

STEVAL-ISB011V1, Li-Ion battery monitor and gas gauge based on the STC3100

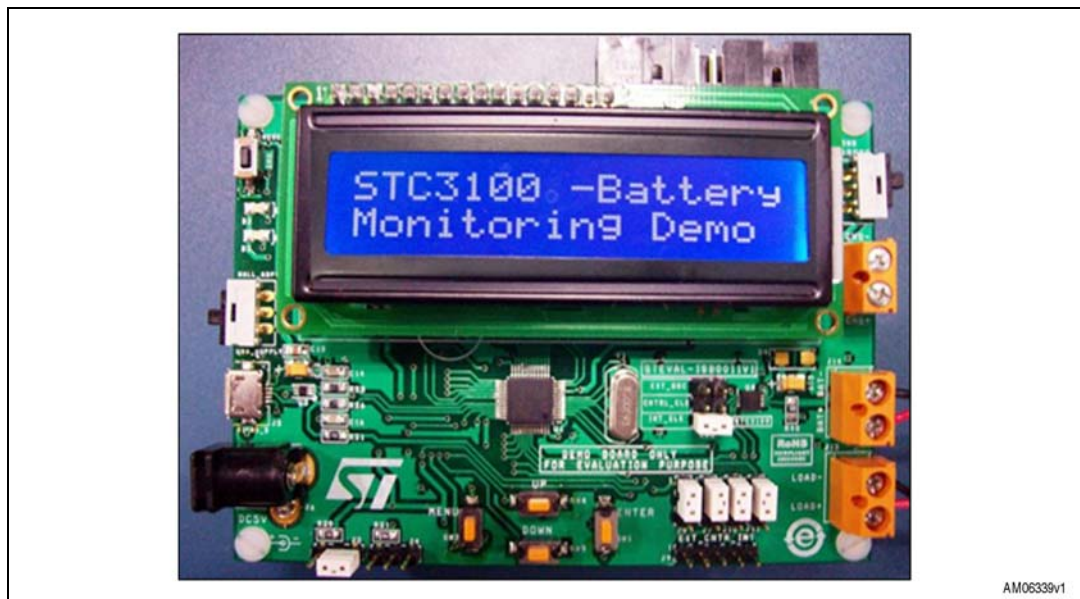
Introduction

This document describes an easy and compact solution to monitor voltage, temperature, current, and capacity of single cell Li-Ion batteries using the STC3100, which has a highly efficient gas gauge. In addition, the board has an internal charger in order to charge the battery. Battery charging can be done through the USB port or by using a DC adaptor.

The board has the following devices:

- Battery monitoring device STC3100
- Microcontroller STM32F102C6
- Voltage regulator LD1117Axx33
- Li-Ion battery charger IC STC4054
- Step-up converter L6920

Figure 1. STEVAL-ISB011V1 Li-Ion battery monitor and gas gauge based on STC3100



Contents

1	Key features	6
1.1	Typical applications	6
2	Getting started	7
2.1	Package	7
2.2	Setting up the board	7
2.3	Hardware layout	8
3	System overview	9
3.1	General description of product architecture	9
3.2	How to start automatic battery capacity learning/detection	10
4	User interface section	11
5	STC3100 settings	14
5.1	How to enter the capacity of the battery	14
5.2	Selecting clock source for STC3100	15
5.3	Status LED description	16
5.4	HyperTerminal settings	16
6	Hardware design description	20
6.1	Microcontroller (STM32)	20
6.2	Battery monitor IC (STC3100)	20
6.3	ESD protection device	21
6.4	Voltage regulator	21
6.5	STC4054 charger IC	22
6.6	Power MOSFET	22
6.7	Reset supervisor	22
7	Connectors and jumpers	23
7.1	JTAG connector	23
7.2	USB connector	24

7.3	Power supply connector	24
7.4	LCD connector	25
7.5	Jumper J7, J8, J10, and J11	25
7.6	Jumper J9 details: connector for external MCU	26
7.7	Clock selection jumper SW6	26
7.8	Jumper J3	26
7.9	Terminal block J12	26
7.10	Terminal block J14	27
7.11	Charger selection switch: SW8	27
8	Hardware schematics	28
9	Bill of material	34
Appendix A	References	38
Revision history	39

List of tables

Table 1.	Charging/discharging status LED (D2)	16
Table 2.	Charging/discharging status LED (D3)	16
Table 3.	Microcontroller details	20
Table 4.	STC3100 details	21
Table 5.	USBLC6 details	21
Table 6.	Voltage regulator	21
Table 7.	Charger IC	22
Table 8.	MOSFET	22
Table 9.	Reset supervisor	22
Table 10.	Pin description of JTAG	23
Table 11.	USB connector pin description	24
Table 12.	LCD connector pinout	25
Table 13.	Selection between onboard and external microcontroller	25
Table 14.	Connector for external MCU	26
Table 15.	Clock selection for STC3100	26
Table 16.	J3 jumper setting	26
Table 17.	Terminal block J12	26
Table 18.	Terminal Block J14	27
Table 19.	Charger selection Switch	27
Table 20.	BOM	34
Table 21.	Document revision history	39

List of figures

Figure 1.	STEVAL-ISB011V1 Li-Ion battery monitor and gas gauge based on STC3100.....	1
Figure 2.	STEVAL-ISB011V1, USB Li-Ion battery charger parts.....	8
Figure 3.	Hardware layout.....	8
Figure 4.	System architecture details.....	9
Figure 5.	Data screen.....	10
Figure 6.	Display tab.....	11
Figure 7.	Welcome message.....	11
Figure 8.	Data screen.....	12
Figure 9.	Main menu.....	12
Figure 10.	Temperature display.....	12
Figure 11.	Voltage display.....	13
Figure 12.	Current display.....	13
Figure 13.	Display message 1.....	14
Figure 14.	Display message 2.....	14
Figure 15.	Display message 3.....	14
Figure 16.	Display message 4.....	15
Figure 17.	Display message 5.....	15
Figure 18.	Display message 6.....	15
Figure 19.	Display message 7.....	16
Figure 20.	HyperTerminal settings 1.....	17
Figure 21.	HyperTerminal settings 2.....	17
Figure 22.	HyperTerminal settings 3.....	18
Figure 23.	HyperTerminal settings 4.....	18
Figure 24.	Dump of data on HyperTerminal settings 4.....	19
Figure 25.	JTAG connector.....	23
Figure 26.	Micro-B USB connector.....	24
Figure 27.	Power supply connector.....	24
Figure 28.	Microcontroller section.....	28
Figure 29.	Clock selection.....	29
Figure 30.	STC4054 battery charger, 3.3 V output.....	29
Figure 31.	LCD power supply switch section.....	30
Figure 32.	JTAG connector, switches and switching MOSFET section.....	31
Figure 33.	Wall adaptor and external oscillator section.....	32
Figure 34.	LCD section and controller selection jumpers.....	32
Figure 35.	USB and 5 V output section.....	33

1 Key features

- STC3100 uses Coulomb counter/gas gauge to keep track of the remaining charge in the battery. The device also reads the charging current, temperature, and voltage of the battery
- Onboard STM32 microcontroller is interfaced with USB, STC3100, LCD, and switches. The battery parameters are sent to the PC via a virtual com port. The board can work without connecting to the PC and parameters are shown locally on the LCD
- Charging and discharging status is displayed by the + and - sign respectively on the LCD and also LED (D2) toggles during charging of the battery and turned off during discharging
- Gas gauge: battery capacity up to +7300 mAh can be monitored (programmable by user)
- Feature of selecting external charger or internal charger for charging the battery using a switch (SW8). This allows the user to use/evaluate the STC3100 using their own charger system
- Onboard charger (STC4054) available to charge the battery
- 4 switches for scrolling through the menu
- Micro-B connector used for communication with the PC to send the various battery parameters. Power from the micro-B connector can also be used to power on the board and to charge the battery using internal charger
- Option of interfacing external microcontroller using jumpers. The onboard battery monitoring device, STC3100, can be disconnected from the onboard microcontroller and the user can connect their own microcontroller to the relevant pins of STC3100 using external connector and jumper selection
- Option for selecting clock source for STC3100 from external oscillator, internal STC3100's clock or from clock generated by internal/external microcontroller (generally PWM/timer output). This is done to save the external oscillator cost.

1.1 Typical applications

- Battery monitoring for handheld devices such as PDAs, mobile phones, MP3 players
- Medical equipment, such as glucometers
- Digital cameras, USB-chargers, digital photo frames
- Consumer applications using a battery.

2 Getting started

2.1 Package

The STEVAL-ISB011V1 demonstration board package includes the following:

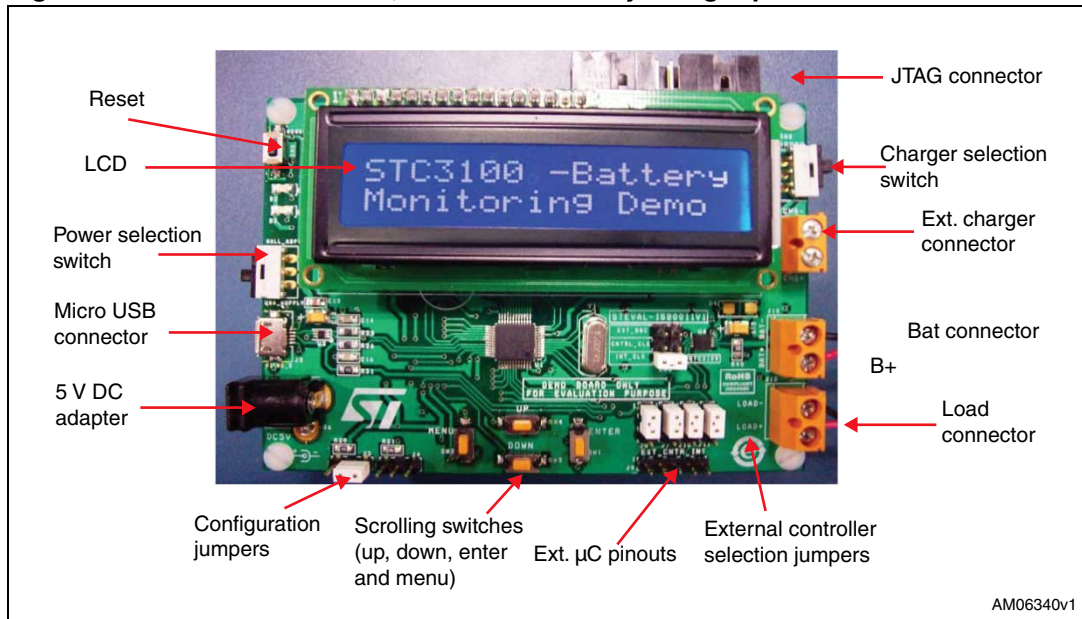
- Hardware content
 - Demonstration board STEVAL-ISB011V1
- Documentation
 - User manual (this document)
 - Schematics, Gerber files, BOM list
- Microcontroller firmware
 - Pre-programmed STM32F102C6 device soldered on the demonstration board
 - Source code is available for the firmware.

2.2 Setting up the board

The Li-Ion battery monitor and charger can be set up as follows:

- Connect the Li-Ion battery pack to the board with appropriate polarity across J14
- Before connecting a battery, set the jumper between pin 1 and 2 of J3. This ensures clearing of the RAM registers of STC3100 and indicates connection of a fresh battery. For details refer to: jumper J3
- The board can be powered up by a power adapter (5 V power supply), by connecting the micro-B cable, or by battery
- Ensure to connect the external power supply source if battery voltage is below cut-off voltage (Cut-off voltage is set to 3.1 V by using STM MOSFET)
- Switch SW7 is used to select between wall adapter or USB as the power source
- To display battery parameters on the HyperTerminal, connect the micro-B cable and open a new HyperTerminal window. Details are given in [Section 5.4: HyperTerminal settings](#)
- If external power source is present, the internal charger can be used to charge the battery using switch SW8
- An external charger can also be connected directly across J12. Switch SW8 is used to select either internal or external charger
- A welcome message (STC3100 battery monitoring demo) is displayed on the LCD during startup. Once again, place the jumper between pin 2 and 3 of J3. For details refer to: jumper J3
- Now use the navigation keys (SW1, SW2, SW3, and SW4) to scroll through the menu.

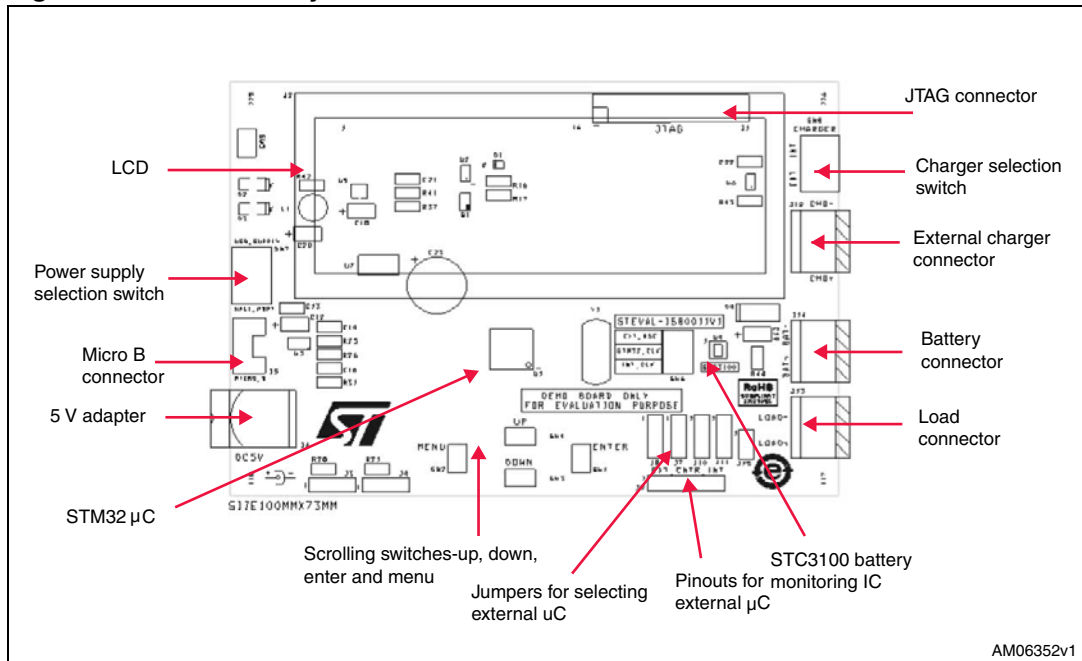
Figure 2. STEVAL-ISB011V1, USB Li-Ion battery charger parts



2.3 Hardware layout

The hardware layout of the PCB is shown in [Figure 3](#), which shows all the components mounted on the board.

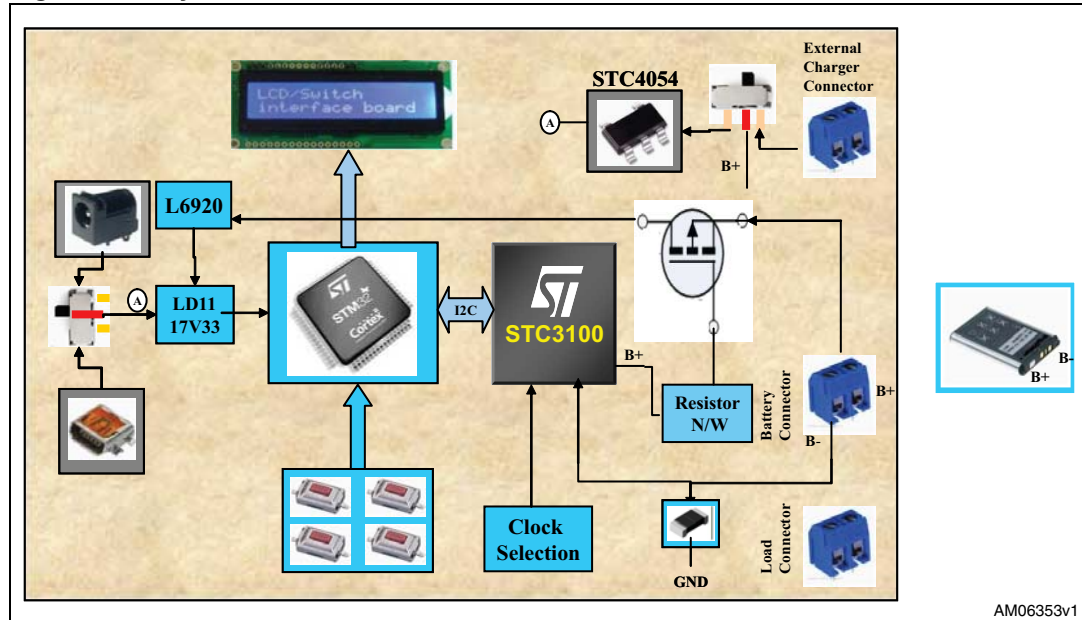
Figure 3. Hardware layout



3 System overview

3.1 General description of product architecture

Figure 4. System architecture details



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- STM32 communicates with STC3100 using I²C communication protocol to obtain information regarding battery capacity, temperature, current, voltage, etc.
- The board is able to run on battery source. When battery reaches its critical voltage the board goes into shutdown mode. To keep track of the battery status, STC3100 is always powered up by battery
- L6920 is configured to step up input voltage to 5 V. Then, LD1117AS33TR produces a constant output voltage of 3.3 V to power on the LCD and STM32
- LCD and switch are used for user interface
- Onboard charger is provided to charge the battery
- Two manual slide switches are provided on the board. SW7 slide switch is used to allow the user to choose only one external power supply at a time i.e. either USB or an external wall adapter
- Second manual slide switch (SW8) is used to select the battery charger, either internal or external
- MOSFET used as a switch is turned on when the board is powered on using battery only. If the battery voltage reaches the critical voltage, the MOSFET is turned off. If any external source (USB or wall adapter) is connected to the board, MOSFET is turned off
- To provide a 32 kHz clock to the STC3100, both the internal clock as well as the external clock options are available. This is selected by external jumper (SW6)
- Whenever the microcontroller accesses the STC3100 registers, LED (D3) blinks and the values are updated

- LED D2 toggles if the battery is in charging position with either an internal or external charger. This LED is turned off if the battery is being discharged and is turned on if the battery voltage is below 3.1 V.

3.2 How to start automatic battery capacity learning/detection

When a new battery is connected it is necessary to calculate the open circuit voltage of the battery. This means there should not be any load across the battery. To achieve this, follow these guidelines:

1. Do not connect external charger with board and change switch position SW8 towards external charger. This ensures that battery is not charged on first connection.
2. Place the jumper between pin 1 and 2 of J3 and then connect the battery. Now, the board acts as a load and consumes power from the battery.
3. Battery parameters appear on the LCD screen as shown in [Figure 5](#).

Figure 5. Data screen



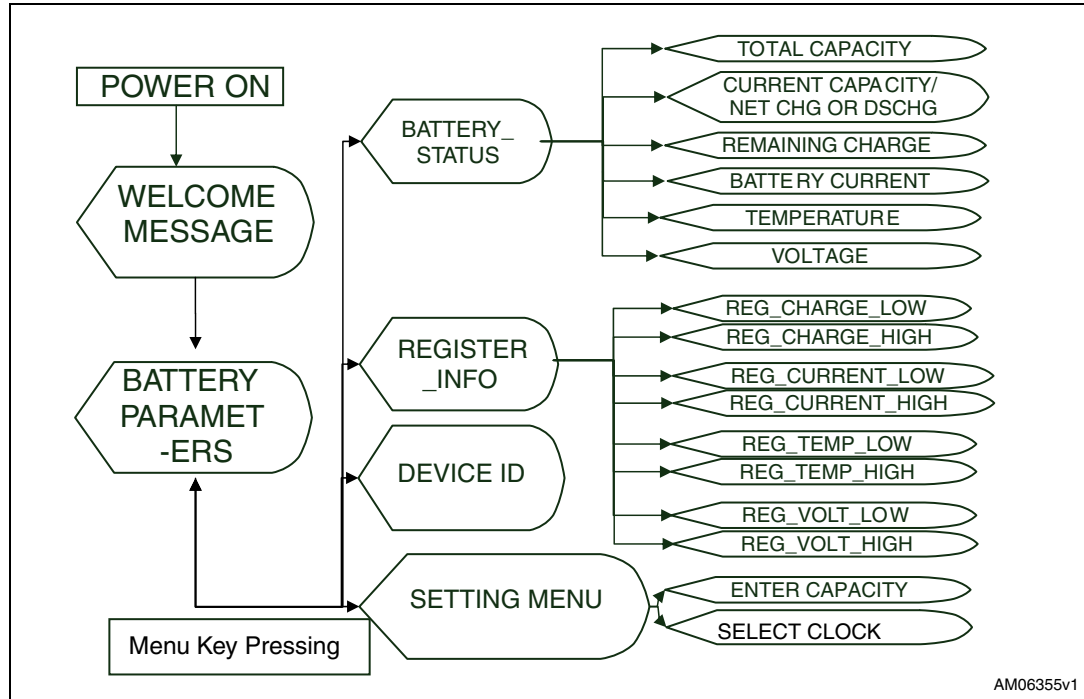
4. Change the jumper position to pin 2 and 3 of J3. Now the default battery capacity (750 mAh) is assumed to be the capacity of the battery.
5. When battery voltage falls below 3.1 V, LED D2 is turned on. This indicates battery in critical condition.
6. Now start the charging process by connecting power source or external battery charger.
7. If charging is still not enabled, battery voltage falls further and, because of the MOSFET, the board enters shutdown mode when battery voltage is around 3.0 V. As a result, board is turned off. But STC3100 is still getting power from the battery.
8. Fully charged condition is achieved when charging current falls below 50 mA for about 30 seconds along with a battery voltage of at least 4.17 V. This can be seen by a change in name from "Total Capacity" to "Actual Capacity". This can be observed on both LCD and HyperTerminal.

Note: *Even if battery charging is stopped in between, there is no problem in actual capacity learning of the battery as all the information is being stored in the RAM registers of STC3100. The only thing to be taken into account is that the battery should not be removed from the system and battery voltage should be above 3.1 V. If any of the conditions are not met, battery capacity learning restarts.*

4 User interface section

There are various options available on the board to display battery status, device ID, register info, etc. [Figure 6](#) shows all the information which it is possible to display on the LCD by using the suitable keys.

Figure 6. Display tab



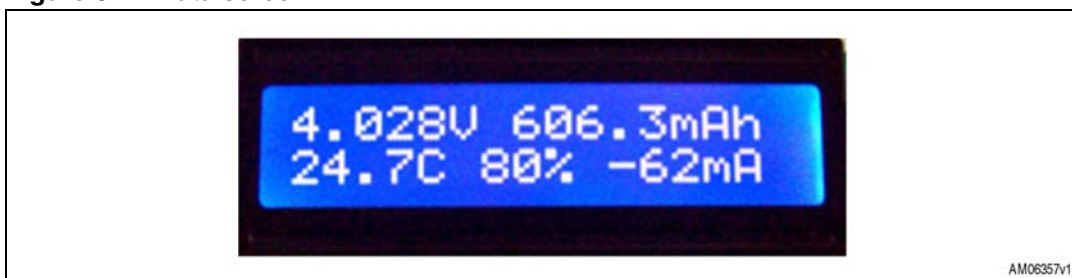
During startup the board displays the message shown in [Figure 7](#).

Figure 7. Welcome message



After some delay, the LCD automatically starts displaying various battery parameters (data screen) as shown:

Figure 8. Data screen



On pressing the menu key, program execution enters MAIN MENU. as shown:

Figure 9. Main menu



While scrolling through the menu, (by pressing the MENU button or navigation buttons) one of the options is always indicated by the arrow mark "<-" as shown in [Figure 9](#). By pressing the ENTER key the corresponding tab is selected which is indicated by arrow mark "<-". To scroll between the different options, use the UP and DOWN switches.

E.g. If TEMPERATURE is being displayed on the LCD screen, as shown:

Figure 10. Temperature display



On pressing DOWN, the LCD displays VOLTAGE.

Figure 11. Voltage display

If the UP key is pressed, then the CURRENT is displayed.

Figure 12. Current display

On pressing the MENU key, control exits all the sub levels and returns to the main menu. And on pressing the MENU key again, the data screen display restarts.

There are 5 switches mounted on the board to scroll through these available options. They are as follows:

- SW1: ENTER switch; to select the currently indicated option by arrow
- SW2: MENU switch; to go to the MAIN menu from any point of the display menu
- SW3 and SW4: DOWN and UP switches; to scroll between the different options displayed on the LCD
- SW5: RESET switch; to reset the microcontroller.

Under the settings menu there are two options: the first is for selecting the clock source for STC3100, while the second is for when the user wants to enter total capacity of the battery.

5 STC3100 settings

5.1 How to enter the capacity of the battery

When a new battery is inserted the user can enter the capacity of the battery. But this is optional. If the user doesn't enter the capacity of the battery, then by default a 750 mAh capacity is considered as the total capacity of the battery and all the data is shown accordingly.

To enter the battery capacity, select the "Settings" tab and select the appropriate option. Now the user is able to see the image shown below:

Figure 13. Display message 1



Using the UP and DOWN switch sets the number. To move to the next digit, press ENTER. When all the digits are set the user is able to see the image shown below:

Figure 14. Display message 2



Press the ENTER switch to continue.

If the total capacity is not entered, and capacity learning is not completed, the user sees the image in [Figure 15](#) on the LCD showing the default capacity.

Figure 15. Display message 3



If the capacity is entered (lets say 740 mAh), and capacity learning is not completed, the user sees the image in [Figure 16](#) on the LCD showing total capacity.

Figure 16. Display message 4



If capacity learning is over, then actual capacity is displayed on the LCD for total capacity.

Figure 17. Display message 5



5.2 Selecting clock source for STC3100

STC3100 requires an accurate clock source of 32.768 kHz and there are three options available to the user in this demonstration board. The first clock is the STC3100's internal clock source, the second is the clock source from an external oscillator and the third is the clock generated by the STM32 microcontroller or from an externally connected source.

Note: By default, STC3100 runs on the internal clock. To change the clock configuration, first go to "Settings" tab. Select the "Select Clock" option. Now, the user is able to see the image in [Figure 18](#) on the LCD.

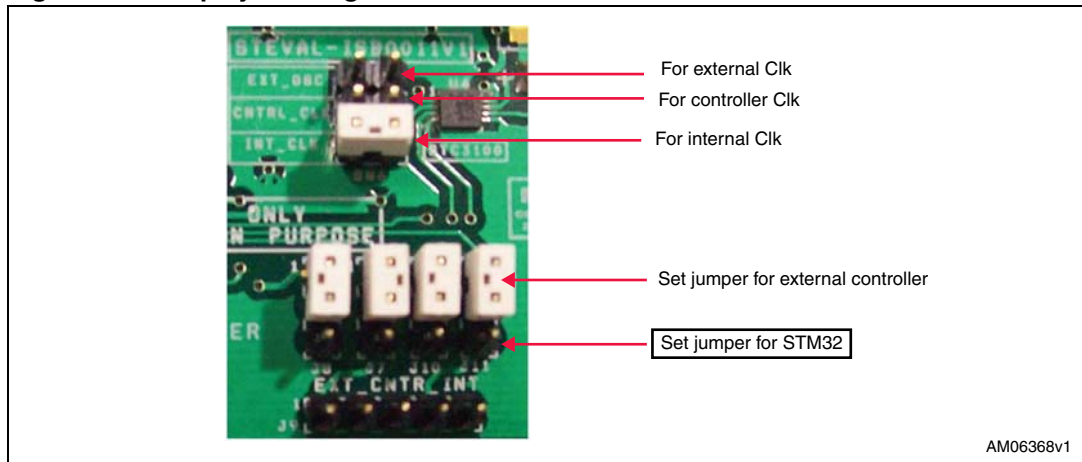
Note: Board has external oscillator footprint.

Figure 18. Display message 6



Now select the appropriate clock and set the jumper accordingly on SW6.

Figure 19. Display message 7



5.3 Status LED description

Table 1. Charging/discharging status LED (D2)

LED	Description	Toggling	Off	On
D2	Charging/discharging status	Charging condition	Discharging condition	Battery in critical condition ($V_{bat} < 3.1\text{ V}$)

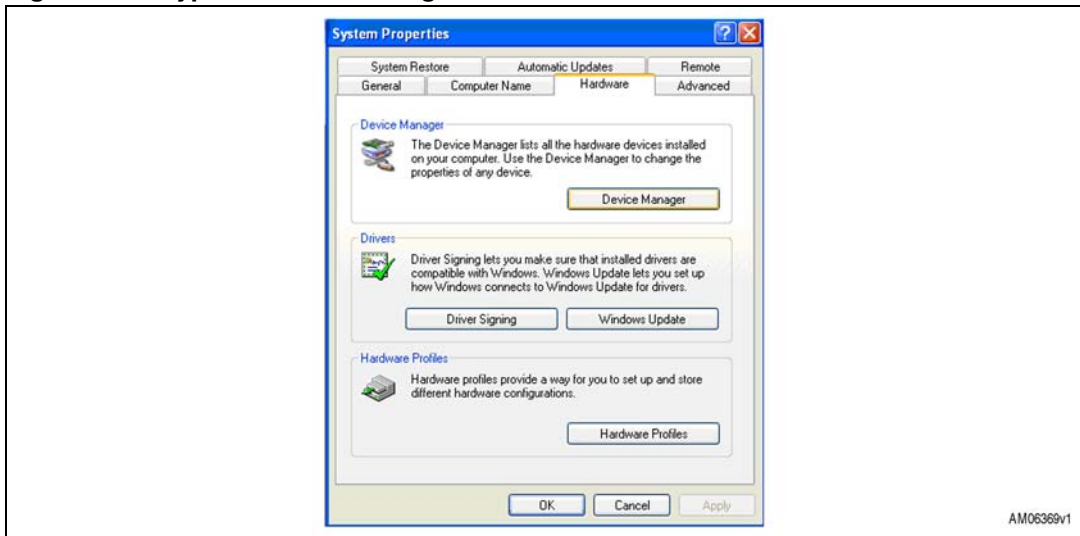
Table 2. Charging/discharging status LED (D3)

LED	Description	Blink	Off
D3	STC3100's register access indicator:	When microcontroller accesses the registers of STC3100.	No access

5.4 HyperTerminal settings

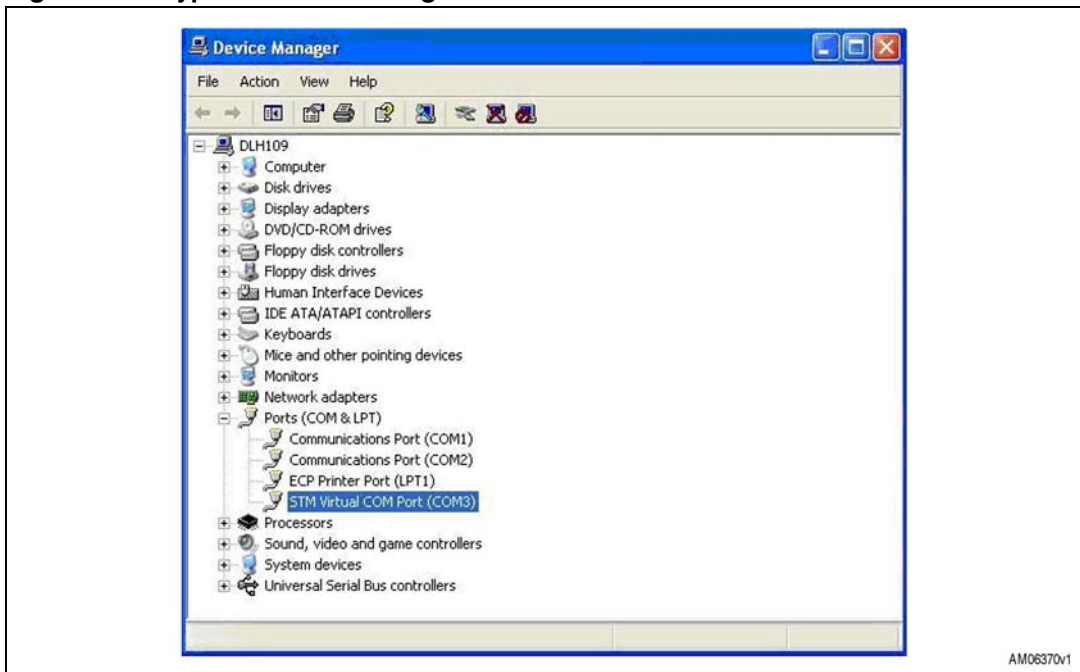
The STC3100 board supports the virtual com port feature. The user can see the battery status and other register information on the HyperTerminal window. To do this, the user should connect the micro-USB cable between the board and the PC, and select the device manager under the hardware tab of system properties, as shown in [Figure 20](#).

Figure 20. HyperTerminal settings 1



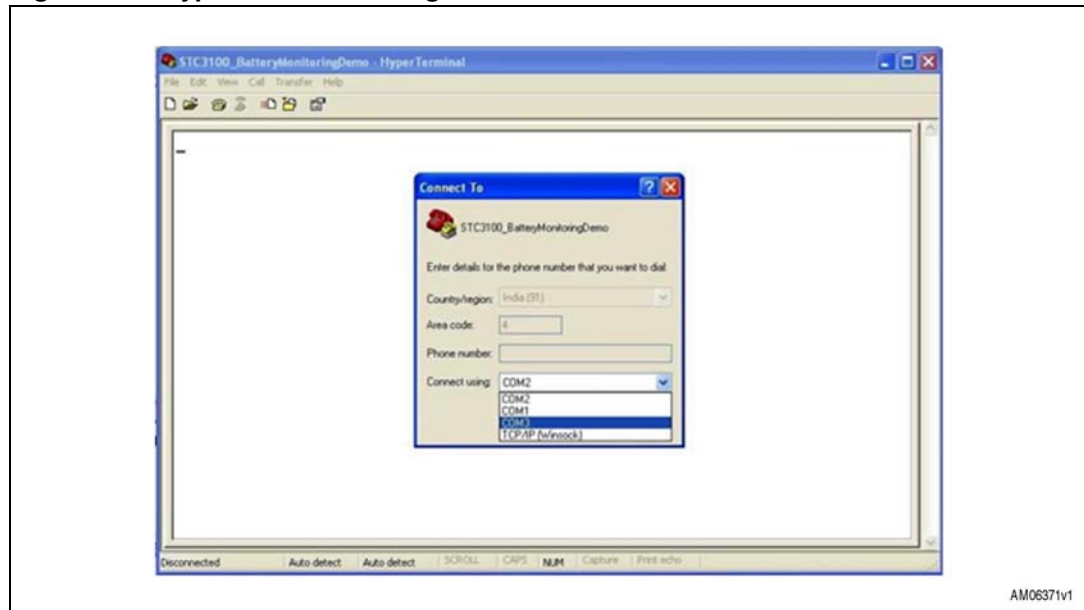
Now the user is able to see the “STM Virtual Com Port” under Ports (COM & LPT). Take a note of the com port number.

Figure 21. HyperTerminal settings 2



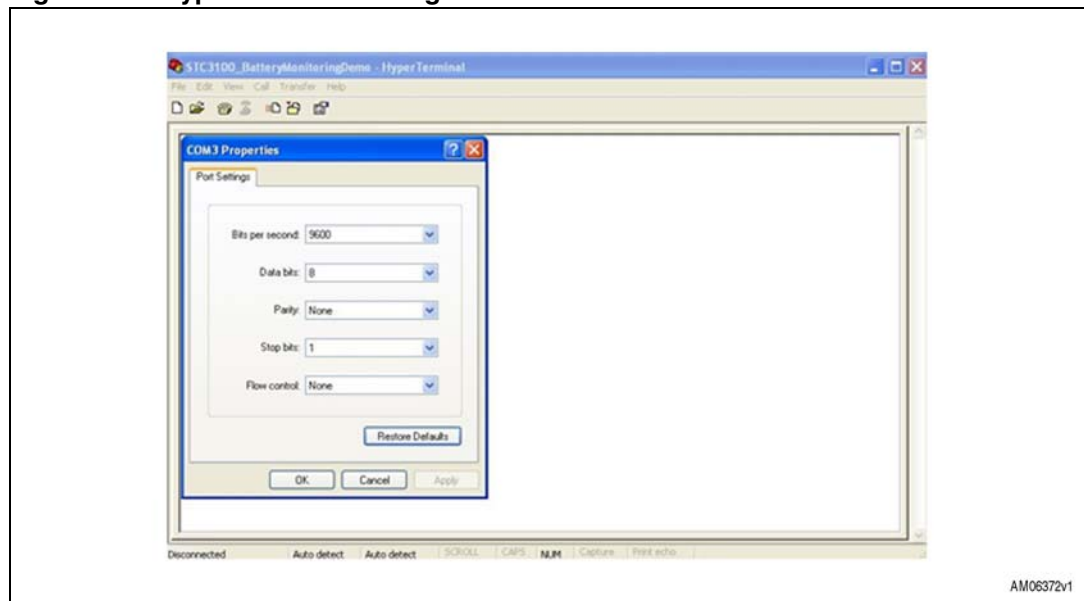
Open the HyperTerminal window and select the same com port. Set the properties as shown in [Figure 22](#).

Figure 22. HyperTerminal settings 3



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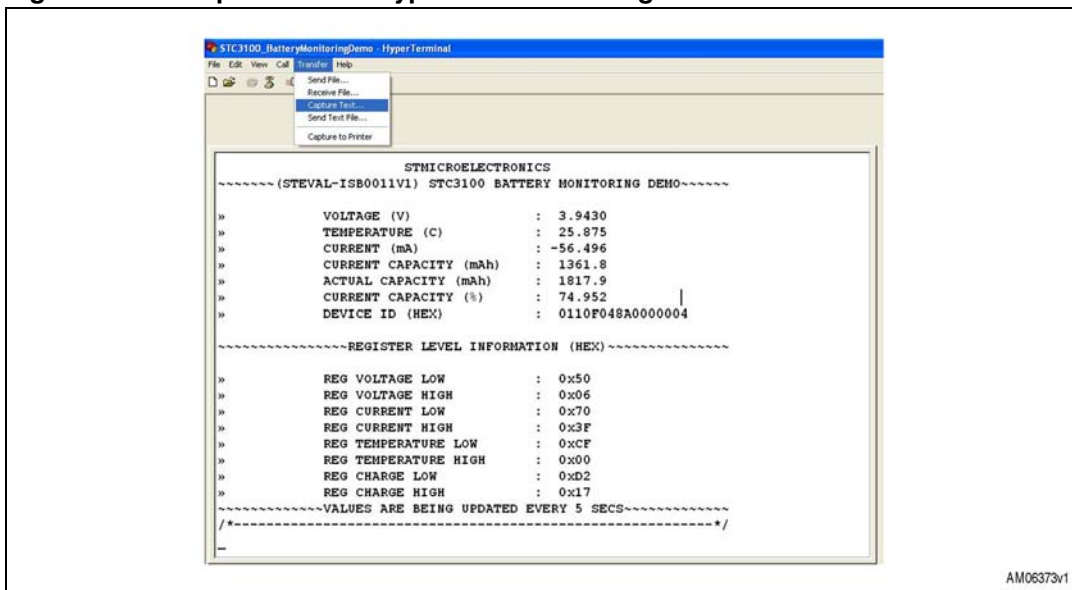
Figure 23. HyperTerminal settings 4



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With the capture text feature of HyperTerminal, it is possible to create a text file showing information of the battery status. Text on HyperTerminal is updated at some interval (in this case it is configured at 5 seconds). This text can be captured and saved in a .txt file using HyperTerminal features. Open this file with WordPad. This add-on feature helps to track the battery status every 5 seconds.

Figure 24. Dump of data on HyperTerminal settings 4



6 Hardware design description

The board supports both USB and a wall adapter. A switch (SW7) is used to choose one of these as the power source. The voltage from these sources is connected to a low drop voltage regulator (LD1117V) to convert it to 3.3 V for powering up all devices such as the LCD, microcontroller, etc.

STC3100 always receives power from the battery. This is done to avoid loss of data stored in RAM registers of the STC3100 during power off. When external supply is absent the whole board consumes power from the battery.

6.1 Microcontroller (STM32)

STM32 is a 32 bit MCU based on the popular ARM 32-bit Cortex™-M3 CPU. The STM32 device (STM32F102C6T6A) used in this demonstration board runs at 48 MHz. The microcontroller has single-cycle multiplication and hardware division. The device supports low power mode such as sleep, stop, and also standby. This device (microcontroller) has up to 5 communication interfaces which includes one I²C (400 kHz), two USARTs (ISO 7816 interfaces, LIN, IrDA capability, modem control), one SPI (12 Mbit/s), and USB 2.0 full speed interface. For more details refer to the STM32F102C6T6A datasheet and RM0008 reference manual.

For this application a minimum of one I²C to interface with the STC3100 is needed, a USB to support a USB based charger, and some general purpose IO's for the user interface. The part numbers used to develop this application are shown in [Table 3](#).

Table 3. Microcontroller details

Feature	Description
Sales type	STM32F102C6T6A:USB access line, USB 2.0 full-speed interface
Package	LQFP-48 (7 x 7) mm
Flash - Kbytes	32
SRAM - Kbytes	4-6
Operating voltage	2.0 to 3.6 V

6.2 Battery monitor IC (STC3100)

The STC3100 monitors the critical parameters of a single-cell Li-Ion battery (voltage, temperature, and current) and includes hardware functions to implement a gas gauge for battery charge monitoring, based on a programmable 12- to 14-bit A-D converter. With a typical 30 mΩ external sense resistor, the battery current can be up to 2.5 A and the accumulator system provides a capacity of up to +/-7300 mAh with a resolution of 0.2 mAh. The device is programmable through the I²C interface. This device also has 32-RAM bytes, 8-byte unique device ID, and a general-purpose I/O. RAM contents are retained even up to a minimum battery voltage of 2.0 V. For more details refer to STC3100 datasheet.

Table 4. STC3100 details

Feature	Description
Order code	STC3100IQT
Package	DFN8 3 x 3
Operating voltage	2.7 to 5.5 V
Operating current consumption	100 μ A

6.3 ESD protection device

USBLC6-2P6 is a monolithic application specific device dedicated to ESD protection of high speed interfaces, such as USB 2.0, Ethernet links and video lines. For more details please refer to the USBLC6 datasheet.

Table 5. USBLC6 details

Feature	Description
Order code	USBLC6-2P6
Package	SOT23-6L

Note: This device is not mounted on the board.

6.4 Voltage regulator

The LD1117 is a low drop voltage regulator able to provide up to 800 mA of output current, available even in the adjustable version ($V_{REF} = 1.25$ V). High efficiency, low drop voltage and the low quiescent current make them particularly suitable for low noise, low power applications, and in battery powered systems. For more details please refer to the LD1117AXX33 datasheet.

The power supply of 3.3 V is generated using this IC to power up the LCD, microcontroller, and all other peripherals except STC3100 which is always powered up from the battery only.

Table 6. Voltage regulator

Feature	Description
Sales Type	LD1117S33TR
Package	SOT-223

6.5 STC4054 charger IC

The STC4054 charger IC is a linear mode charger which charges the battery at 4.2 V at programmable current level. During constant current charging mode, charging current is programmed to a value of around 350 mA. This value is selected by connecting a 1 %, 2.8 k Ω resistor R_{prog} across the PROG pin. When the battery voltage approaches the charge voltage (4.20 V), the charger enters into a constant voltage charging mode and the charging current decreases. When the current level reaches the end-of-charge level, the battery is almost fully charged, and the charger enters maintenance mode. For more details please refer to the STC4054 datasheet.

Table 7. Charger IC

Feature	Description
Order code	STC4054GR
Package	TSOT23-5L

6.6 Power MOSFET

The MOSFET is used to disconnect the battery from the board when the battery is in critical condition or when an external power source is present. During discharging process this MOSFET is turned on so as to consume power from the battery. For more details please refer to the STT3PF30L datasheet.

Table 8. MOSFET

Feature	Description
Sales type	STT5PF20V
Package	SOT23-6L

6.7 Reset supervisor

The STM809/810/811/812 RESET circuits are low-power supervisory devices used to monitor power supplies. They perform a single function: to assert a reset signal whenever the VCC supply voltage drops below a pre-set value and to keep it asserted until VCC has risen above the pre-set threshold for a minimum period of time. This device has excellent features such as 40 ms reset pulse width (MIN), low supply current - 6 μ A (TYP), and guaranteed reset assertion down to VCC = 1.0 V. For more details refer to the STM810 datasheet.

Table 9. Reset supervisor

Feature	Description
Sales type	STM810SWX6F
Package	SOT23-3

Note: This device is not mounted on the board.

7 Connectors and jumpers

7.1 JTAG connector

Figure 25. JTAG connector

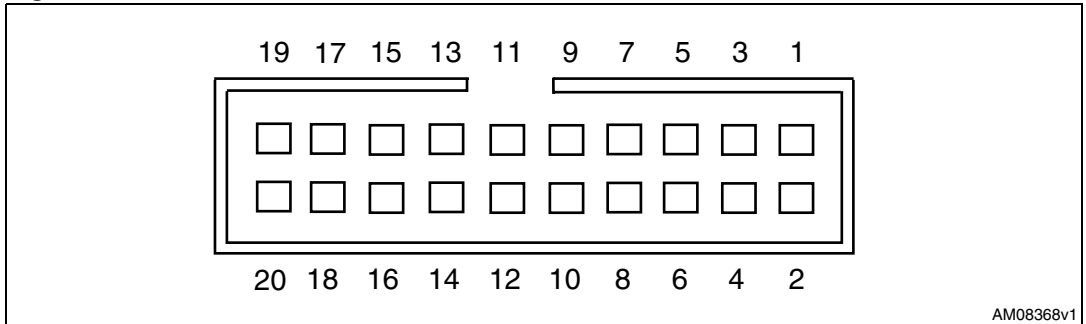


Table 10. Pin description of JTAG

Pin number	Description	Pin number	Description
1	3.3 V power	2	3.3 V power
3	TRST	4	GND
5	TDI	6	GND
7	TMS	8	GND
9	TCK	10	GND
11	RTCK	12	GND
13	TDO	14	GND
15	nSRST	16	GND
17	DBGRQ	18	GND
19	DBGACK	20	GND

The JTAG connector is available on the board for re-programming the microcontroller and debugging.

7.2 USB connector

The standard USB micro-B type (5-pin) connector is used. An additional 4 connections (pins 6 and 7 in the schematics) are connected to the body of the connector. Make sure that these pins (shell/shield) are connected to ground through an RC circuit. Maximum current drawn by the board from USB host/hub is less than 500 mA in any condition, in order to respect the USB specifications.

Figure 26. Micro-B USB connector



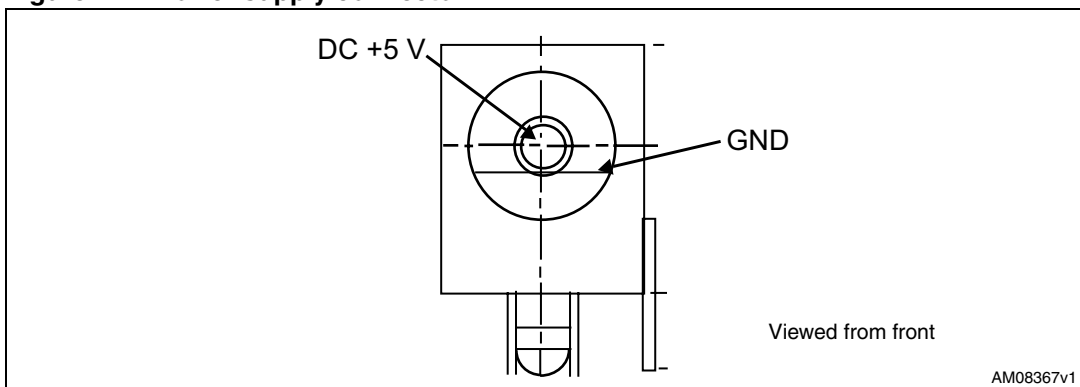
Table 11. USB connector pin description

Pin number	Description	Pin number	Description
1	VBUS(Power): +5 V supply from USB bus	6	SHIELD
2	DM: USB D- signal	7	SHIELD
3	DP: USB D+ signal		
4	--		
5	GND: ground signal		

7.3 Power supply connector

An adaptor connector is available for connecting an external voltage source. An adaptor of 5 V DC and current rating of 600 mA or more may be used.

Figure 27. Power supply connector



7.4 LCD connector

Table 12. LCD connector pinout

Pin no.	Details
1	GND
2	3.3 V
3	Contrast—Connect to 3.3 V through resistor
4	RS
5	GND
6	Enable
7	GND
8	GND
9	GND
10	GND
11	D4
12	D5
13	D6
14	D7
15	3V3
16	GND

7.5 Jumper J7, J8, J10, and J11

Table 13. Selection between onboard and external microcontroller

Jumper designator	Pins	Signal name (of STC3100)	Description
J7	1 - 2	I/O pin	Onboard MCU STM32
	2 - 3	I/O pin	External MCU
J8	1 - 2	Clock source	Onboard MCU STM32
	2 - 3	Clock source	External MCU
J10	1 - 2	SDA pin	Onboard MCU STM32
	2 - 3	SDA pin	External MCU
J11	1 - 2	SCL pin	Onboard MCU STM32
	2 - 3	SCL pin	External MCU

7.6 Jumper J9 details: connector for external MCU

Table 14. Connector for external MCU

Pin no.	Description
1	Pinout for IO pin of STC3100 for external uC
2	Pinout for external clock source of STC3100 for external uC
3	Pinout for SDA line for external uC
4	Pinout for SCL line for external uC
5	Pinout for GND connection for external uC

7.7 Clock selection jumper SW6

Table 15. Clock selection for STC3100

Jumper	Description
1 - 2	Connects clock pin of STC3100 with onboard external oscillator
3 - 4	Connects clock pin of STC3100 with STM32 generated clock
5 - 6	Internal clock of STC3100 is selected.

7.8 Jumper J3

Table 16. J3 jumper setting

Jumper	Description
1 - 2	Put jumper when a new battery is connected. This ensures a clearing of RAM resistors of STC3100.
2 - 3	Put the jumper once the data screen (battery parameters) is displayed.

7.9 Terminal block J12

Table 17. Terminal block J12

Tag name	Description
CHG+	Charger positive terminal
CHG-	Charger negative terminal

7.10 Terminal block J14

Table 18. Terminal Block J14

Tag name	Description
Load+	Load positive terminal
Load-	Load negative terminal

Note: Load connector is connected in parallel to battery. When the user is connecting a load externally, it is the user's responsibility to make sure that the battery avoids drain condition (battery goes under dead condition because of deep discharge). In many circuits working on a battery there are inbuilt low-battery prevention circuits. However, if not available, the user needs to implement this.

7.11 Charger selection switch: SW8

Table 19. Charger selection Switch

Jumper	Description
1 - 3	Select external charger
1 - 2	Select internal charger



8 Hardware schematics

Figure 28, 29, 30, 31, 32, 33, 34, and 35 show the schematics diagrams for the board.

Figure 28. Microcontroller section

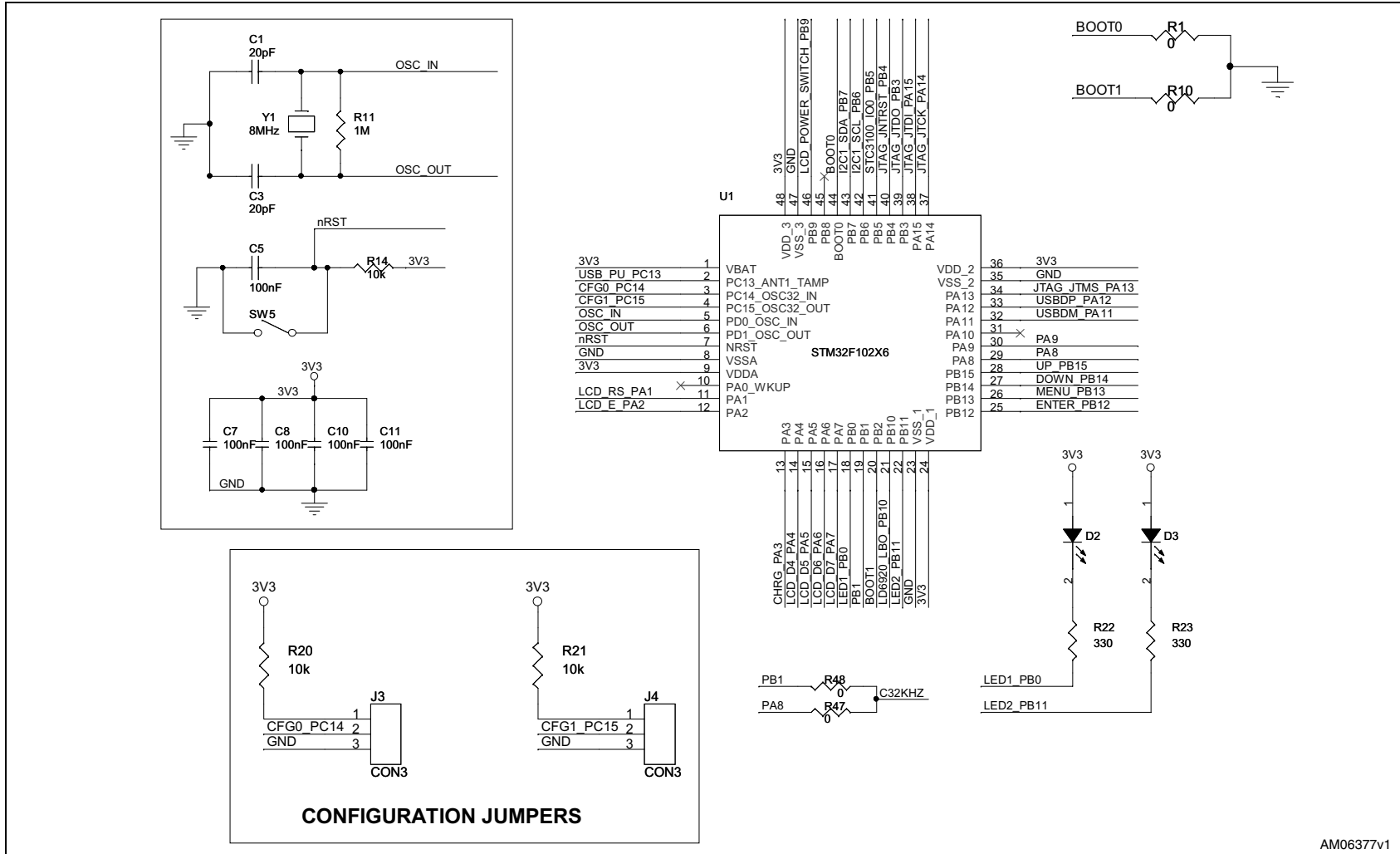


Figure 29. Clock selection

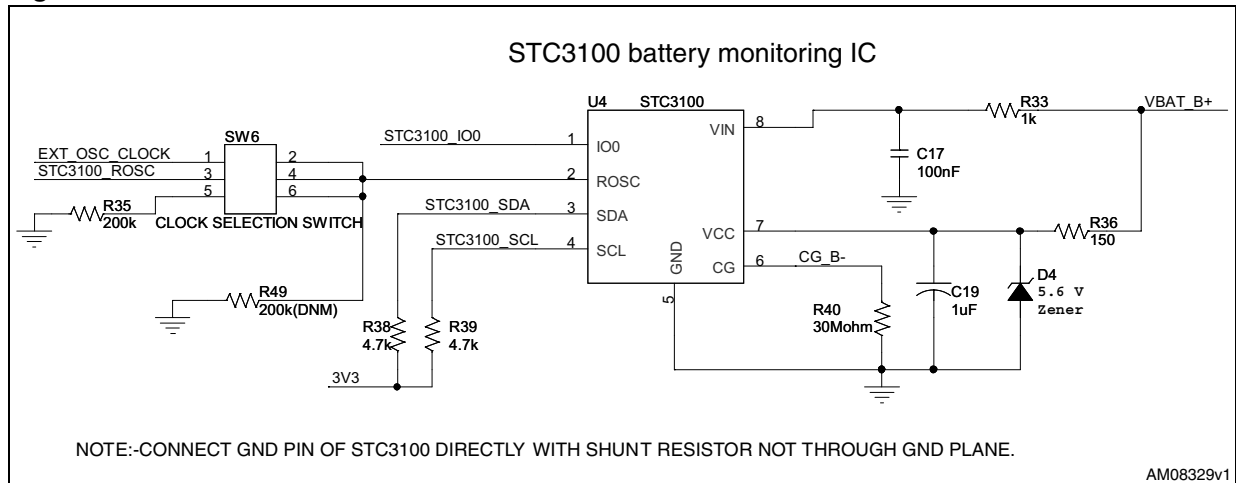


Figure 30. STC4054 battery charger, 3.3 V output

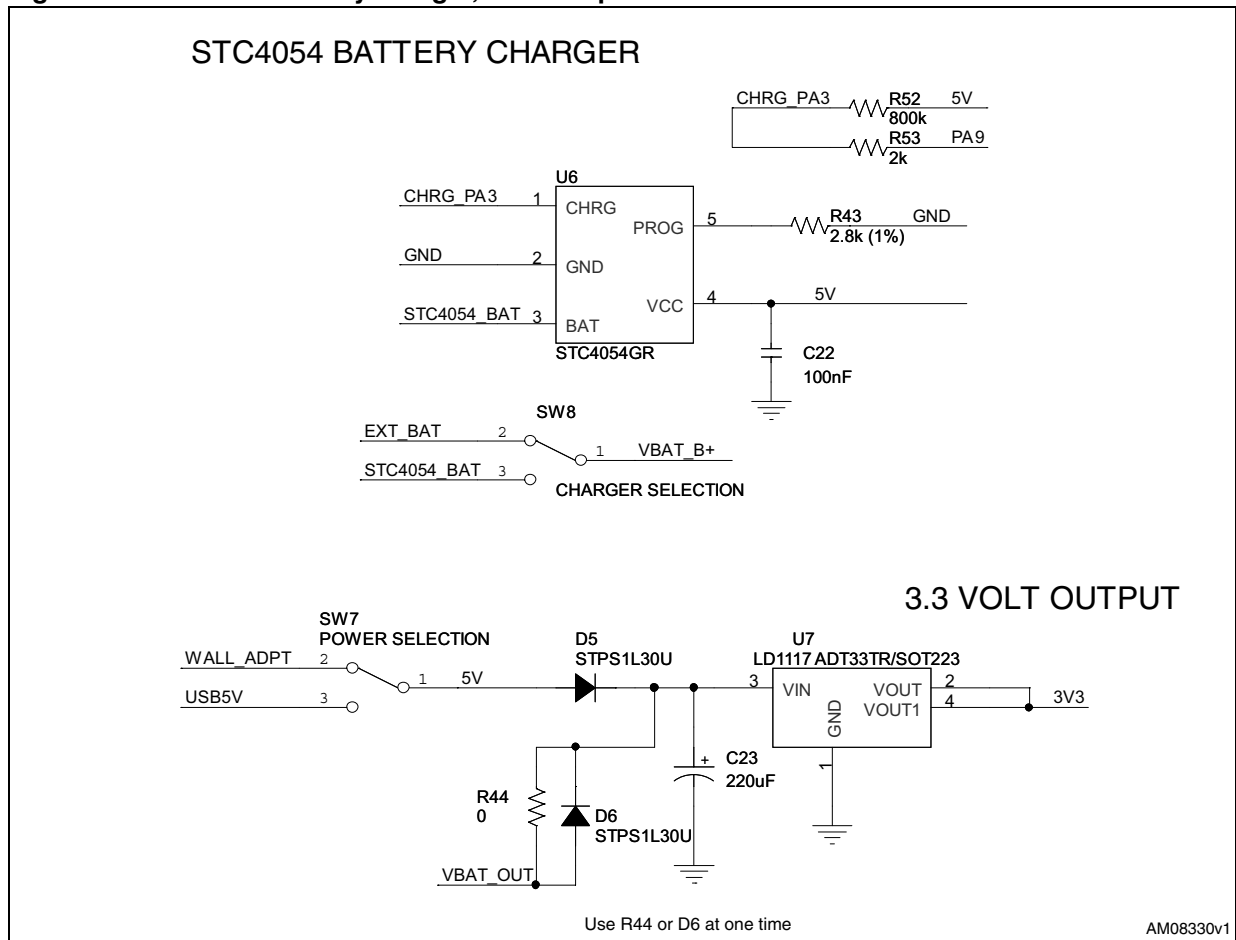


Figure 31. LCD power supply switch section

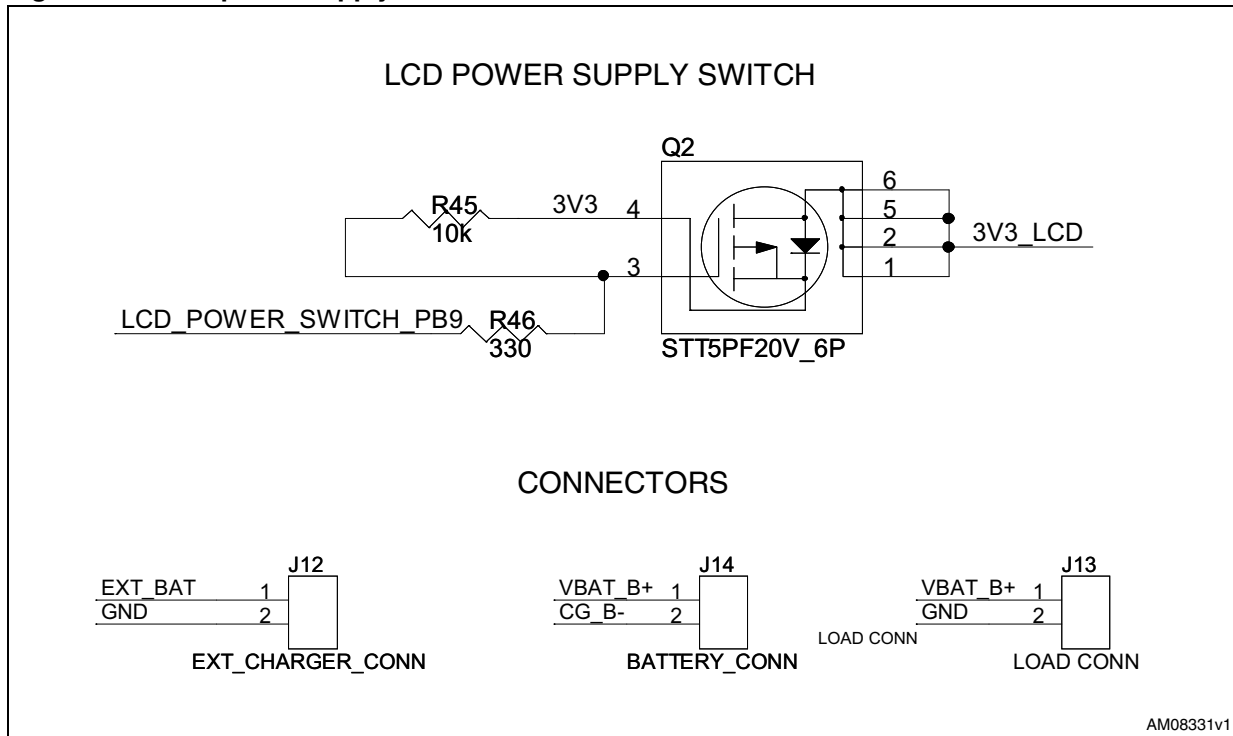




Figure 32. JTAG connector, switches and switching MOSFET section

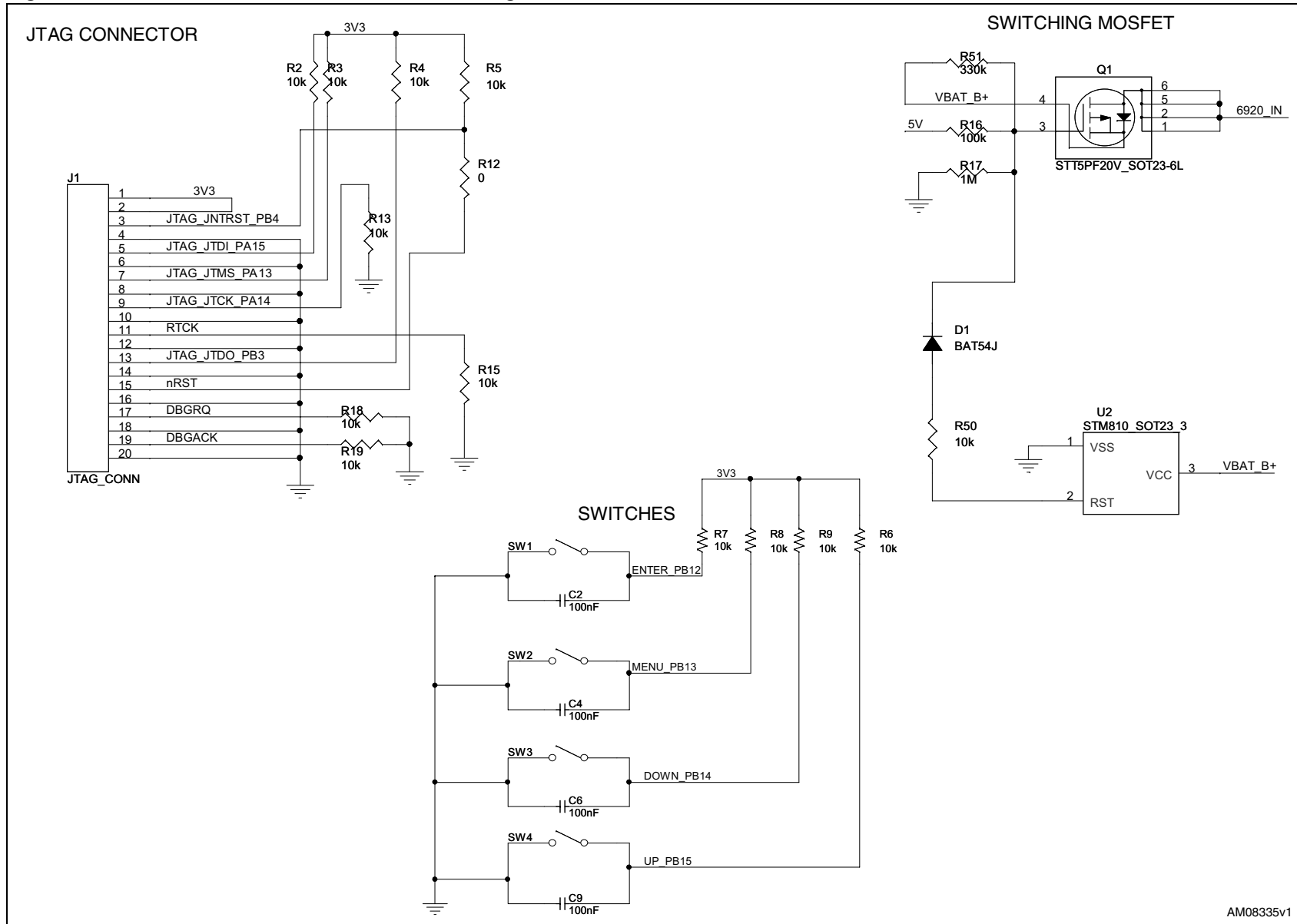


Figure 33. Wall adaptor and external oscillator section

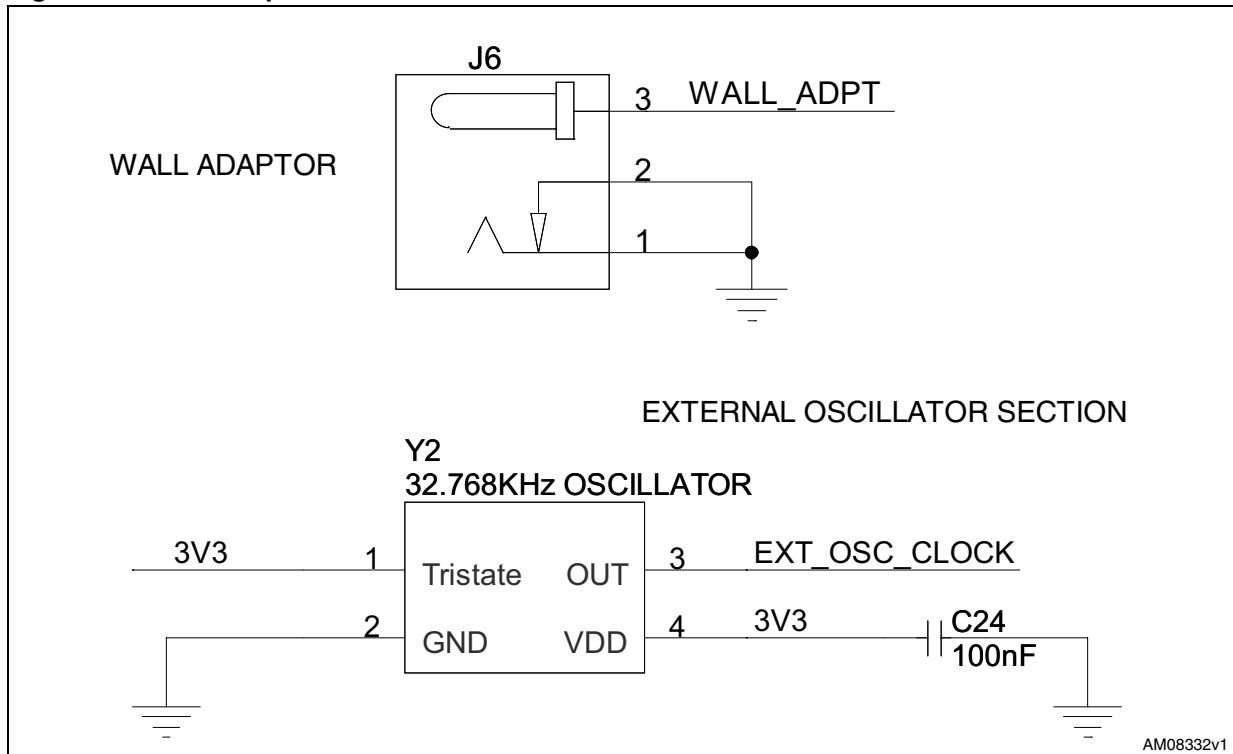


Figure 34. LCD section and controller selection jumpers

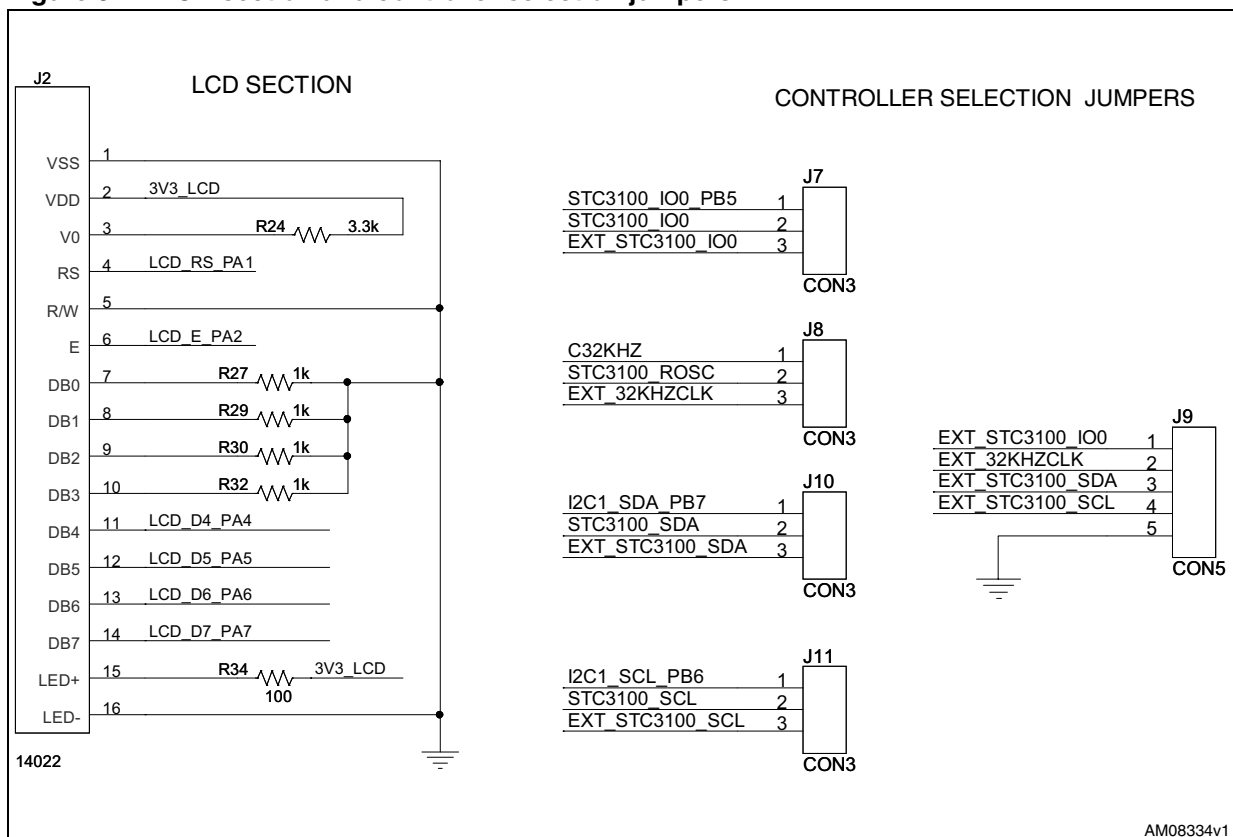
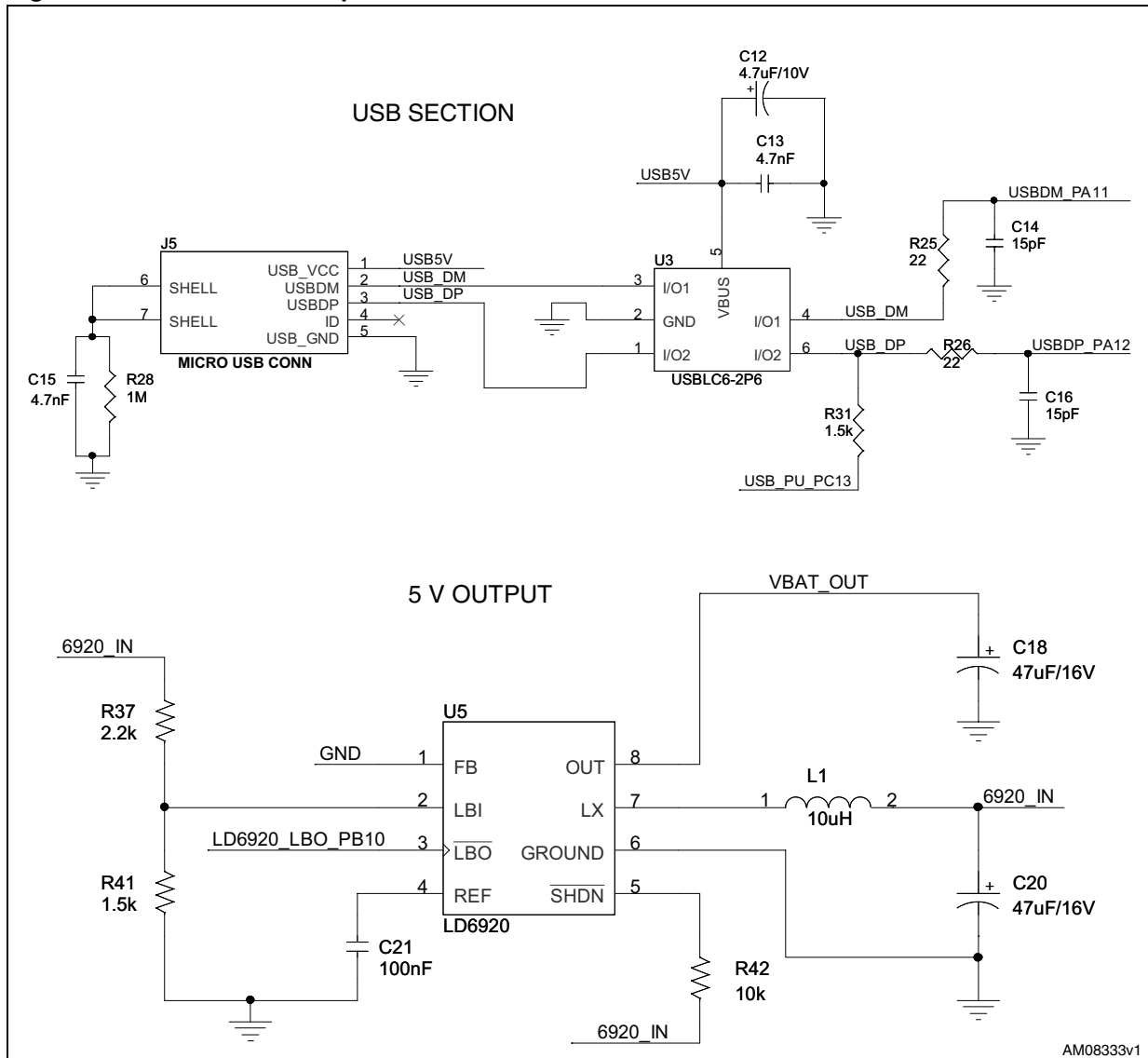


Figure 35. USB and 5 V output section



AM08333v1

9 Bill of material

Table 20. BOM

Category	Reference designator	Component description	Package	Manufacturer	Manufacturer's ordering code / orderable part number or equivalent	Supplier	Supplier ordering code
ST devices	U1	STM32 low-density USB access line, 48in, 32 K Flash, 6 K RAM	LQFP48	STMicroelectronics	STM32F102C6T6A		
	U2	Reset circuit	SOT23-3	STMicroelectronics	STM810RWX6F		
	U3	USBLC6_2P6 very low capacitance ESD protection	SOT23-6L	STMicroelectronics	USBLC6-2P6		
	U4	Battery monitor IC with Coulomb counter/gas gauge	DFN8 3x3	STMicroelectronics	STC3100IQT		
	U5	Step-up converter	TSSOP8	STMicroelectronics	L6920D		
	U6	800 mA standalone linear Li-Ion battery charger with thermal regulation	TSOT23-5L	STMicroelectronics	STC4054GR		
	U7	Low drop fixed and adjustable positive voltage regulators	SOT-223	STMicroelectronics	LD1117AS33TR		
	D1	BAT54JFILM	SMB	STMicroelectronics	BAT54JFILM		
	D5, D6	STPS1L30U (low drop power Schottky rectifier)	SMB	STMicroelectronics	STPS1L30U		
	Q1, Q2	P-channel power MOSFET	SOT23-6L	STMicroelectronics	STT5PF20V		

**Table 20. BOM (continued)**

Category	Reference designator	Component description	Package	Manufacturer	Manufacturer's ordering code / orderable part number or equivalent	Supplier	Supplier ordering code
Crystal and Oscillator	Y1	Quartz crystal 8 MHz	11.35 mmx4.35 mm, SS4	Jauch	Q 8.0-SS4-30-30/30		
	Y2	Oscillator 32 kHz	SMD	Any			
Connectors and jumpers	J1	JTAG connector	Box header, right angle, 20-way, 2x10-pin, 2.54 mm x 2.54 mm pitch	Protectron	P9604-20-15-1		
	J6	Power JACK 2.5 mm	Socket, DC power, 2.5 mm, right angle, locking type	Protectron	PDCJ01-08	Protectron	PDCJ01-08
	J3,J4,J7,J8,J10,J11	CON3	1x3 header, 2.54 mm pitch	Any			
	J9	CON5	1x5 header 2.54 mmx2.54 mm pitch				
	J12,J13,J14	Terminal block, side entry, 2-way Pitch: 5.08 mm; mounting type: PC board;	2-pin terminal block, 5.08 mm pitch, orange colour	WEIDMULLER	WEIDMULLER PM5.08/2/90	Farnell	Part# 1131853
	J2	LCD_CONNECTOR 14022	1x16 header, 2.54 mm pitch	Any			
	J5	USB micro-B connector	SMD	Protectron	P707MIB-05-9		
	Capacitors	C14, C16	15 pF	SMD0805	Any		
C1, C3		20 pF	SMD0805	Any			
C13, C15		4.7 nF	SMD0805	Any			



Table 20. BOM (continued)

Category	Reference designator	Component description	Package	Manufacturer	Manufacturer's ordering code / orderable part number or equivalent	Supplier	Supplier ordering code
Capacitors	C2,C4,C5,C6,C7,C8 ,C9,C10,C11,C17,C21,C22, C24	100 nF	SMD0805	Any			
	C19	1 μ F	SMD0805	Any			
	C12	4.7 μ F/10 V	EIA 3216-18/ size A	Any			
	C18, C20	47 μ F	EIA 3216-18/ size B	Any			
	C23	100 μ F/16 V	Through hole	Panasonic-ECG	ECE-A1CKA101	Digi-Key	P833-ND
LEDs	D2, D3	LED	SMD0805	Any			
Inductors	L1	10 μ H	SMD	Coiltronics/Div of Cooper/Bussmann	SD53-100-R	Digi-Key	513-1457-1-ND
Resistors	R1,R10,R12, R44(DNM), R47(DNM),R48	0	SMD0805	Any			
	R22,R23,R46	330 Ω	SMD0805	Any			
	R24	3.3 k Ω	SMD0805	Any			
	R2,R3,R4,R5,R6,R7 ,R8,R9,R13,R14, R15,R18,R19,R20, R21,R42, R45, R50	10 k Ω	SMD0805	Any			
	R25, R26	22 Ω	SMD0805	Any			
	R27,R29,R30,R32, R33	1 k Ω	SMD0805	Any			
	R11,R17,R28	1 M Ω	SMD0805	Any			
	R31, R41	1.5 k Ω	SMD0805	Any			
	R53	2 k Ω	SMD0805	Any			

**Table 20. BOM (continued)**

Category	Reference designator	Component description	Package	Manufacturer	Manufacturer's ordering code / orderable part number or equivalent	Supplier	Supplier ordering code
Resistors	R34	100 Ω	SMD0805	Any			
	R35, R49	200 k Ω	SMD0805	Any			
	R36	150 Ω	SMD0805	Any			
	R37	2.2 k Ω	SMD0805	Any			
	R38, R39	4.7 k Ω	SMD0805	Any			
	R40	Resistor, metal strip, 0.03 Ω 1 % 0.125 W	SMD0805	Any	WSL-0805 .03 1 % EB E3	Farnell	Part# 1107335
	R43	2.8 k Ω (1 %)	SMD0805	Any			
	R52	800 k Ω	SMD0805	Any			
	R51	330 k Ω	SMD0805	Any			
	R16	100 k Ω	SMD0805	Any			
Switches	SW1,SW2,SW3, SW4,SW5	Pushbutton switch, SMD	Tactile switch, SPNO, SMD. 6 mmx3.5 mm	MULTICOMP	DTSM-32S-B	Farnell	Part# 9471898
	SW6	2x3-pin header	2x3 header, 2.54 mmx2.54 mm pitch				
	SW7, SW8	Slide switch, SPDT, horizontal	Through hole, 2.54 mm pitch	EAO	01-10290-01	Farnell	674357
Others	D4	5.6 V Zener diode	SMD	Any			
		Oriole LCD, 16 x 2 alpha numeric LCD	Modular	Oriole			

Note: Do not mount R44, R47, R49, R50, R52, and R53 resistors

Do not mount C12, C13, and C22

U2,U3,Y2, D1,D4 not mounted

The term equivalent has been used where the exact part number from the mentioned vendor may not have been used.

Appendix A References

1. STC3100 datasheet
2. STM32F102C6 datasheet
3. USBLC6-2 datasheet
4. STC4054 datasheet
5. LD1117AXX33 datasheet

Revision history

Table 21. Document revision history

Date	Revision	Changes
27-Jan-2011	1	Initial release.

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