through-hole (push-4)	Farnell	535-916
SW8	1	Push-button Switches		4-leg through-hole (push-4)	Farnell	535-916
D2	1	LED (red) - 3 mm		Through-hole	Farnell	322-570
D3	1	LED (green)- 3 mm		Through-hole	Farnell	322-544
J2	1	Power Jack		Through-hole	Any	

Table 2. BOM (continued)

Designator	Qty	Reference	Value / generic part number	Package	Manufacturer/ supplier	Manufacturer's /supplier's ordering code / orderable part number
J1	1	Signal and power headers		SIP-8 (berg strip)	Local	
J3	1	ICC connector		Header5x2/ IDC-10B	Farnell	1106782
R3, R4, R5, R7	4	Resistor-10 k Ω		0805	Any	
R1, R2	2	Resistor-330 Ω		0805	Any	
R6	1	Resistor-2.2 k Ω		0805	Any	
R9	1	Resistor- 470 Ω		0805	Any	
R8	1	Resistor potentiometer 0 – 10 k Ω	3296W-1- 203LF	Through-hole PCB mount	Bourns / Farnell	935 - 3240
C1,C3,C6	3	Capacitor-100 nF		0805	Any	
C5	1	Capacitor-10 nF		0805	Any	
C7	1	Capacitor-33 μ F/ 25 V (Cylindrical)		Cylindrical	Any	
C2	1	Capacitor-10 μ F/ 16 V		Tantalum	Any	
C4	1	Capacitor-330 nF		0805	Any	

Appendix D Connecting an external microcontroller to evaluation board

A jumper J1 has been provided on the board for probing the important signals of the board (see [Appendix B](#)). This jumper can be used to connect an external microcontroller with the evaluation board. Follow the steps below to connect an external microcontroller with the evaluation board:

1. Remove (desolder) the microcontroller ST7FLITE39F2 (U2) from the board.
2. Connect pin number 1 (DIN/DOUT) of jumper J1 to pin DIN/DOUT of the external microcontroller from which data and commands will be sent to the device STLED316S (U3).
3. Connect pin number 2 (CLK) of jumper J1 to pin CLK of the external microcontroller from which the clock signal will be sent the device STLED316S (U3).
4. Connect pin number 3 (STB) of jumper J1 to pin STB of the external microcontroller from which the control signal (STROBE) will be sent the device STLED316S (U3).
5. Connect pin number 4 (IRQ_N) of jumper J1 to pin IRQ_N of the external microcontroller which is configured as interrupt input and will receive the interrupt signals coming from the device STLED316S (U3).
6. Connect pin number 7 (GND) of jumper J1 to the GND pin of the external microcontroller to make a common ground level (reference) for the whole system.

- Note:*
- 1 *The pins of the external microcontroller should have been configured properly as being mentioned in the datasheet of the device STLED316S.*
 - 2 *The operation of the board will depend on the software loaded in the memory of the external microcontroller.*
 - 3 *The setup will not be able to have ICC communication with the external microcontroller using the jumper J3.*
 - 4 *The RESET switch of the board does not work when the external microcontroller is used.*

4 Revision history

Table 3. Document revision history

Date	Revision	Changes
03-Jan-2008	1	Initial release

Please Read Carefully:

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