EMEVB8500 EVALUATION BOARD USER GUIDE

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1   INTRODUCTION

The EMEVB8500 board is targeted at rapid evaluation and prototyping of integrated energy harvesting solutions based on EM8500 series 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.

2   MAIN FEATURES

Hardware

- l   Long Term storage selection (on-board Supercap or external)
- l   Supercap discharge path
- l   Short term storage selection (on-board capacitor or external)
- l   External harvester selection
- l   Expansion header for prototyping and external connection
- l   Configurable wake-up line with push-button
- l   EM8500 series I2C pull-up selection

Software

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

Refer to EMPB85xx User Manual.
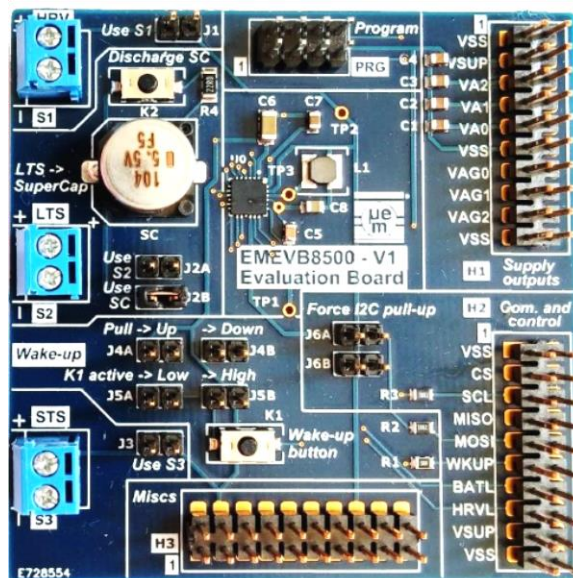
3   OVERVIEW

The EMEVB8500 exists in different variants to support each device of the EM8500 series. In this document without specific description the name 8500 applies for any members of the EM8500 series. Some particular description refers to specific parts (e.g: EM8500, EM8502,…).

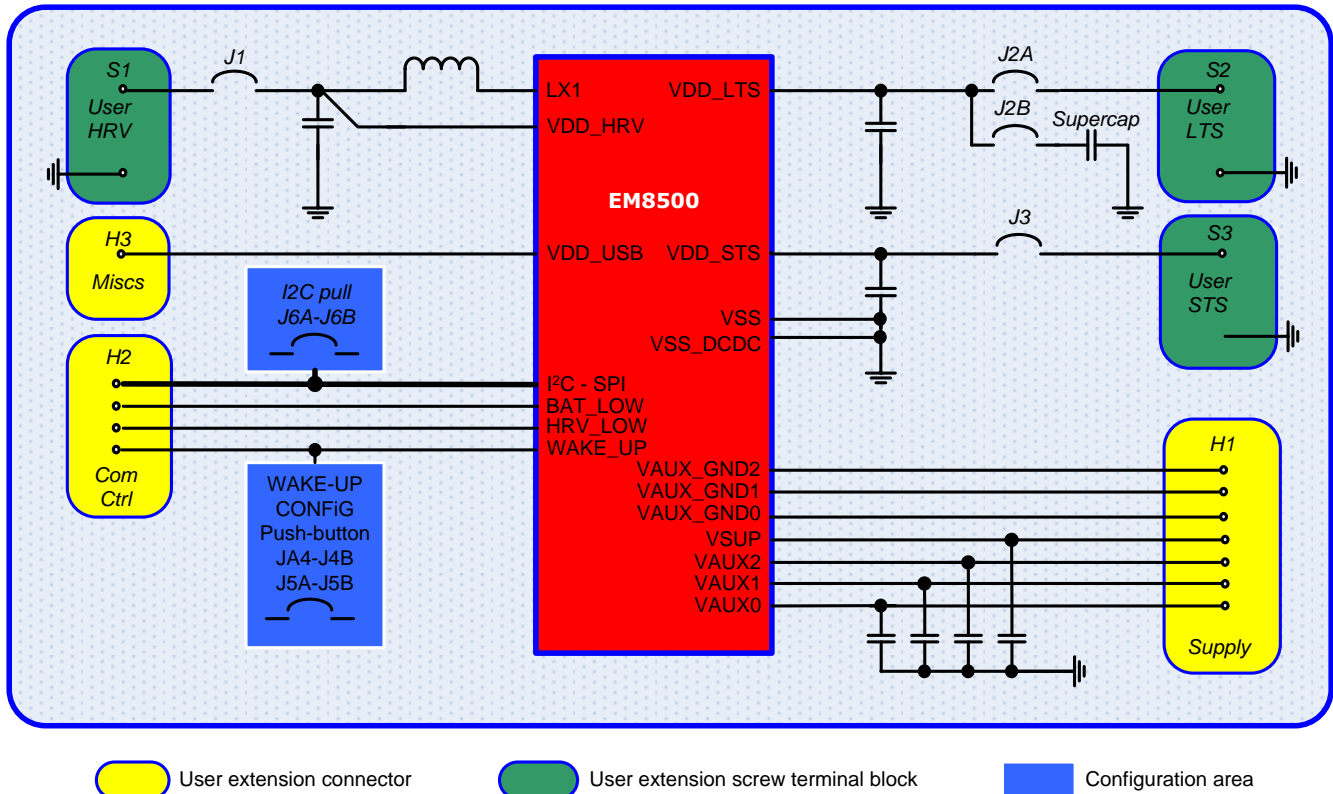The architecture of the EMEVB8500 is based on the following block diagram
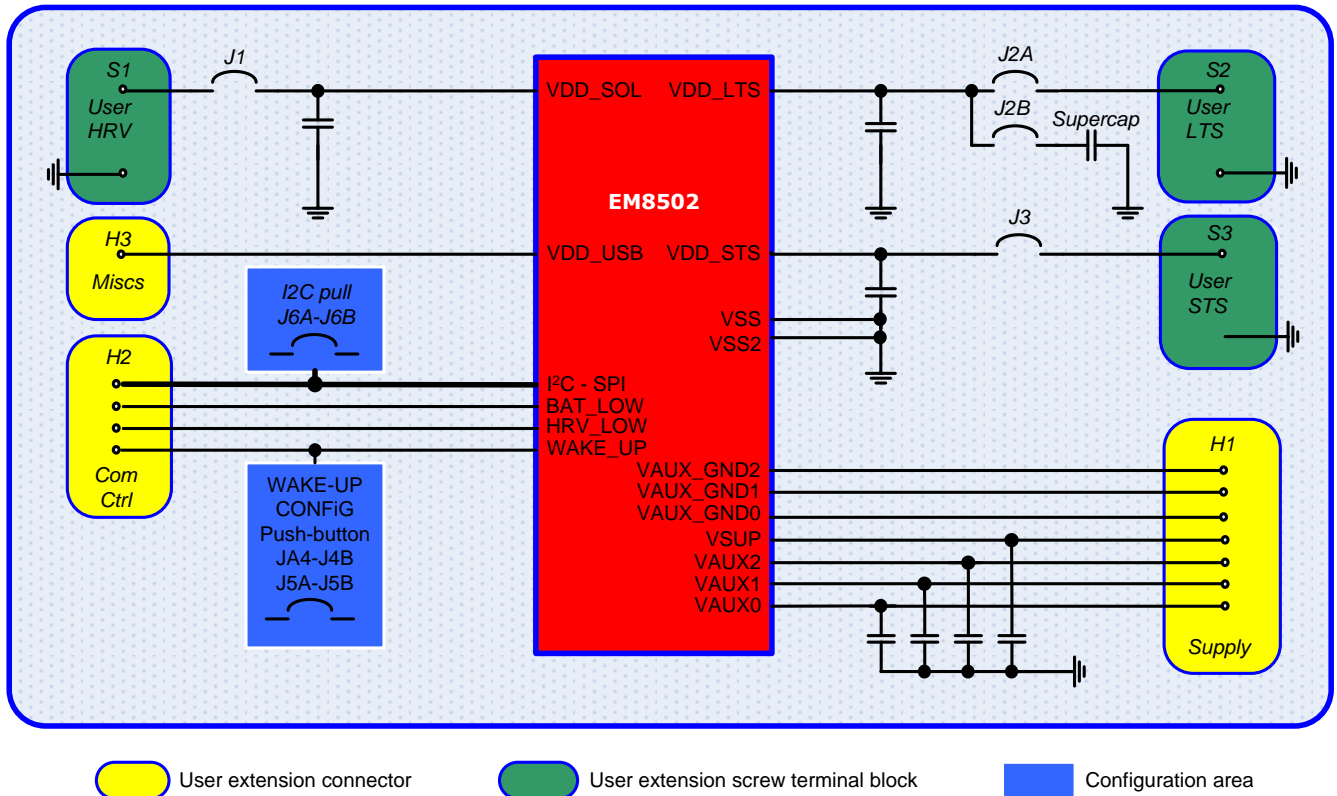

Figure 3-1 EMEVB8500 System Architecture for EM8500

Figure 3-2 EMEVB8500 System Architecture for EM8502

4   EMEVB8500 BOARD

4.1   DESCRIPTION

The board for EM8500 variant is equipped with:

l   EM8500 core design consisting of the EM8500 devices and required external components.

l   Extension header (H1) used to supply the application

l   Extension header (H2) used to interface the communication and control signals between application and EM8500.

l   Extension header (H3) used to expose other signals (STS, LTS, HRV, USB ...)

l   Extension header (PRG) used to configure the EM8500

l   Terminal block (S1) to connect any external harvester

l   Terminal block (S2) to connect an external Long Term Storage to LTS (primary or secondary storage)

l   Terminal block (S3) to connect an external Short Term Storage to STS

l   Supercap (SC) as LTS with a dedicated discharge path

l   Different jumper areas to select the terminal blocks or internal board resources and configure I2C lines or Wake-up line

l   Push button (K2) used for the Supercap discharging

l   Polarity configurable push button (K1) used for Wake-up control line.

The board for EM8502 variant is equipped with:

l   EM8502 core design consisting of the EM8502 devices and required external components.

l   Same as EM8500 variant

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).

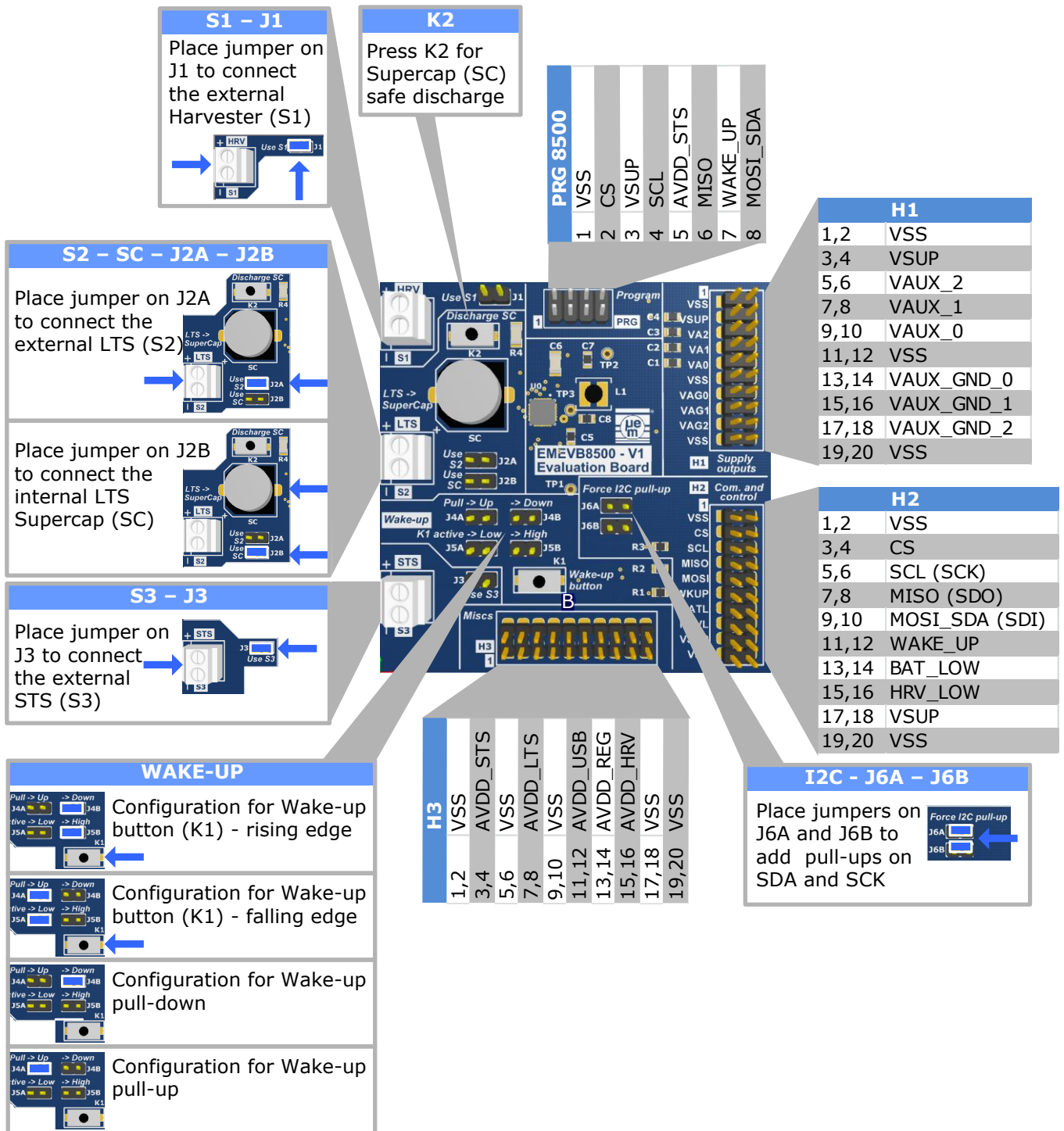S1, S2 and S3 are 2 pins screw terminal block (3.5 mm pitch).

S1 – J1

Place jumper on J1 to connect the external Harvester (S1)

K2

Press K2 for Supercap (SC) safe discharge

S2 – SC – J2A – J2B

Place jumper on J2A to connect the external LTS (S2)

Place jumper on J2B to connect the internal LTS Supercap (SC)

S3 – J3

Place jumper on J3 to connect the external STS (S3)

WAKE-UP

Configuration for Wake-up button (K1) - rising edge

Configuration for Wake-up button (K1) - falling edge

Configuration for Wake-up pull-down

Configuration for Wake-up pull-up

I2C - J6A – J6B

Place jumpers on J6A and J6B to add pull-ups on SDA and SCK

PRG 8500		
1	VSS	
2	CS	
3	VSUP	
4	SCL	
5	AVDD_STS	
6	MISO	
7	WAKE_UP	
8	MOSI_SDA	

H1	
1,2	VSS
3,4	VSUP
5,6	VAUX_2
7,8	VAUX_1
9,10	VAUX_0
11,12	VSS
13,14	VAUX_GND_0
15,16	VAUX_GND_1
17,18	VAUX_GND_2
19,20	VSS

H2	
1,2	VSS
3,4	CS
5,6	SCL (SCK)
7,8	MISO (SDO)
9,10	MOSI_SDA (SDI)
11,12	WAKE_UP
13,14	BAT_LOW
15,16	HRV_LOW
17,18	VSUP
19,20	VSS

H3										
	VSS	AVDD_STS	VSS	AVDD_LTS	VSS	AVDD_USB	AVDD_REG	AVDD_HRV	VSS	VSS
	1,2	3,4	5,6	7,8	9,10	11,12	13,14	15,16	17,18	19,20

Figure 4-1: EMEVB8500 Description

4.2   FEATURES DESCRIPTION

4.2.1   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 series ground)
2	VSS	Supply		System ground connection (EM8500 series 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 series ground)
12	VSS	Supply		System ground connection (EM8500 series 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 series ground)
20	VSS	Supply		System ground connection (EM8500 series ground)

Table 4-1 H1 Pin-out description

4.2.2   H2 extension connector

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

NO.	PIN NAME	I/O TYPE DIRECTION(*)	SUPPLY	DESCRIPTION
1	VSS	Supply		System ground connection (EM8500 series ground)
2	VSS	Supply		System ground connection (EM8500 series 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 series ground)
20	VSS	Supply		System ground connection (EM8500 series ground)

Table 4-2 H1 Pin-out Description

4.2.3   H3 extension connector

H3 connects/monitors several other signals

NO.	PIN NAME	I/O TYPE		DESCRIPTION
		DIRECTION(*)	SUPPLY	
1	VSS	Supply		System ground connection (EM8500 series ground)
2	VSS	Supply		System ground connection (EM8500 series 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 series ground)
6	VSS	Supply		System ground connection (EM8500 series 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 series ground)
10	VSS	Supply		System ground connection (EM8500 series 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 (VDD_SOL)	Input		Connection for energy harvester
16	VDD_HRV (VDD_SOL)	Input		Connection for energy harvester
17	VSS	Supply		System ground connection (EM8500 series ground)
18	VSS	Supply		System ground connection (EM8500 series ground)
19	VSS	Supply		System ground connection (EM8500 series ground)
20	VSS	Supply		System ground connection (EM8500 series ground)

Table 4-3 H3 Pin-out Description

4.2.4   PRG extension connector

A dedicated connector is available to access all required lines used to configure the EM8500 series (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.

NO.	PIN NAME	I/O TYPE		DESCRIPTION
		DIRECTION(*)	SUPPLY	
1	VSS	Supply		System ground connection (EM8500 series 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 4-4 PRG Pin-out Description

4.2.5 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 (VDD_SOL pin of the EM8502), a jumper must be placed on J1.

Figure 4-2: 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 series ESD protection diode connected to VSS.

4.2.6 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 series, a jumper must be placed on J2A (Jumper on J2B must be removed).
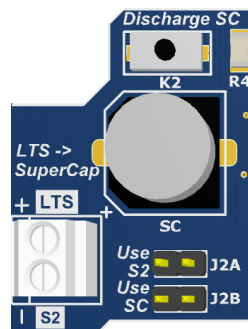
Figure 4-3: EMEVB8500 LTS, S2 & K2 View

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 series ESD protection diode connected to VSS and may damage the LTS. When using a battery, do not connect battery with reversed polarity.

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4.2.7 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 series, a jumper must be placed on J3.
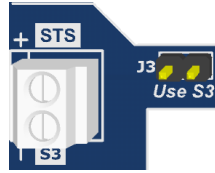
Figure 4-4: EMEVB8500 STS & S3 View

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 series ESD protection diodes connected to VSS and may damage the device.

4.2.8   WAKE-UP control line

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

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

Configuration for Wake-up button (K1) - falling edge

Configuration for Wake-up button (K1) - rising edge

Configuration for Wake-up pull-down

Configuration for Wake-up pull-up

Configuration for Wake-up floating
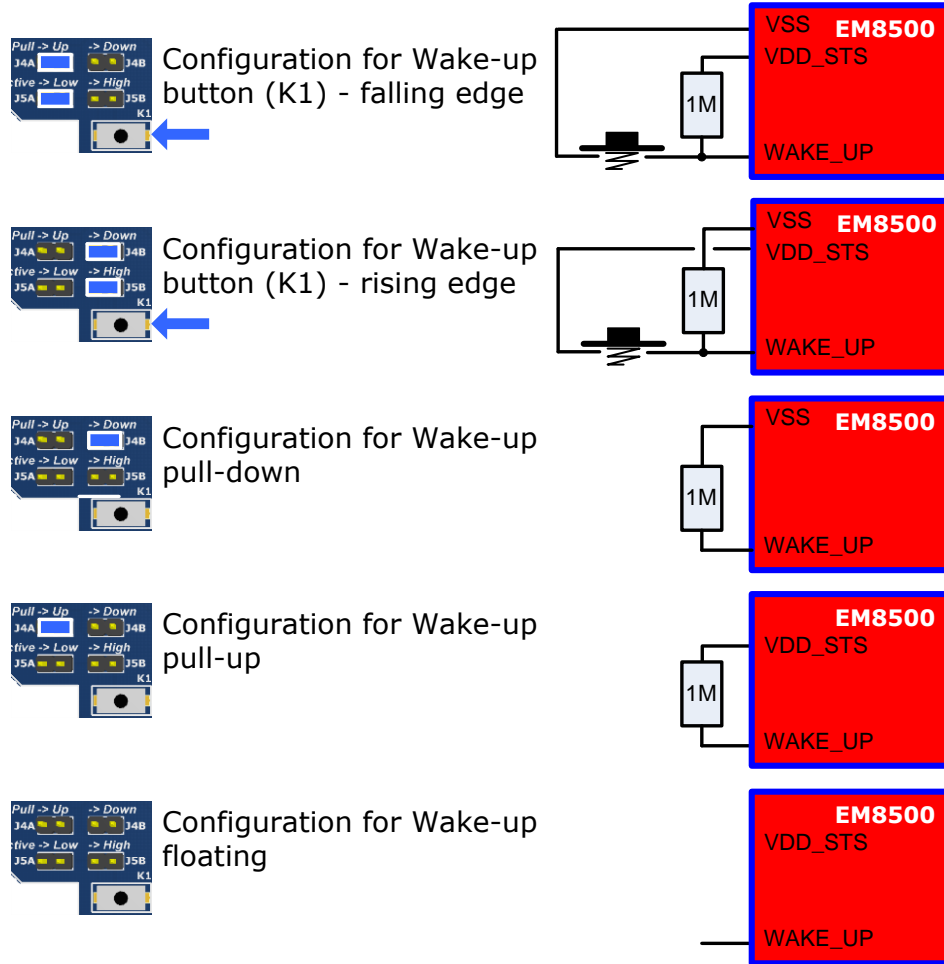
Figure 4-5: EMEVB8500 WAKE-UP multiple Configuration Examples

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4.2.9 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 4-6: EMEVB8500 I2C Pull-ups Configuration

4.3 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 series 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.

4.4   SCHEMATIC

Figure 4-7: EMEVB8500 Schematic
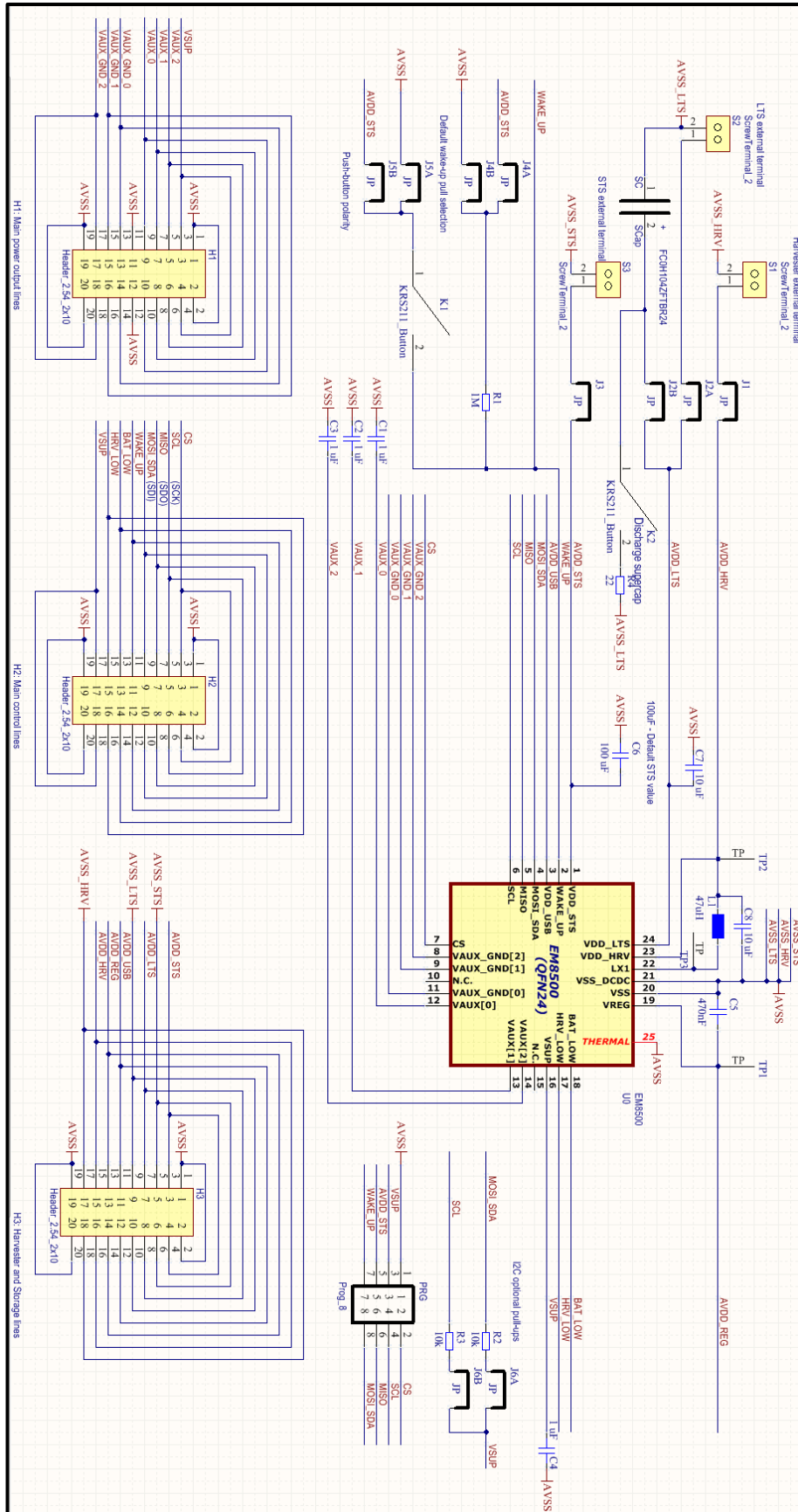
Note: The schematics for EM8500 and EM8502 devices are based on Figure 4-7: EMEVB8500 Schematic. The differences for each variant are listed in the

Table 4-5 EMEVB8500 schematic *variant*

Schematic Name	EM8500 Variant	EM8502 Variant
L1	Coil 47uH	Resistor 0 ohm
EM8500 Symbol – pin name VDD_HRV	Pin name VDD_HRV	No Connect pin
EM8500 Symbol – pin name LX1	Pin name LX1	Pin name VDD_SOL
EM8500 Symbol – pin name VSS_DCDC	Pin name VSS_DCDC	Pin name VSS2
EM8500 Symbol	EM8500 device	EM8502 device

Table 4-5 EMEVB8500 schematic variant description

4.5   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	EM8500 harvester controller QFN24 (EM8500 variant) EM8502 harvester controller QFN24 (EM8502 variant)
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 (EM8500 variant) Resistor SMD 3216 0 (EM8502 variant)
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 4-6 Bill of Material

5   LIST OF FIGURES

6   LIST OF TABLES