EMEVB85xx EVALUATION BOARD USER GUIDE

TABLE OF CONTENTS

1 INTRODUCTION

The EM85xx naming shall be used in this document as a generic part number name for EM85xx devices.

The EMEVB85xx naming shall be used in this document as a generic part number name for EM85xx evaluation board.

The EMEVB85xx board is targeted at rapid evaluation and prototyping of integrated energy harvesting solutions based on EM85xx devices. The evaluation board offers a set of features to show the performance of EM85xx hardware applications.

The EMEVB85xx board allows flexibility with various configuration, external harvester input, internal or external storage elements and user connections.

2 MAIN FEATURES

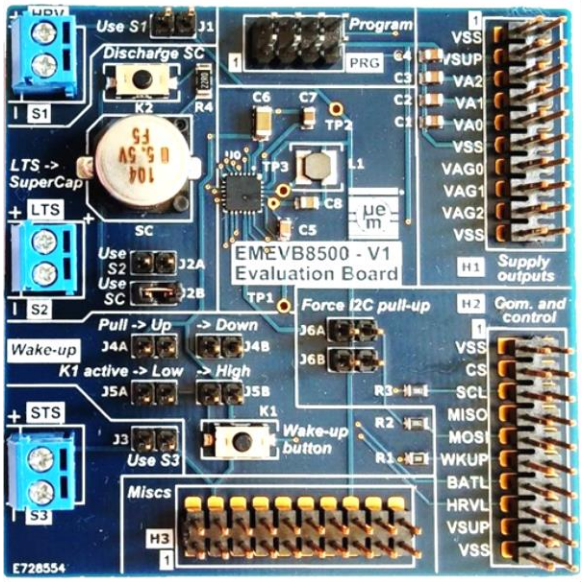
Hardware

- 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
- EM85xx I2C pull-up selection

Software

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

Refer to EMPB85xx User Manual.



3 OVERVIEW

The EMEVB85xx exists in different variants to support each device of the EM85xx devices. In this document without specific description the name 85xx applies for any members of the EM85xx product family. Some particular description refers to specific parts (e.g: EM8500, EM8502, EM8504,…).

The architecture of the EMEVB85xx is based on the following block(s) diagram(s)

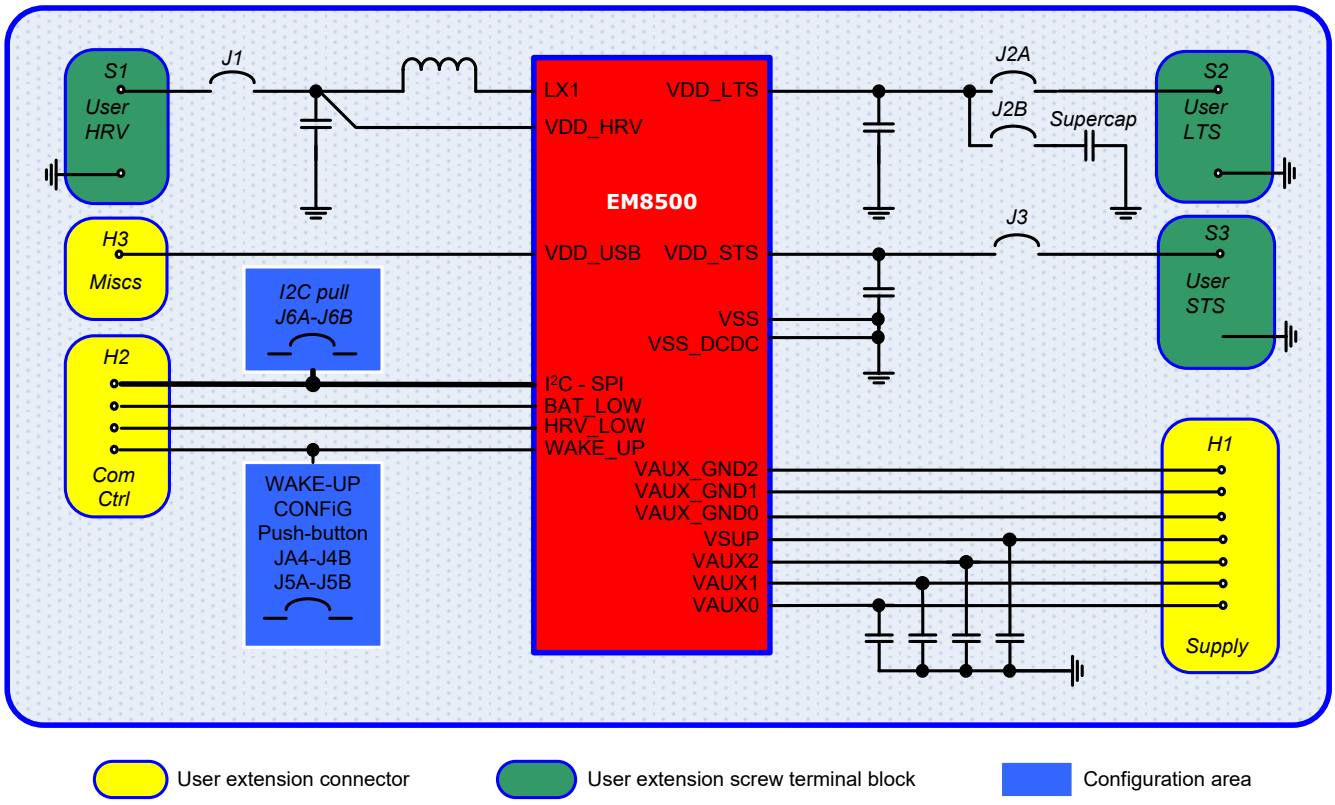


Figure 3-1 EMEVB8500 System Architecture for EM8500

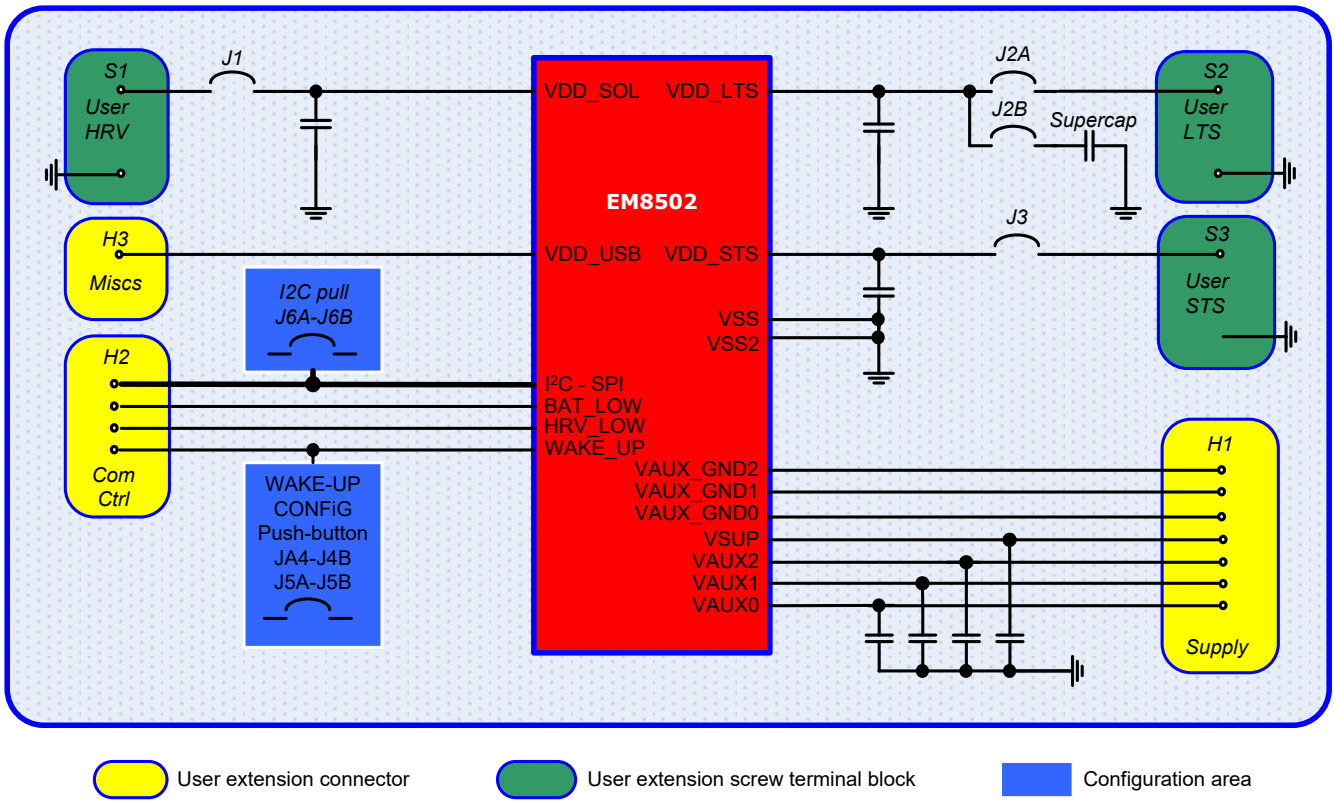


Figure 3-2 EMEVB8502 System Architecture for EM8502

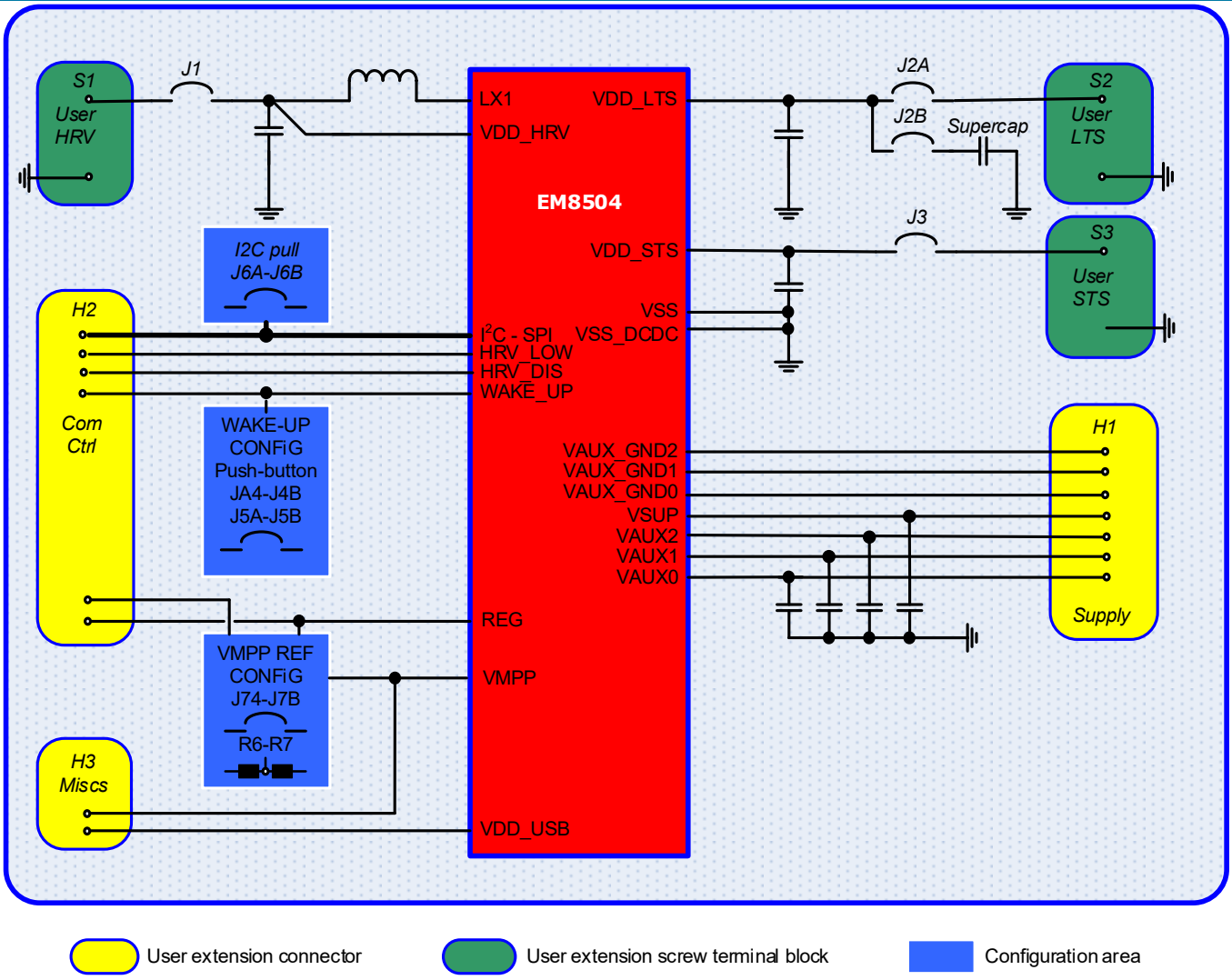


Figure 3-3 EMEVB8504 System Architecture for EM8504

4 EMEVB85XX BOARD

4.1 DESCRIPTION

The board for EM8500 variant 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 for EM8502 variant is equipped with:

- EM8502 core design consisting of the EM8502 devices and required external components.
- Same as EM8500 variant

The board for EM8504 variant is equipped with:

- EM8504 core design consisting of the EM8504 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 EM8504.
- Extension header (H3) used to expose other signals (STS, LTS, HRV, USB ...)
- Extension header (PRG) used to configure the EM8504
- 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, Wake-up line, VMPP
- 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).

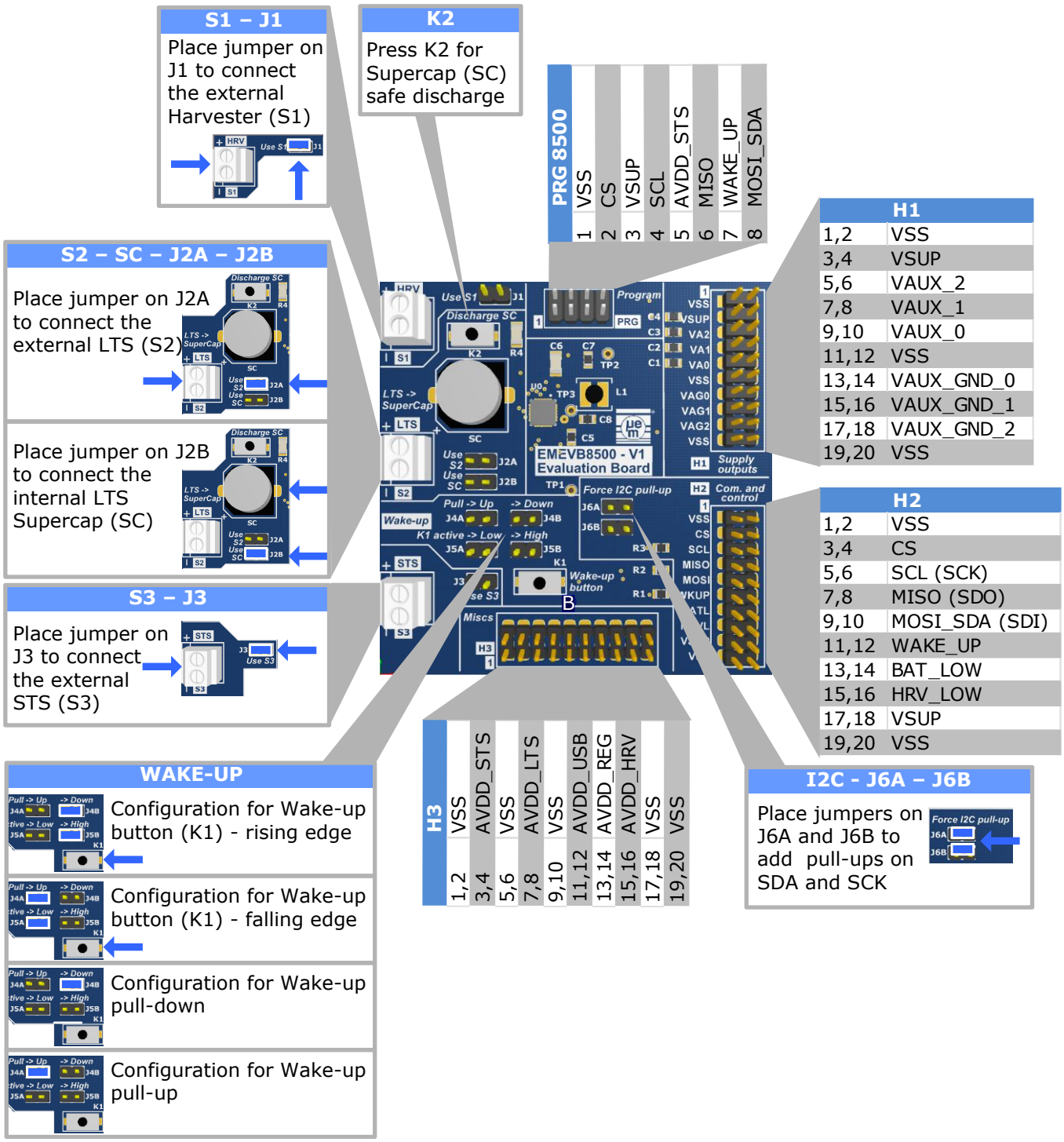


Figure 4-1: EMEVB8500 / EMEVB8502 Description

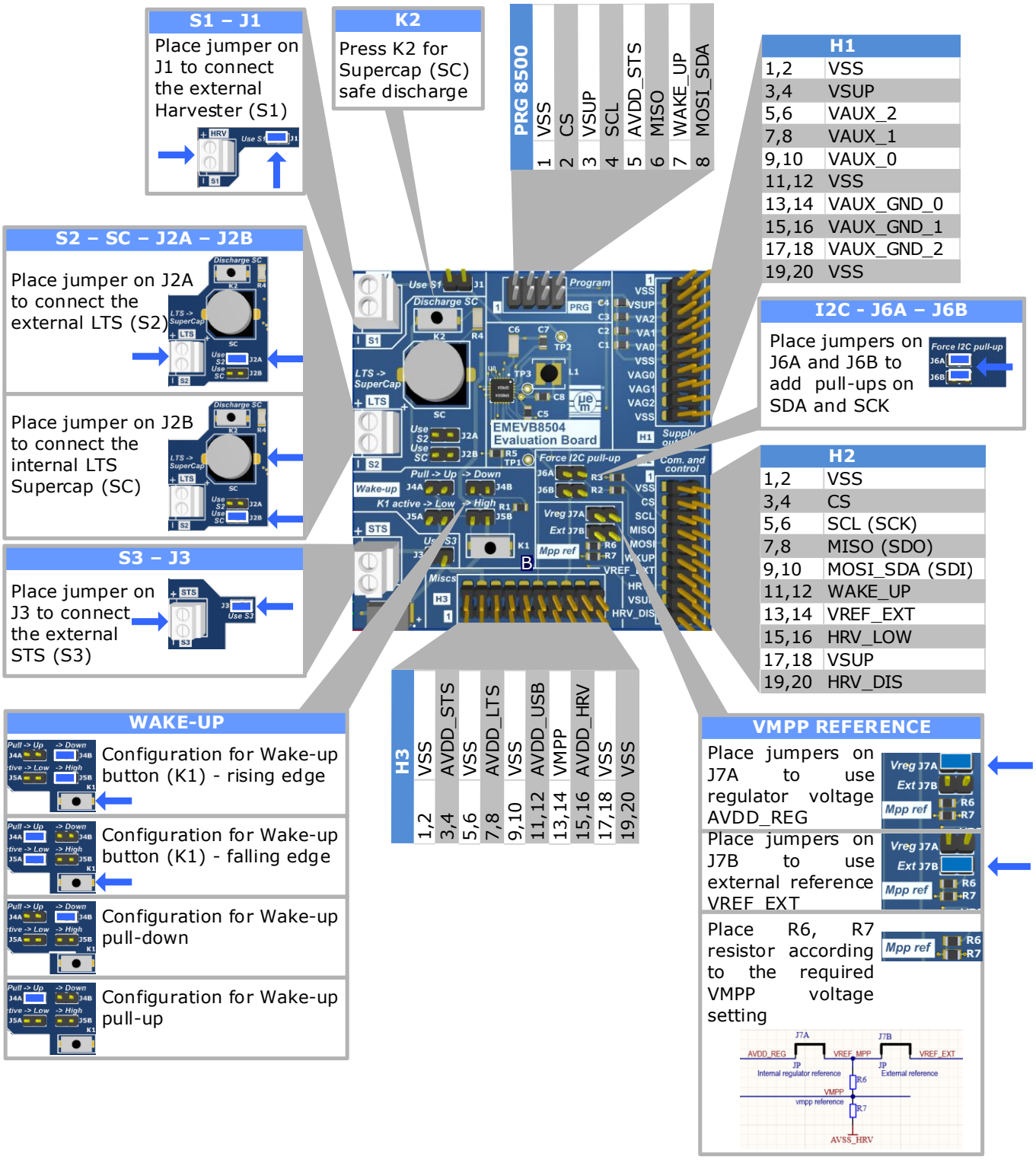


Figure 4-2: EMEVB8504 Description

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 for EMEVB8500 / EMEVB8502

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 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 H2 Pin-out Description for EMEVB8500 / EMEVB8502

4.2.3 H2 extension connector for EMEVB8504

H2 connects the SPI/I2C communication lines VREF_EXT, HRV_DIS and HRV_LOW control lines

		I/O TYPE		DESCRIPTION
NO.	PIN NAME	DIRECTION(*)	SUPPLY	
1	VSS	Supply		System ground connection (EM8504 device ground)
2	VSS	Supply		System ground connection (EM8504 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

		I/O TYPE		DESCRIPTION
NO.	PIN NAME	DIRECTION(*)	SUPPLY	
12	WAKE_UP	Input	All (STS)	Wake-up pin
13	VREF_EXT	Output	VSUP	External MPP voltage reference input
14	VREF_EXT	Output	VSUP	External MPP voltage reference input
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	HRV_DIS	Supply		Harvester DCDC disable pin
20	HRV_DIS	Supply		Harvester DCDC disable pin

Table 4-3 H2 Pin-out Description for EMEVB8504

4.2.4 H3 extension connector for EMEVB8500 / EMEVB8502

H3 connects/monitors several other signals

		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	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 4-4 H3 Pin-out Description for EMEVB8500 / EMEVB8502

4.2.5 H3 extension connector for EMEVB8504

H3 connects/monitors several other signals

		I/O TYPE		DESCRIPTION
NO.	PIN NAME	DIRECTION(*)	SUPPLY	
1	VSS	Supply		System ground connection (EM8504 device ground)
2	VSS	Supply		System ground connection (EM8504 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 (EM8504 device ground)
6	VSS	Supply		System ground connection (EM8504 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 (EM8504 device ground)
10	VSS	Supply		System ground connection (EM8504 device ground)
11	VREG	Output		Regulated voltage connection
11	VREG	Output		Regulated voltage connection
13	VMPP	Input		Maximum Power Point reference pin
14	VMPP	Input		Maximum Power Point reference pin
15	VDD_HRV	Input		Connection for energy harvester
16	VDD_HRV	Input		Connection for energy harvester
17	VSS	Supply		System ground connection (EM8504 device ground)
18	VSS	Supply		System ground connection (EM8504 device ground)
19	VSS	Supply		System ground connection (EM8504 device ground)
20	VSS	Supply		System ground connection (EM8504 device ground)

Table 4-5 H3 Pin-out Description for EMEVB8504

4.2.6 PRG extension connector

A dedicated connector is available to access all required lines used to configure the EM85xx devices (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 (EM85xx 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 4-6 PRG Pin-out Description

4.2.7 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.

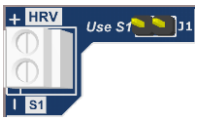


Figure 4-3: EMEVB85xx HRV & S1 View

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 EM85xx series ESD protection diode connected to VSS.

4.2.8 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 EM85xx devices, a jumper must be placed on J2A (Jumper on J2B must be removed).

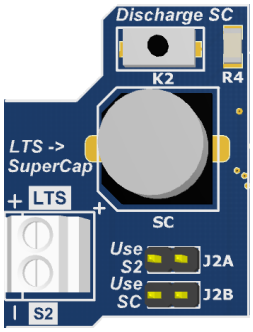


Figure 4-4: EMEVB85xx LTS, S2 & K2 View

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 EM85xx devices ESD protection diode connected to VSS and may damage the LTS. When using a battery, do not connect battery with reversed polarity.

4.2.9 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 EM85xx devices, a jumper must be placed on J3.

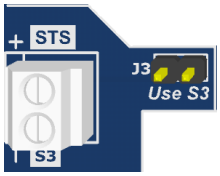


Figure 4-5: EMEVB85xx STS & S3 View

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 EM85xx devices ESD protection diodes connected to VSS and may damage the device.

4.2.10 WAKE-UP control line

The WAKE_UP pin of the EM85xx devices is available for external connection or can be driven by push button K1.

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

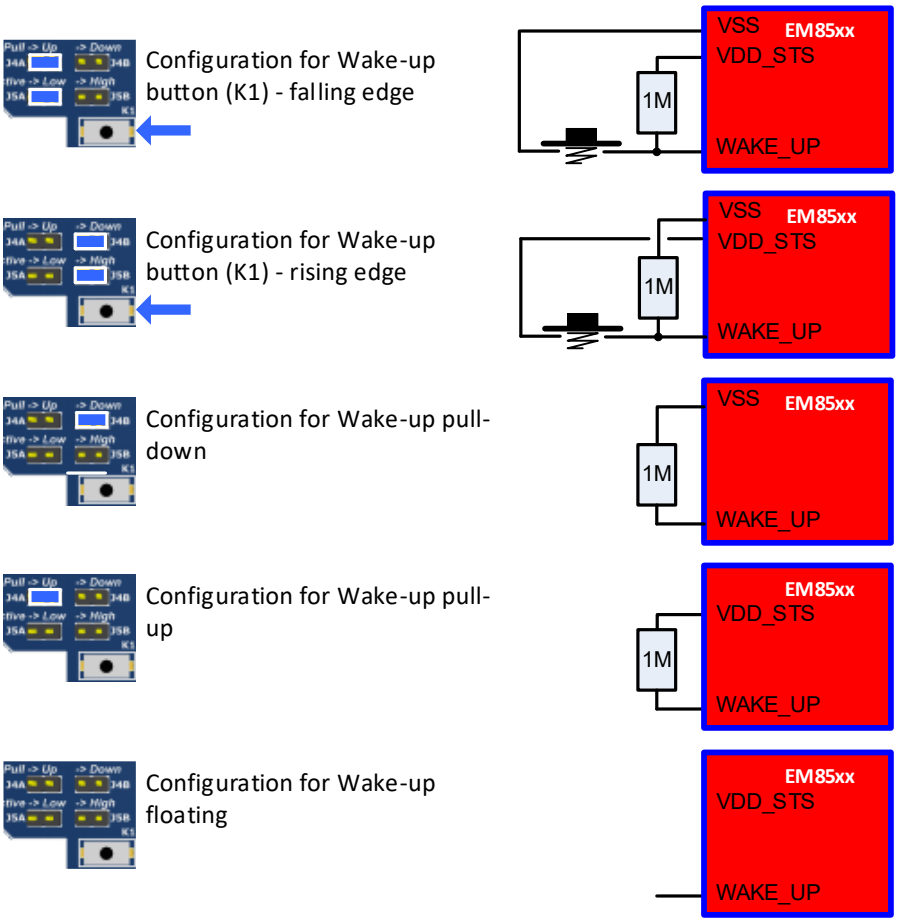


Figure 4-6: EMEVB85xx WAKE-UP multiple Configuration Examples

4.2.11 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 4-7: EMEVB85xx I2C Pull-ups Configuration

4.2.12 VMPP configuration for EMEVB8504

To efficiently support different DC sources, EM8504 offers a configurable MPPT controller with external reference. The MPP target voltage applied on VMPP indicates to the DCDC what level it has to regulate on VDD_HRV. This target voltage must be set at the point the solar cell delivers the maximum power. The evaluation board offers flexibility to apply this voltage on VMPP pin.

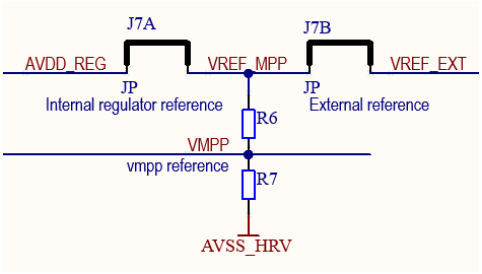


Figure 4-8: EMEVB8504 VMPP configuration schematic

VMPP is set by the resistor bridge R6 and R7. The voltage supplying the resistor bridge can be selected by J7A and J7B. By using J7A the VMPP voltage will be based on the EM8504 regulator voltage. By using J7B the VMPP voltage will be based on the external voltage VREF_EXT (available on the H2 connector pins 13 and 14).

Figure 4-9: EMEVB8504 VMPP configuration schematic configuration area

By default, the bridge's resistors R6 and R7 are not assembled. The footprint resistors R6 and R7 are available on the board to assemble the resistors (SMD 2012/1206) according to the required voltage.

4.2.13 HRV_dis for EMEVB8504

The pin HRV_DIS is available on the Header H2 (position 19, 20). By default, the line is left open. A footprint resistor R5 is available on the board to assemble a pull-down resistor (SMD 2012/1206).

Figure 4-10: EMEVB8504 HRV_DIS Pull-down resistor 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 FOR EMEVB8500 / EMEVB8502

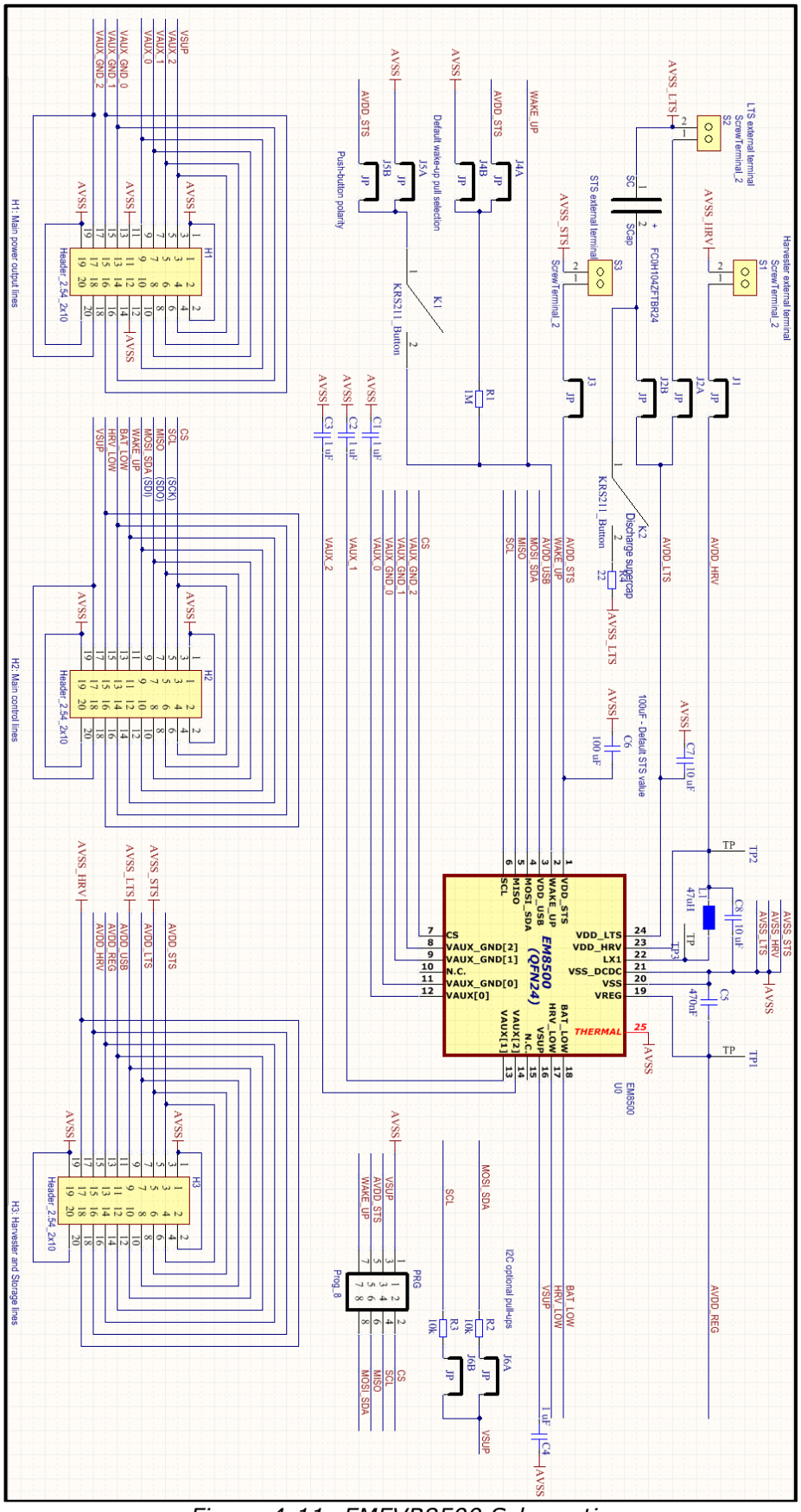


Figure 4-11: EMEVB8500 Schematic

Note: The schematics for EM8500 and EM8502 devices are based on Figure 4-11: EMEVB8500 Schematic. The differences for each variant are listed in the

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 4-7 EMEVB8500 / EMEVB8502 schematic variant description

4.5 SCHEMATIC FOR EMEVB8504

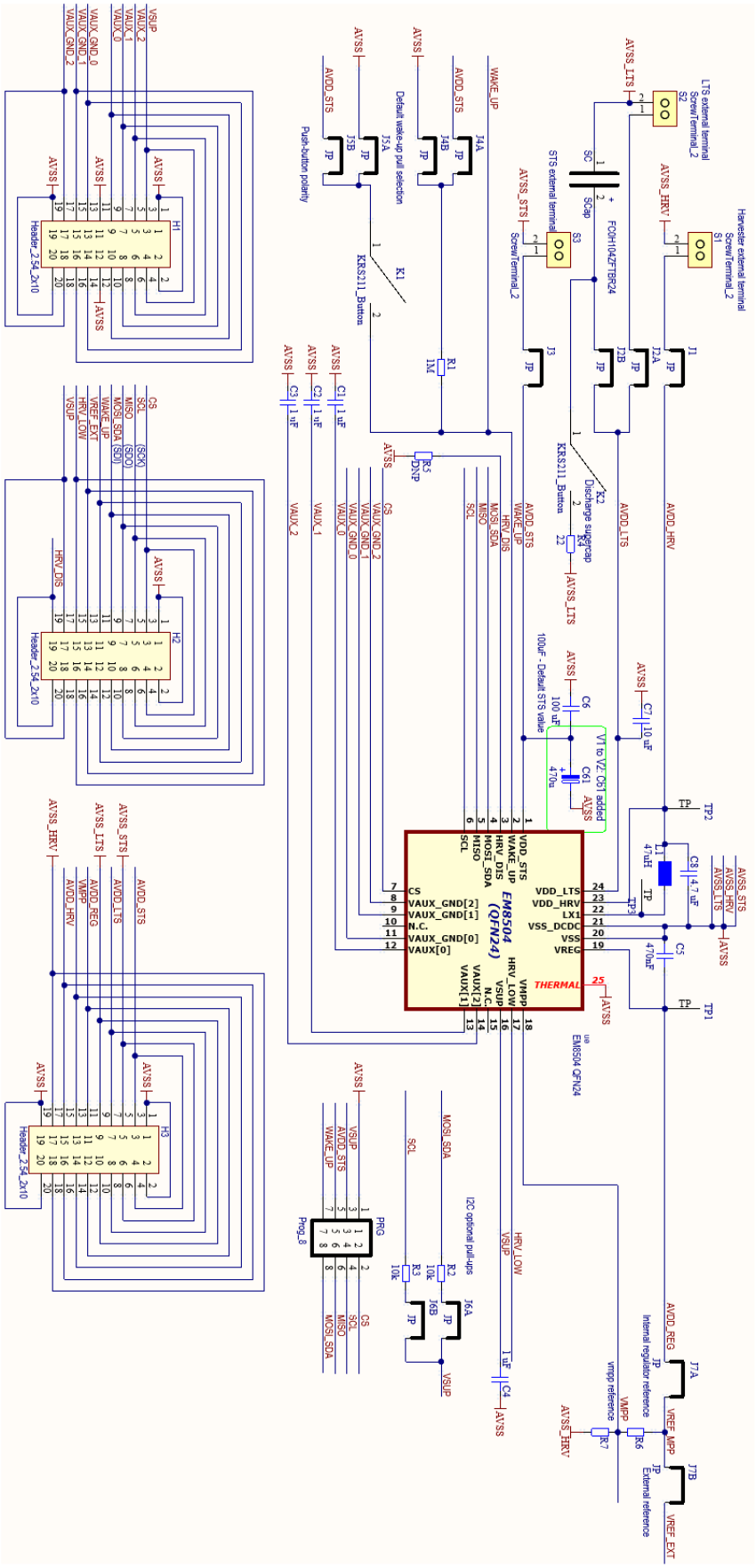


Figure 4-12: EMEVB8504 Schematic

4.6 BILL OF MATERIAL FOR EMEVB8500 / EMEVB8502

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 4-8 Bill of Material for EMEVB8500 / EMEVB8502

4.7 BILL OF MATERIAL FOR EMEVB8504

Designator	Part Description
C1,C2,C3,C4	Capacitor SMD 2012 1uF
C5	Capacitor SMD 2012 470nF
C6	Capacitor SMD 3216 100uF
C7	Capacitor SMD 2012 10uF
C8	Capacitor SMD 2012 4.7uF
EM8504	EM8504 harvester controller QFN24
H1,H2,H3	Header 2x10 2.54mm
J1,J2A,J2B,J3,J4A,J4B,J5A,J6A,J6B, J7A, J7B	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
R5,R6,R7	Resistor SMD 2012 – Not assembled
S1,S2,S3	Screw Terminal TE Connectivity 1776275-2
SC	Supercap Kemet FC0H104ZFTBR24 0.1F

Table 4-9 Bill of Material for EMEVB8504

5 LIST OF FIGURES

6 LIST OF TABLES

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