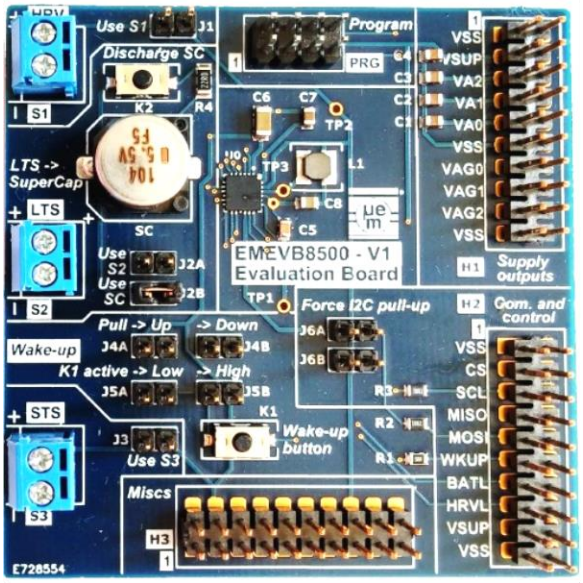
# EMEVB8500 EVALUATION BOARD USER MANUAL




## Description

The EMEVB8500 board is targeted at rapid evaluation and prototyping of integrated energy harvesting solutions based on EM8500 family of devices. The evaluation board offers a set of features to show the performance of EM8500 hardware applications.

The EMEVB8500 board allows flexibility with various configuration, external harvester input, internal or external storage elements and user connections.

## Main Features

Hardware

Long Term storage selection (on-board Supercap or external)

Supercap discharge path

Short term storage selection (on-board capacitor or external)

External harvester selection

Expansion header for prototyping and external connection

Configurable wake-up line with push-button

EM8500 I2C pull-up selection

Software

EMPB85xx Software is available when the configuration tool EMPB85xx is used.

Refer to EMPB85xx User Manual.

# 1. OVERVIEW

The architecture of the EMEVB8500 is based on the following block diagram

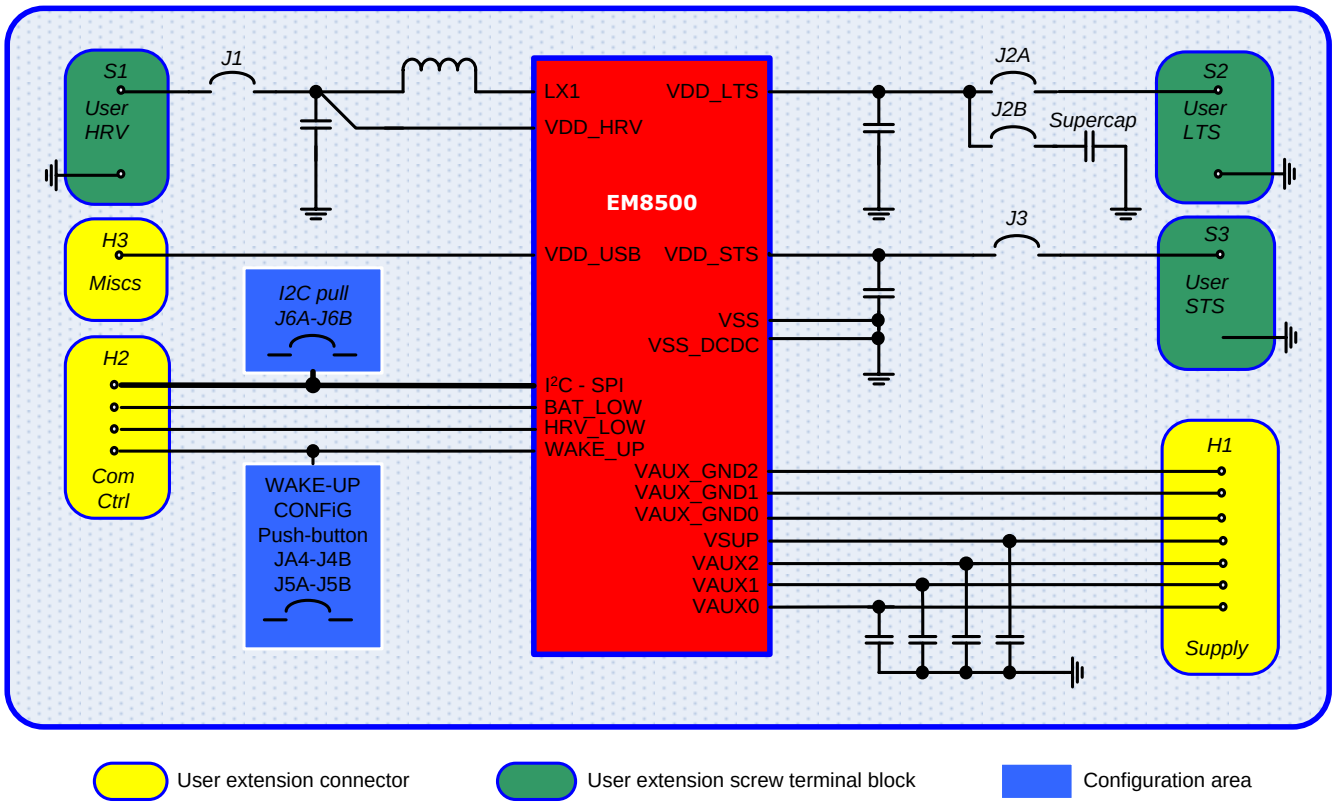



Figure 1-1 EMEVB8500 System Architecture

# 2. EMEVB8500 BOARD

## 2.1. DESCRIPTION

The board is equipped with:

- EM8500 core design consisting of the EM8500 devices and required external components.
- Extension header (H1) used to supply the application
- Extension header (H2) used to interface the communication and control signals between application and EM8500.
- Extension header (H3) used to expose other signals (STS, LTS, HRV, USB ...)
- Extension header (PRG) used to configure the EM8500
- Terminal block (S1) to connect any external harvester
- Terminal block (S2) to connect an external Long Term Storage to LTS (primary or secondary storage)
- Terminal block (S3) to connect an external Short Term Storage to STS
- Supercap (SC) as LTS with a dedicated discharge path
- Different jumper areas to select the terminal blocks or internal board resources and configure I2C lines or Wake-up line
- Push button (K2) used for the Supercap discharging
- Polarity configurable push button (K1) used for Wake-up control line.

The board dimension is 65 x 65 mm.

H1, H2 and H3 are male headers 2x10 pins (2.54 mm pitch).

PRG is male headers 2x4 pins (2.54 mm pitch).

S1, S2 and S3 are 2 pins screw terminal block (3.5 mm pitch).

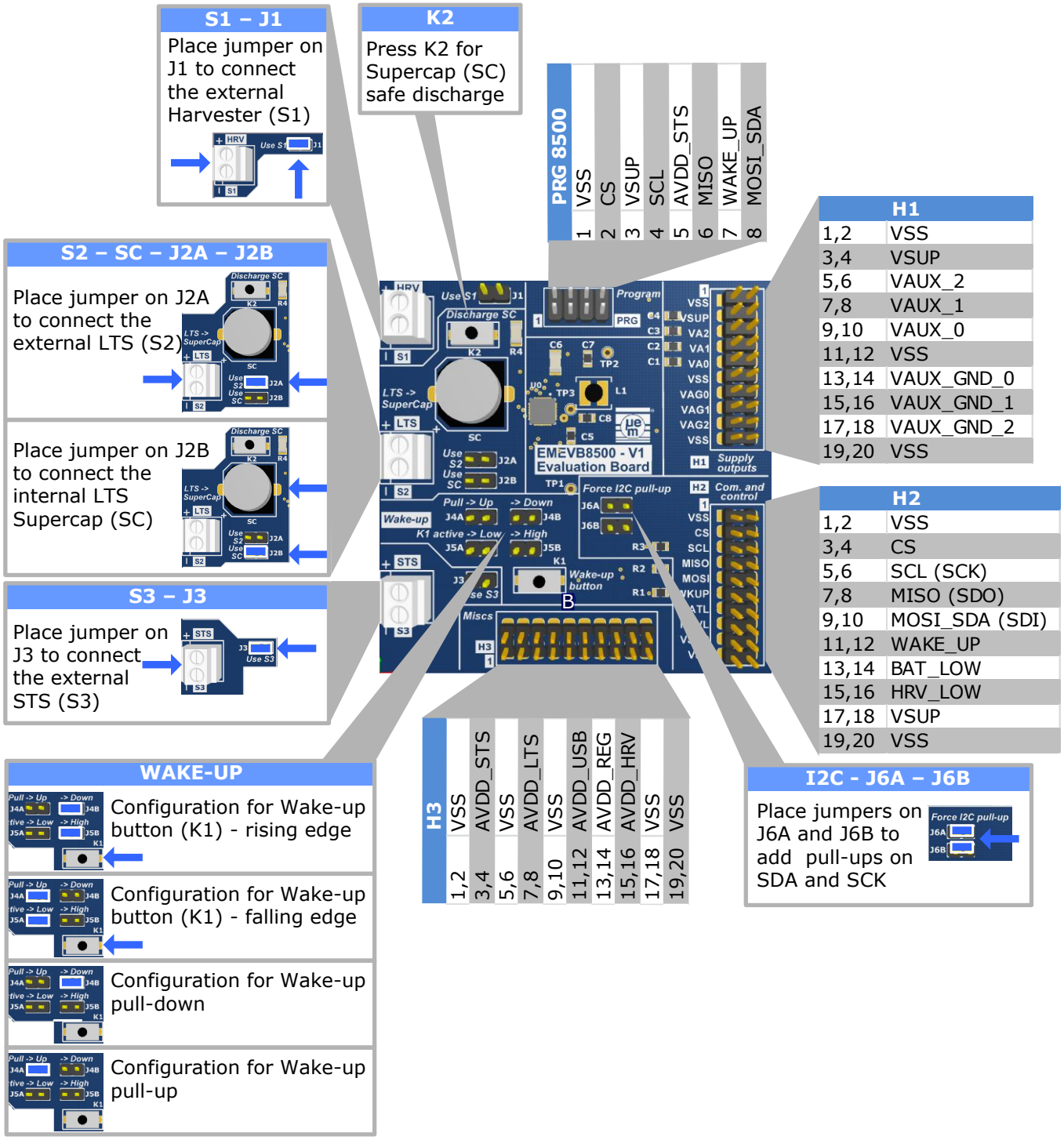



Figure 2-1: EMEVB8500 Description

## 2.2. FEATURES DESCRIPTION

### 2.2.1. H1 EXTENSION CONNECTOR

H1 connects the supply lines VSUP, VAUX and VAUX_GND lines to the application

| | | I/O TYPE | | DESCRIPTION |
|---|---|---|---|---|
| NO. | PIN NAME | DIRECTION(*) | SUPPLY | |
| 1 | VSS | Supply | | System ground connection (EM8500 device ground) |
| 2 | VSS | Supply | | System ground connection (EM8500 device ground) |
| 3 | VSUP | Output | | Main supply |
| 4 | VSUP | Output | | Main supply |
| 5 | VAUX[2] | Output | | Auxiliary 2 supply connection |
| 6 | VAUX[2] | Output | | Auxiliary 2 supply connection |
| 7 | VAUX[1] | Output | | Auxiliary 1 supply connection |
| 8 | VAUX[1] | Output | | Auxiliary 1 supply connection |
| 9 | VAUX[0] | Output | | Auxiliary 0 supply connection |
| 10 | VAUX[0] | Output | | Auxiliary 0 supply connection |
| 11 | VSS | Supply | | System ground connection (EM8500 device ground) |
| 12 | VSS | Supply | | System ground connection (EM8500 device ground) |
| 13 | VAUX_GND[0] | Output | | Auxiliary 0 ground supply connection |
| 14 | VAUX_GND[0] | Supply | | Auxiliary 0 ground supply connection |
| 15 | VAUX_GND[1] | Output | | Auxiliary 1 ground supply connection |
| 16 | VAUX_GND[1] | Output | | Auxiliary 1 ground supply connection |
| 17 | VAUX_GND[2] | Output | | Auxiliary 2 ground supply connection |
| 18 | VAUX_GND[2] | Output | | Auxiliary 2 ground supply connection |
| 19 | VSS | Supply | | System ground connection (EM8500 device ground) |
| 20 | VSS | Supply | | System ground connection (EM8500 device ground) |

Table 2-1 H1 Pin-out description

### 2.2.2. H2 EXTENSION CONNECTOR

H2 connects the SPI/I2C communication lines and BT_LOW and HRV_LOW control lines

| | | I/O TYPE | | DESCRIPTION |
|---|---|---|---|---|
| NO. | PIN NAME | DIRECTION(*) | SUPPLY | |
| 1 | VSS | Supply | | System ground connection (EM8500 device ground) |
| 2 | VSS | Supply | | System ground connection (EM8500 device ground) |
| 3 | CS | Input | VSUP | SPI chip select and SPI/I2C selection mode (when at '1') |
| 4 | CS | Input | VSUP | SPI chip select and SPI/I2C selection mode (when at '1') |
| 5 | SCL(SCK) | Input | VSUP | I2C/SPI clock connection |
| 6 | SCL(SCK) | Input | VSUP | I2C/SPI clock connection |
| 7 | MISO (SDO) | Output | VSUP | SPI MISO data connection |
| 8 | MISO (SDO) | Output | VSUP | SPI MISO data connection |
| 9 | MOSI (SDA) | Input (Inout) | VSUP | SPI MOSI input (SDA I2C inout) data connection |
| 10 | MOSI (SDA) | Input (Inout) | VSUP | SPI MOSI input (SDA I2C inout) data connection |
| 11 | WAKE_UP | Input | All (STS) | Wake-up pin |
| 12 | WAKE_UP | Input | All (STS) | Wake-up pin |
| 13 | BAT_LOW | Output | VSUP | Battery low indicator (when at '1') |
| 14 | BAT_LOW | Output | VSUP | Battery low indicator (when at '1') |
| 15 | HRV_LOW | Output | VSUP | Energy harvester cell low indicator (when at '1') |
| 16 | HRV_LOW | Output | VSUP | Energy harvester cell low indicator (when at '1') |
| 17 | VSUP | Output | | Main supply |
| 18 | VSUP | Output | | Main supply |
| 19 | VSS | Supply | | System ground connection (EM8500 device ground) |
| 20 | VSS | Supply | | System ground connection (EM8500 device ground) |

Table 2-2 H1 Pin-out Description

### 2.2.3. H3 EXTENSION CONNECTOR

H3 connects/monitors several other signals

| | | I/O TYPE | | DESCRIPTION |
|---|---|---|---|---|
| NO. | PIN NAME | DIRECTION(*) | SUPPLY | |
| 1 | VSS | Supply | | System ground connection (EM8500 device ground) |
| 2 | VSS | Supply | | System ground connection (EM8500 device ground) |
| 3 | VDD_STS | I/O | | Connection for the Short Term energy Storage element |
| 4 | VDD_STS | I/O | | Connection for the Short Term energy Storage element |
| 5 | VSS | Supply | | System ground connection (EM8500 device ground) |
| 6 | VSS | Supply | | System ground connection (EM8500 device ground) |
| 7 | VDD_LTS | I/O | | Connection for the Long Term energy Storage element |
| 8 | VDD_LTS | I/O | | Connection for the Long Term energy Storage element |
| 9 | VSS | Supply | | System ground connection (EM8500 device ground) |
| 10 | VSS | Supply | | System ground connection (EM8500 device ground) |
| 11 | VDD_USB | Input | | USB power supply connection |
| 12 | VDD_USB | Input | | USB power supply connection |
| 13 | VREG | Output | | Regulated voltage connection |
| 14 | VREG | Output | | Regulated voltage connection |
| 15 | VDD_HRV | Input | | Connection for energy harvester |
| 16 | VDD_HRV | Input | | Connection for energy harvester |
| 17 | VSS | Supply | | System ground connection (EM8500 device ground) |
| 18 | VSS | Supply | | System ground connection (EM8500 device ground) |
| 19 | VSS | Supply | | System ground connection (EM8500 device ground) |
| 20 | VSS | Supply | | System ground connection (EM8500 device ground) |

Table 2-3 H3 Pin-out Description

### 2.2.4. PRG EXTENSION CONNECTOR

A dedicated connector is available to access all required lines used to configure the EM8500 (EEPROM or access to registers).

The communications (SPI/I2C) lines are also available on the H2 extension connector (for the application). To avoid conflicts, the connections to the application should be disconnected during accesses through PRG.

| | | I/O TYPE | | DESCRIPTION |
|---|---|---|---|---|
| NO. | PIN NAME | DIRECTION(*) | SUPPLY | |
| 1 | VSS | Supply | | System ground connection (EM8500 device ground) |
| 2 | CS | Input | VSUP | SPI chip select and SPI/I2C selection mode (when at '1') |
| 3 | VSUP | Output | | Main supply |
| 4 | SCL(SCK) | Input | VSUP | I2C/SPI clock connection |
| 5 | VDD_STS | I/O | | Connection for the Short Term energy Storage element |
| 6 | MISO (SDO) | Output | VSUP | SPI MISO data connection |
| 7 | WAKE_UP | Input | All (STS) | Wake-up pin |
| 8 | MOSI (SDA) | Input (Inout) | VSUP | SPI MOSI input (SDA I2C inout) data connection |

Table 2-4 PRG Pin-out Description

### 2.2.5. S1 TERMINAL AND HRV

An external harvester can be connected to the S1 screw block terminal. To connect the external harvester to the VDD_HRV pin of the EM8500, a jumper must be placed on J1.

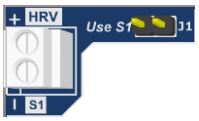



Figure 2-2: EMEVB8500 HRV & S1 View

Notes:

(1) There is no default on-board harvester available.
**(2) Observe polarity when connecting the input external harvester. Reverse polarity generates high leakage current across the EM8500 ESD protection diode connected to VSS.**

### 2.2.6. S2 TERMINAL AND LTS

The external Long Term Storage can be connected to the S2 screw block terminal. To connect the external Long Term Storage to the VDD_LTS pin of the EM8500, a jumper must be placed on J2A (Jumper on J2B must be removed).

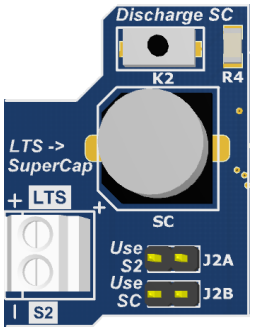



Figure 2-3: EMEVB8500 LTS, S2 & K2 View

Notes:

(1) A default on board LTS capacitor C7 (10uF) is connected on VDD_LTS. This capacitor cannot be disconnected except by physically removing it.
(2) When using the on-board Supercap (SC) as Long Term Storage a jumper on J2B must be placed (Jumper on J2A must be removed).
(3) A dedicated Supercap discharge circuit is available on board. To ensure that the on board Supercap is correctly discharged, keep button K2 pressed for at least 15 seconds.
**(4) Observe polarity when connecting the external Long Term Storage. Reverse polarity generates high leakage across the EM8500 ESD protection diode connected to VSS and may damage the LTS. When using a battery, do not connect battery with reversed polarity.**

### 2.2.7. S3 TERMINAL AND STS

The external Short Term Storage can be connected to the S3 screw block terminal. To connect the external Short Term Storage to the VDD_STS pin of the EM8500, a jumper must be placed on J3.


Figure 2-4: EMEVB8500 STS & S3 View

Notes:

(1) A default on-board STS capacitor C6 (100uF) is connected on VDD_STS. This capacitor cannot be disconnected except by physically removing it.

**(2) Observe polarity when connecting the external Short Term Storage. Reverse polarity generates high leakage across the EM8500 ESD protection diodes connected to VSS and may damage the device.**

### 2.2.8. WAKE-UP CONTROL LINE

The WAKE_UP pin of the EM8500 is available for external connection or can be driven by push button K1.

Its configuration is determined by jumpers J4A, J4B, J5A and J5B.

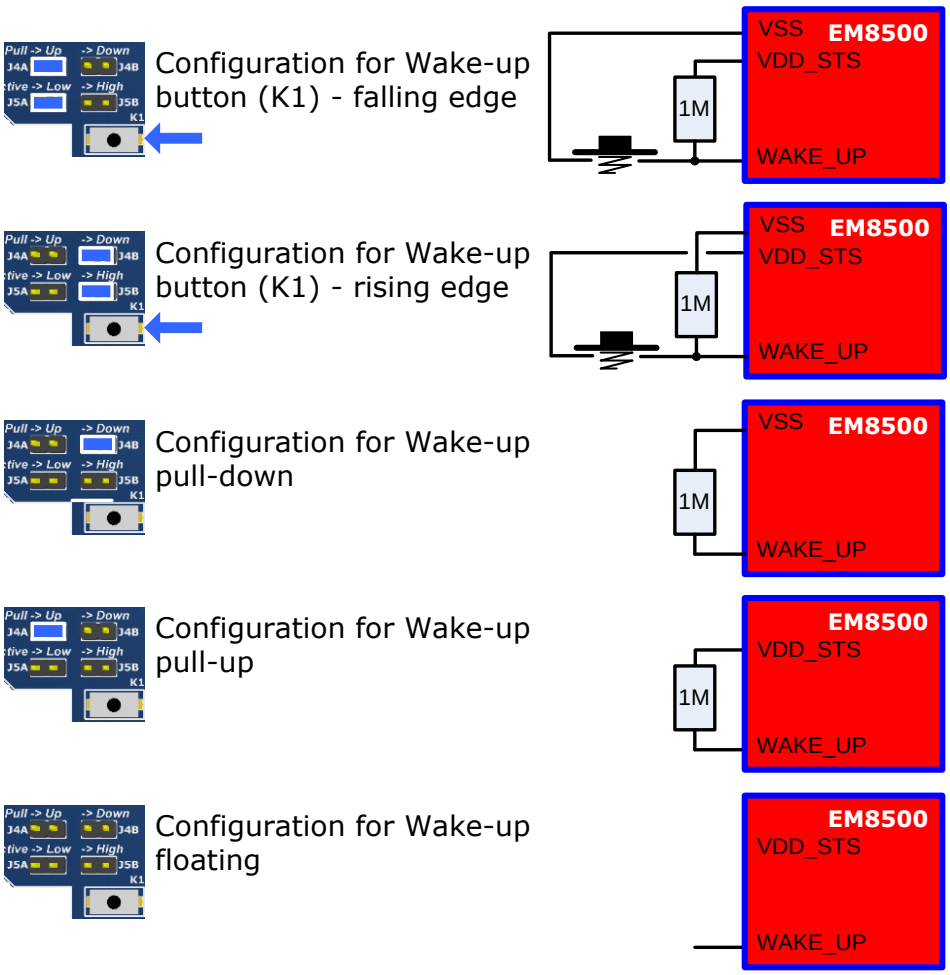



Figure 2-5: EMEVB8500 WAKE-UP multiple Configuration Examples

### 2.2.9. I2C LINES CONFIGURATION

The I2C communication pins (SCL and MOSI_SDA) do not incorporate internal pull-ups. It is possible to add external 10Kohms pull-ups resistors (R2 and R3) by adding jumpers on J6A and JPB.


Figure 2-6: EMEVB8500 I2C Pull-ups Configuration

## 2.3. GOOD PRACTICES AND RECOMMENDATIONS

Find below a check-list of common recommendations that should not be overlooked

**CS Line**

When using I2C communication, ensure that the CS line is kept low (either use a pull-down resistor on CS or tied directly to ground).

If CS is floating the SPI bus might erroneously be selected instead of the I2C and I2C communication cannot be established.

**Communication Lines**

When using EM8500 without a microcontroller or other hardware to control the communication lines, the floating lines (and their respective input buffers) might consume significant energy which may reduce the efficiency of your system (especially when the harvester source provides low levels of energy). Keep the MOSI (SDA), SCl(SCK) and CS lines to defined levels (no floating lines). Use pull resistors or direct connection to a well-defined level (‘0’ or ‘1’)

Note: Depending on your WAKE-UP configuration, also apply the same rule for WAKE-UP line.

## 2.4. SCHEMATIC

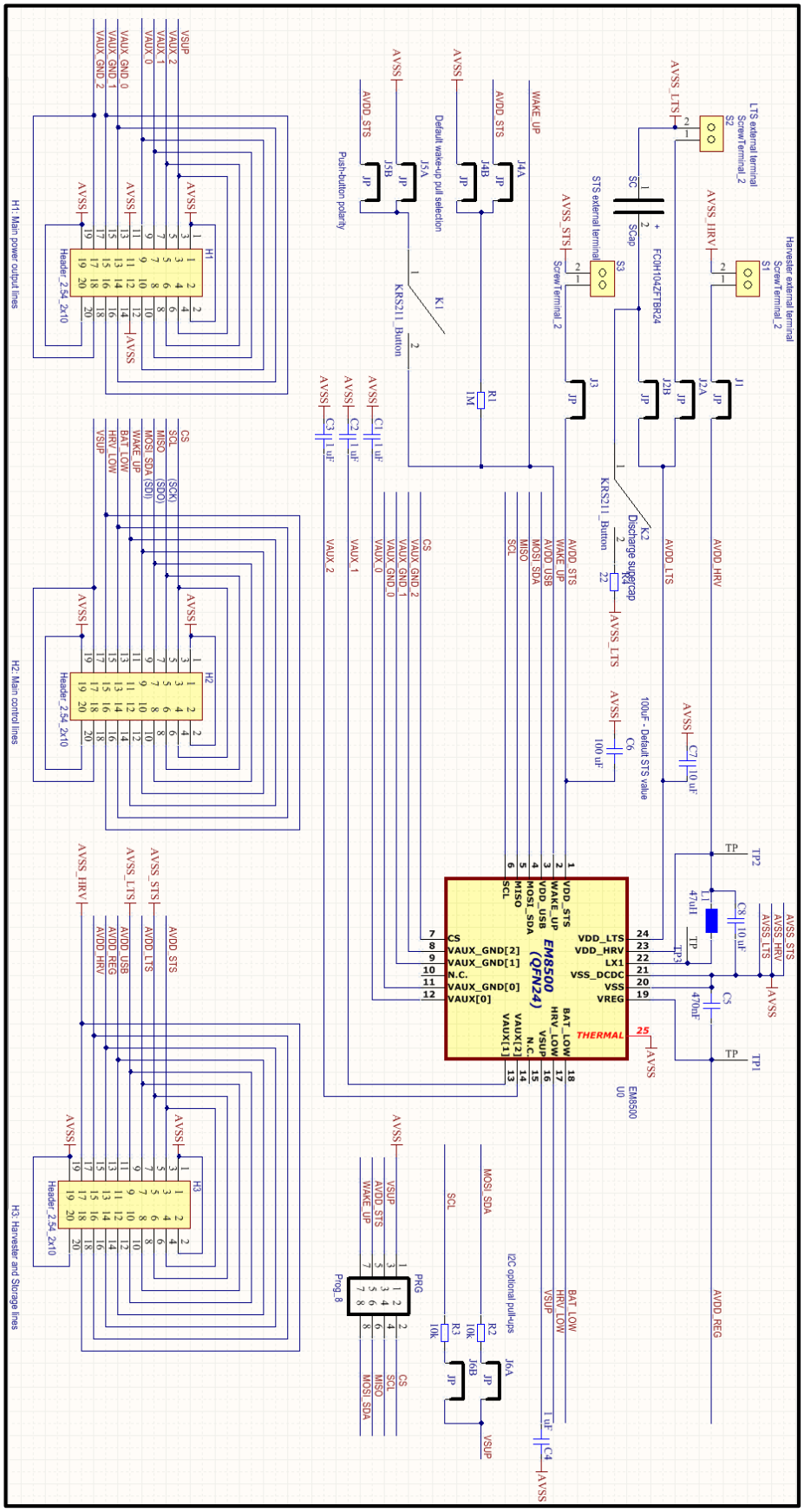



Figure 2-7: EMEVB8500 Schematic

## 2.5. BOM

| Designator | Part Description |
|---|---|
| C1,C2,C3,C4 | Capacitor SMD 2012 1uF |
| C5 | Capacitor SMD 2012 470nF |
| C6 | Capacitor SMD 3216 100uF |
| C7,C8 | Capacitor SMD 2012 10uF |
| EM8500 | EM harvester controller QFN24 |
| H1,H2,H3 | Header 2x10 2.54mm |
| J1,J2A,J2B,J3,J4A,J4B,J5A,J6A,J6B | Jumper 2.54mm |
| K1,K2 | Button C&K KSR211GLFS |
| L1 | Coil 47uH TDK VLS3012ET-470M |
| PRG | Header 2x4 2.54mm |
| R1 | Resistor SMD 2012 1M |
| R2,R3 | Resistor SMD 2012 10K |
| R4 | Resistor SMD 3216 22 |
| S1,S2,S3 | Screw Terminal TE Connectivity 1776275-2 |
| SC | Supercap Kemet FC0H104ZFTBR24 0.1F |

Table 2-5 Bill of Material

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