

How to use the AEK-POW-BMSLV battery management system evaluation board for low-voltage applications

Introduction

The **AEK-POW-BMSLV** evaluation board combines advanced features with an efficient design, providing a complete solution for optimizing the performance and durability of 48 V battery systems.

The AEK-POW-BMSLV has been specifically designed to manage the battery management system for low-voltage applications: applications whose voltage range is below 60 V, for example, motorcycles auxiliary power and electric bikes.

The AEK-POW-BMSLV is built with automotive-grade components. It can be connected to a battery pack to monitor both the state of charge (SOC) and state of health (SOH) of each battery.

It hosts the following devices: SPC58EC80E5, L9963E, L9963T, SPSB100 (customized version with CAN port), and VNQ7050AJ.

The SPC58EC80E5 automotive-grade microcontroller is responsible for calculating the SOC and the SOH of the battery pack connected, based on the measurement provided by the L9963E through the L9963T ISOSPI to SPI transceiver.

The SPSB100 power management integrated circuit (PMIC) has been integrated in this board as a customized version. This version features an embedded CAN-FD transceiver able to address and transmit the relevant information from the AEK-POW-BMSLV to an external domain control zone.

Thanks to the L9963T transceiver, the MCU, and the L9963E communicate through the ISOSPI protocol, implementing differential communication for higher noise immunity. This is not strictly required considering that it is a low voltage application, but it opens the possibility for easy extension to the high voltage case.

The main activity of the L9963E is monitoring cells through stack voltage measurement, cell voltage measurement, temperature measurement, and coulomb counting. Measurement and diagnostic tasks can be executed either on demand or periodically, with a programmable cycle interval.

The main functions of a standard BMS are monitoring and protecting the battery pack. The protection function brings the system to a safe state in case of under/overvoltage and overheating. Our board safety features include overload and overvoltage protection, against potential issues that could compromise battery integrity, alongside overdischarge protection to prevent excessive discharge and extend battery life.

Its compact dimensions (145x65 mm) ensure easy integration into various applications requiring precise battery management. Moreover, it offers customizable features such as cell voltage and temperature sensing, cell balancing, safety monitoring, diagnostics algorithms, fault detection and storage, auxiliary battery voltage measurement, and several control systems.

It also manages battery balancing by passive discharge, thanks to the software already preloaded on the on-board SPC58EC80E5 microcontroller.

The versatile CAN2.0A/B protocol facilitates integration into several systems and efficient component communication.

The AEK-POW-BMSLV is equipped with two CAN ports for flexible networked connections, while four high-side channels outputs optimized power distribution. The BMS adjusts to various battery configurations, supporting up to 14 series-connected cells.

The AEK-POW-BMSLV features an elaborate monitoring network to sense the voltage of each cell, the current of the entire battery pack and the cell temperature through 8 external thermistors (not included in the package) to be placed according to your application requirements. This sensing allows elaborating the SOC of each battery cell and, consequently, the state of charge of all battery packs.

The SOC allows assessing the remaining battery capacity. For maintenance reasons, it is important to monitor the SOC estimation over time.

AEK-POW-BMSLV core features ensure battery health and longevity. Continuous voltage monitoring provides real-time information about the battery status, enabling quick detection of deviations from ideal voltage levels, ensuring reliability, and preventing potential issues.

According to our algorithm based on an extended Kalman filter for the SOC calculation, the more the SOC differs from its nominal value (that is, its value when the batteries are new), the more a cell of the battery pack risks overdischarge.

Thus, the SOC evolution over time allows asserting the state of health (SOH) of a cell or a battery pack to spot early indications that a cell is at risk of overdischarge or overcharging.

The SOC of a battery cell is required to maintain its safe operation during charge, discharge, and storage.

However, SOC cannot be measured directly and is estimated from other measurements and known parameters (such as characterization curves or look-up tables). This information on the battery cells is necessary to determine how the voltage varies according to the current, the temperature, etc., based on the battery chemical composition and production lot used.

In the AutoDevKit ecosystem, we developed a demo application based on the SPC58EC80E5 microcontroller, to estimate the SOC of 14 cells in a BMS node connected with an AEK-POW-BMSLV evaluation board.

The results of SOC estimation, cell voltage, battery pack temperatures and current can be printed via the serial port to a terminal on the PC with a speed rate of 115200 bps.

Important: *The AEK-POW-BMSLV evaluation board is designed for R&D laboratory use only. It is not intended for field use in vehicles. Moreover, it is not a reference design. Its purpose is evaluation and not production as stated in our Terms of use*

Figure 1. AEK-POW-BMSLV evaluation board

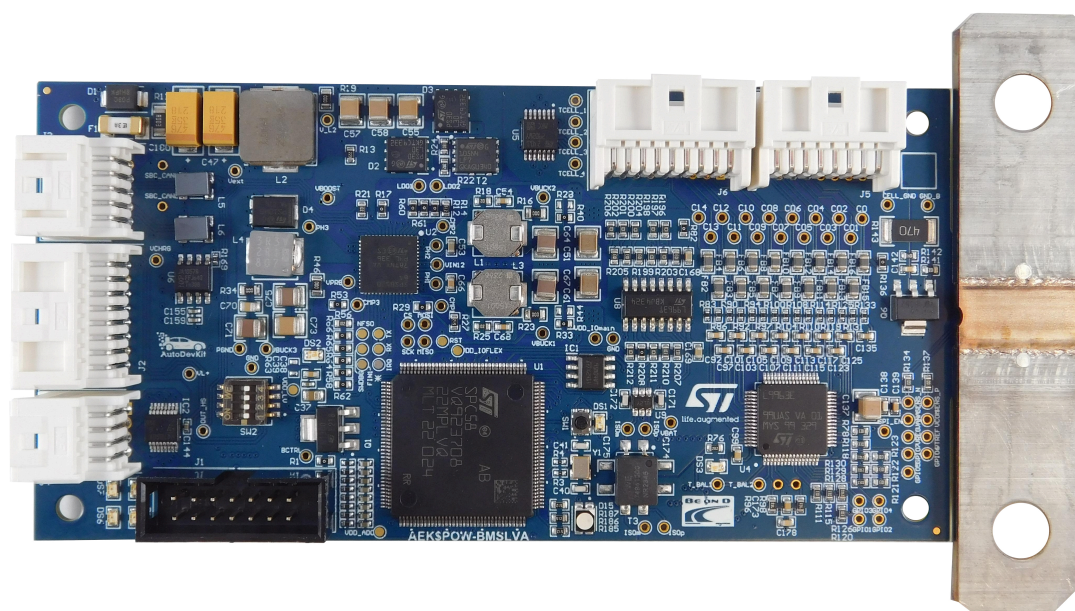
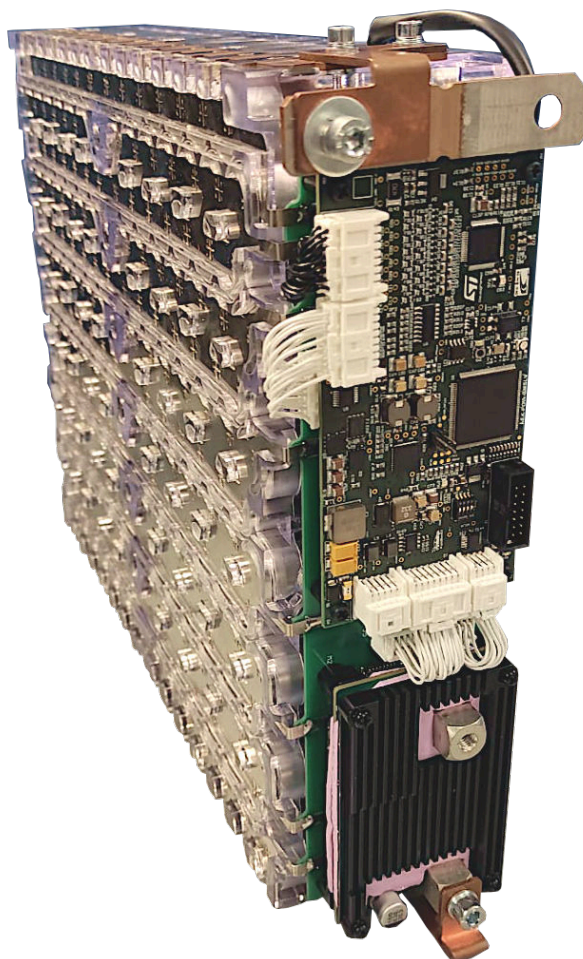


Figure 2. Application example: AEK-POW-BMSLV connected with a demo battery pack

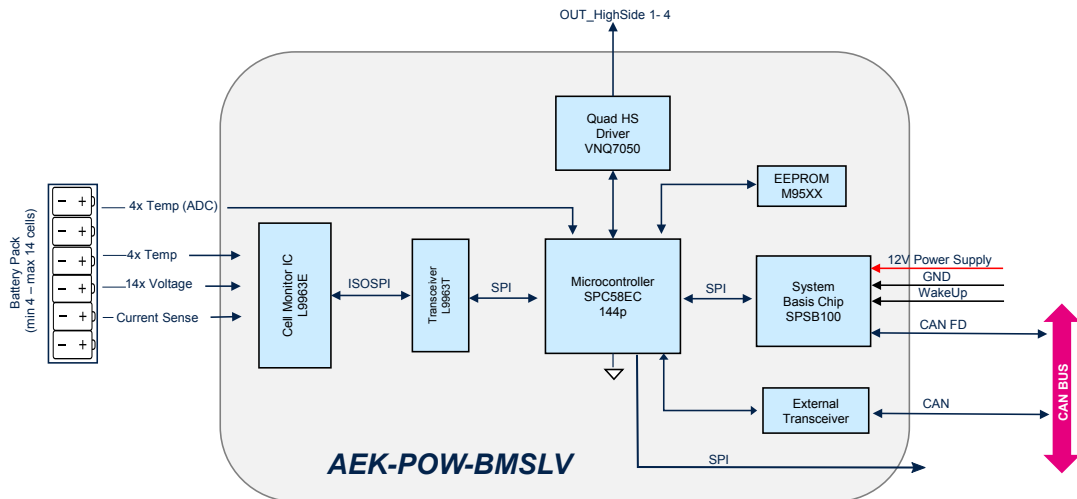


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1 Hardware overview

1.1 Block diagram

Figure 3. AEK-POW-BMSLV architecture



1.2 Board features

- Low-voltage (<60V) single board for a complete battery management system (BMS)
- Hosts:
 - L9963E AEC-Q100 qualified automotive multicell battery monitoring and balancing IC
 - L9963T AEC-Q100 qualified automotive general-purpose SPI to isolated SPI bidirectional transceiver
- SPC58EC80E5 microcontroller automotive grade to perform charge balancing and to compute the state of charge (SOC) and the state of health (SOH)
- VNQ7050AJ quad channel high-side driver for battery pack contactor driving
- SPSB100 (custom version with CAN port) fully integrated power management system IC of which the following features have been implemented on the board:
 - CAN FD transceiver for external communication
- Additional external CAN transceiver
- SPI for external communication
- Configurable window watchdog
- System wake-up feature and ignition wake-up
- Fault collection control unit (FCCU) used to collect eventual issues raised by the micro and according to an implemented logic perform some actions like system shutdown
- Fail-safe diagnosis from SPSB100 to microcontroller
- Voltage and current monitoring of every single cell and of the entire battery node
- 8 GPIOs to connect temperature sensors as NTCs, of which four GPIOs wired to the microcontroller while the other four to the L9963E
- Passive balancing is executed through 100kΩ external resistors
- Dimensions: 145x65mm
- Included in the AutoDevKit ecosystem

1.3 Hardware main components

Figure 4. AEK-POW-BMSLV main components (top view)

1. SPSB100 power management IC (custom version with CAN port)
2. L9963T automotive general purpose SPI to isolated SPI transceiver
3. STN4NF06L automotive-grade N-channel 60 V, 0.07 Ohm typ. 4 A STripFET II Power MOSFET in SOT-223 package
4. VNQ7050AJTR quad-channel HSD with analog current sense
5. SPC58EC80E5 32-bit Power Architecture MCU for Automotive General Purpose Applications - Chorus family
6. M95M04-A125 automotive 4096 Kbit SPI bus EEPROM with high speed clock
7. L9963E automotive chip for battery management applications with daisy chain up to 31 devices

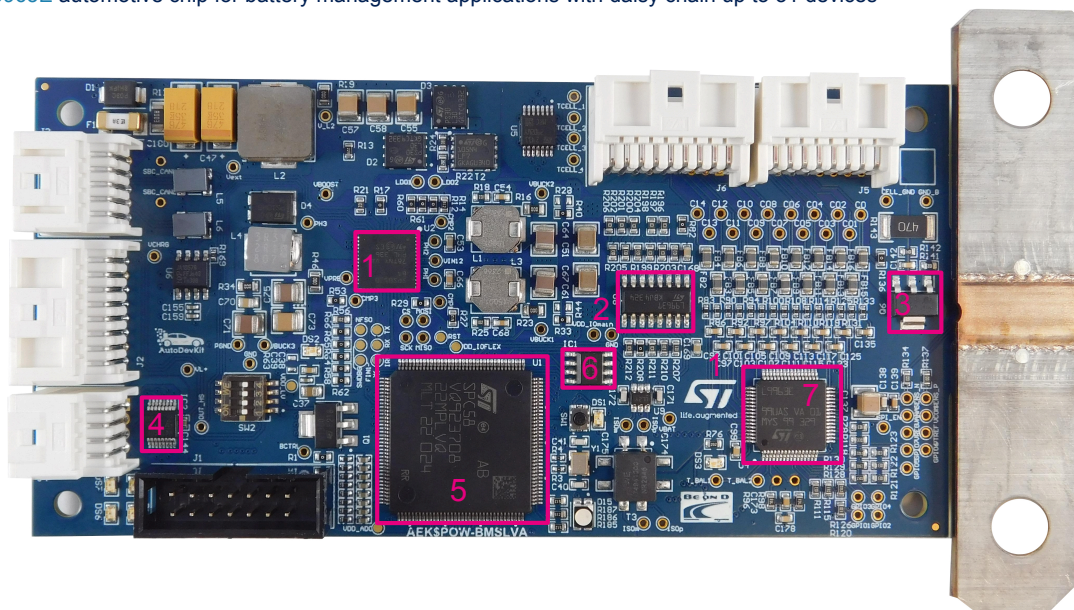
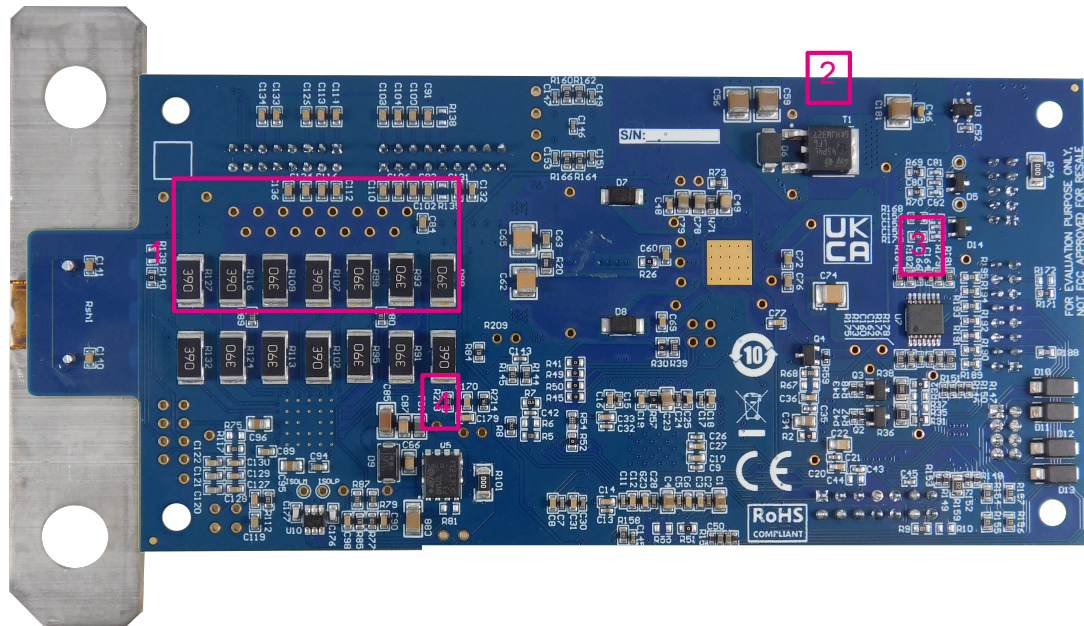


Figure 5. AEK-POW-BMSLV main components (bottom view)

1. Passive balancing resistors
2. **STD45P4LLF6AG** automotive-grade P-channel -40 V, 12 mOhm typ., -50 A STripFET F6 Power MOSFET in a DPAK package
3. **LM2902W** low-power quad operational amplifier
4. **STL8N10LF3** automotive-grade N-channel 100 V, 25 mOhm typ., 7.8 A STripFET F3 Power MOSFET in a PowerFLAT 5x6 package



1.3.1 SPC58EC80E5QMC1X MCU

- AEC-Q100 qualified with comprehensive new generation ASIL-B safety concept
- Dual core (32-bit power architecture tech. CPU)
- 4224 KB on-chip flash memory
- 2 of 8 can bus are available for external communication
- 3.3 V supply by the SPSB100 in turn supplied by battery pack

1.3.2 L9963E multicell battery monitoring and balancing IC

- AEC-Q100 qualified
- 4 to 14 cell series measurement with 0us desynchronization delay
- 16-bit voltage ADC max error of $\pm 2m$ in the range [0,5-4,3] V
- 2.66 Mbps ISO SPI communication using the L9963T transceiver
- 200 mA passive internal balancing current for each cell
- Two 5 V regulators supporting external load connection with 25 mA (VCOM) and 50 mA (VTREF) current capability

1.3.3 VNQ7050AJTR Quad channel high-side driver

- AEC-Q100 qualified
- 4 independent high-side channels controlled via GPIO channels compatible with 3 V and 5 V CMOS
- Up to 4 A (limited current due to track width on PCB) current capability
- Analog feedback of load current with high precision proportional current mirror
- Undervoltage shutdown, overvoltage clamp, and load current limitation protections
- Overtemperature and power limitation configurable with a dedicated fault pin
- Voltage range of 4 to 28 (internally connected to supply on the channels KL30_Vcc)

1.3.4 SPSB100 power management IC

- Provides power management interface for BMS
- Manages CAN communication for system monitoring and control
- Includes protection circuits for system safety and reliability

1.3.5 M95M04-A125 EEPROM

- To store calibration data, ensuring accurate and reliable calibration of system parameters.

1.3.6 STN4NF06L automotive-grade Power MOSFET

- Developed using STMicroelectronics unique STripFET process, which is specifically designed to minimize input capacitance and gate charge
- AEC-Q101 qualified
- 100% avalanche tested
- Low gate charge

1.3.7 STD45P4LLF6AG automotive-grade P-channel Power MOSFET

- Developed using the STripFET™ F6 technology, with a new trench gate structure
- Very low $R_{DS(on)}$
- Designed for automotive applications and AEC-Q101 qualified
- Very low on-resistance
- Very low gate charge
- High avalanche ruggedness
- Low gate drive power loss

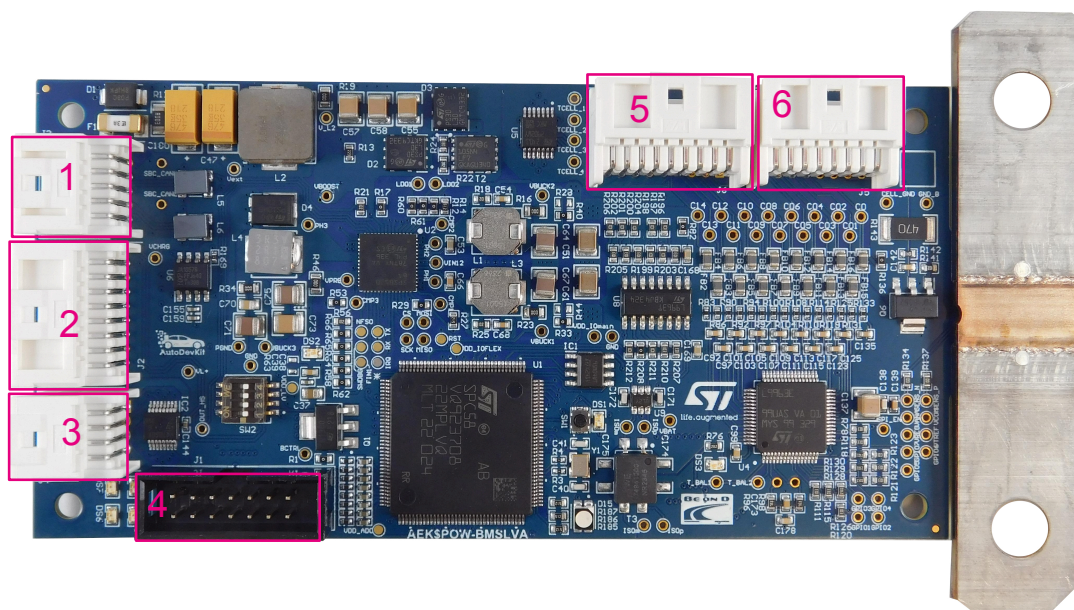
1.3.8 LM2902W low-power quad operational amplifier

- Wide gain bandwidth: 1.3 MHz
- Input common-mode voltage range includes negative rail
- Large voltage gain: 100 dB
- Very low supply current per amplifier: 375 μ A
- Low input bias current: 20 nA
- Low input offset current: 2 nA
- ESD internal protection: 800 V
- Wide power supply range
- Single supply: 3 V to 30 V
- Dual supplies: ± 1.5 V to ± 15 V

1.3.9 Board connectors

Figure 6. AEK-POW-BMSLV evaluation board

1. J3: 10-pin connector for power supply, CAN communication and SPSB100 control
2. J2: 16-pin connector for data output
3. J4: 8-pin connector for power outputs
4. J1: JTAG connector for board programming
5. J6: 18-pin connector for cell balancing and sensors
6. J5: 16-pin connector for cell balancing and sensors



1.3.9.1 J1 connector

J1 connector is a standard JTAG connector for board programming and debugging.

1.3.9.2 J2 connector

J2 is a 16-pin header connector for driver control, sensing outputs and supply.

This connector is physically connected to the MCU as described in the table below.

It allows the user to connect the board to external systems according to application needs.

Table 1. J2 pin description

Pin	Function	I/O	Description
1	EXTERNAL_GPIO_1	I/O	Generical GPIO
2	EXTERNAL_GPIO_2	I/O	Generical GPIO
3	EXTERNAL_GPIO_3	I/O	Generical GPIO
4	EXTERNAL_GPIO_4	I/O	Generical GPIO
5	EXTERNAL_ADC_1	Input	Analog sensing
6	SPI_SCK	Output	SPI clock
7	EXTERNAL_ADC_2	Input	Analog sensing
8	SPI_CSN	Output	SPI chip select
9	EXTERNAL_ADC_3	Input	Analog sensing with a range of 0-105 V
10	SPI_MOSI	Output	SPI master out slave in

Pin	Function	I/O	Description
11	EXTERNAL_ADC_4	Input	Analog sensing with a range of 0-105 V
12	SPI_MISO	Input	SPI master in slave out
13	V_ext	Output	Voltage supply output (Vcc_ext: 12 V)
14	EXTERNAL_GPIO_5	I/O	Generical GPIO
15	GND	Output	Ground reference
16	EXTERNAL_ADC_5	Input	Analog sensing

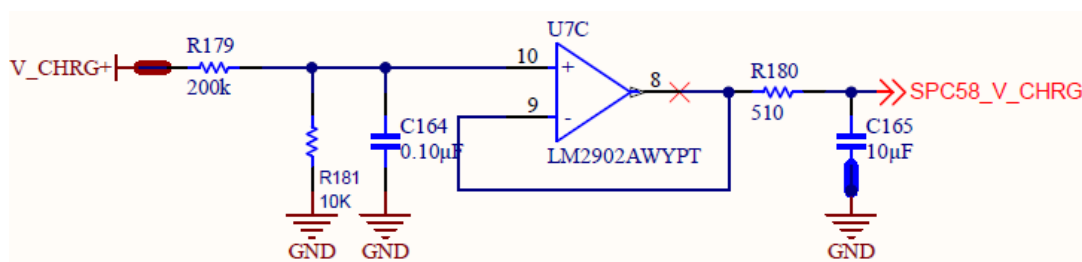
Attention: *GPIOs are connected directly to the MCU without protection. The input voltage range of these pins is 0-5 V. To avoid damaging the board, do not connect pins out of this voltage range.*

GPIOs are connected to the MCU as follows:

- EXTERNAL_GPIO_1 to pin 10
- EXTERNAL_GPIO_2 to pin 9
- EXTERNAL_GPIO_3 to pin 11
- EXTERNAL_GPIO_4 to pin 12
- EXTERNAL_GPIO_5 to pin 13

External_ADC_1, External_ADC_2, and External_ADC_5 are directly connected to the MCU, respectively to pins 15, 16, and 17. External_ADC_3 and External_ADC_4 are connected to the microcontroller through the following circuit:

Figure 7. External_ADC_3 circuit schematic



The maximum input voltage is calculated as follows:

$$V_{in} = V_{out} \cdot \frac{200k\Omega + 10k\Omega}{10k\Omega}$$

The maximum input voltage for these two channels is 105 V, considering that the maximum input voltage of the ADC is 5 V ($V_{out} = 5$ V).

SPI four pins are connected to the MCU as follows:

- SPI_CS to pin 5
- SPI_MOSI to pin 6
- SPI_MISO to pin 7
- SPI_SCK to pin 8

1.3.9.3 J3 connector

J3 is a 10-pin main connector with supply input and CAN bus outputs.

Table 2. J3 pin description

Pin	Function	I/O	Description
1	KL15_Enable	I/O	SBC_IGN pin of SPSB100, corresponds to KL15 signal input (enable for SPSB100 power supply)
2	SBC_WakeUp	I/O	SBC_WKUP SPSB100 wake-up input
3	CAN1_L	I/O	Master low-level CAN1 bus line

Pin	Function	I/O	Description
4	CAN1_H	I/O	Master high-level CAN1 bus line
5	SBC_CAN_H	I/O	SPSB100 high-level CAN bus line
6	SBC_CAN_L	I/O	SPSB100 low-level CAN bus line
7	GND	Input	Ground additional pin
8	SBC_HS_OUT	Input	High-side driver output to supply contacts
9	KL31_GND	Input	Power ground reference
10	KL30_Vcc	Input	12 V input for power supply

Note: CAN1 bus terminal resistance is 120 Ω .

1.3.9.4 J4 connector

J4 connector is an 8-pin connector with high-side outputs (up to 4 A) from power supply.

Table 3. J4 pin description

Pin	Function	I/O	Description
1	Out_HighSide_1	Output	Power HighSide output
2	GND	Output	Ground reference
3	Out_HighSide_2	Output	Power High Side output
4	GND	Output	Ground reference
5	Out_HighSide_3	Output	Power High Side output
6	GND	Output	Ground Reference
7	Out_HighSide_4	Output	Power High Side output
8	GND	Output	Ground reference

1.3.9.5 J5 connector

J5 connector is a 16-pin cell balancing and sensing connector with external temperature sensing inputs.

Table 4. J5 pin description

Pin	Function	I/O	Description
1	CELL_05	Input	Cell voltage measurement point 5
2	CELL_06	Input	Cell voltage measurement point 6
3	CELL_03	Input	Cell voltage measurement point 3
4	CELL_04	Input	Cell voltage measurement point 4
5	CELL_01	Input	Cell voltage measurement point 1
6	CELL_02	Input	Cell voltage measurement point 2
7	CELL_GND	Output	Connected to CELL_00 trough soldered resistance R136 as GND_BAT
8	CELL_00	Input	Cell voltage measurement point 0
9	L9963_TEMP_IN_3	Input	External NTC voltage input measured with the L9963E
10	GND_BAT	Output	GND BAT reference for external NTC
11	L9963_TEMP_IN_4	Input	External NTC voltage input measured with the L9963E
12	GND_BAT	Output	GND BAT reference for external NTC
13	SPC58_TEMP_IN_3	Input	External NTC voltage input measured with the SPC58

Pin	Function	I/O	Description
14	GND	Output	GND reference for external NTC
15	SPC58_TEMP_IN_4	Input	External NTC voltage input measured with the SPC58
16	GND	Output	GND reference for external NTC

1.3.9.6

J6 connector

J6 connector is a 18-pin cell balancing and sensing connector with external temperature sensing inputs.

Table 5. J6 pin description

Pin	Function	I/O	Description
1	CELL_07	Input	Cell voltage measurement point 7
2	CELL_08	Input	Cell voltage measurement point 8
3	CELL_09	Input	Cell voltage measurement point 9
4	CELL_10	Input	Cell voltage measurement point 10
5	CELL_11	Input	Cell voltage measurement point 11
6	CELL_12	Input	Cell voltage measurement point 12
7	CELL_13	Input	Cell voltage measurement point 13
8	CELL_14	Input	Cell voltage measurement point 14
9	EXT_I_SENSE_M	Input	External shunt negative point voltage resistor measured with the L9963E
10	EXT_I_SENSE_P	Input	External shunt positive point voltage resistor measured with the L9963E
11	L9963_TEMP_IN_2	Input	External NTC voltage input measured with the L9963E
12	GND_BAT	Output	GND BAT reference for external NTC
13	L9963_TEMP_IN_1	Input	External NTC voltage input measured with the L9963E
14	GND_BAT	Output	GND BAT reference for external NTCs
15	SPC58_TEMP_IN_2	Input	External NTC voltage input measured with the SPC58
16	GND	Output	GND reference for external NTCs
17	SPC58_TEMP_IN_1	Input	External NTC voltage input measured with the SPC58
18	GND	Output	GND reference for external NTCs

Note: In case, you do not want to use the on-board sensing resistor, use EXT_I_SENSE_M and EXT_I_SENSE_P pins after removing the shunt resistor already mounted onboard.

2 How to use the AEK-POW-BMSLV

Follow the procedure below to set up the board correctly and minimize the risk of damaging it.

Step 1. Plug connectors as described below.

Caution: Follow the connection order to prevent any safety issue.

Step 1a. Connect J3. This connector features contactors for power supply as well as for CAN communication. Pins KL15_Enable and KL30_Vcc are connected to the positive terminal of the power supply. The PGND pin should be connected to the negative terminal. The remaining pins are dedicated to CAN communication. It is essential to connect the CAN connectors to the appropriate reading devices, as there are two CAN channels.

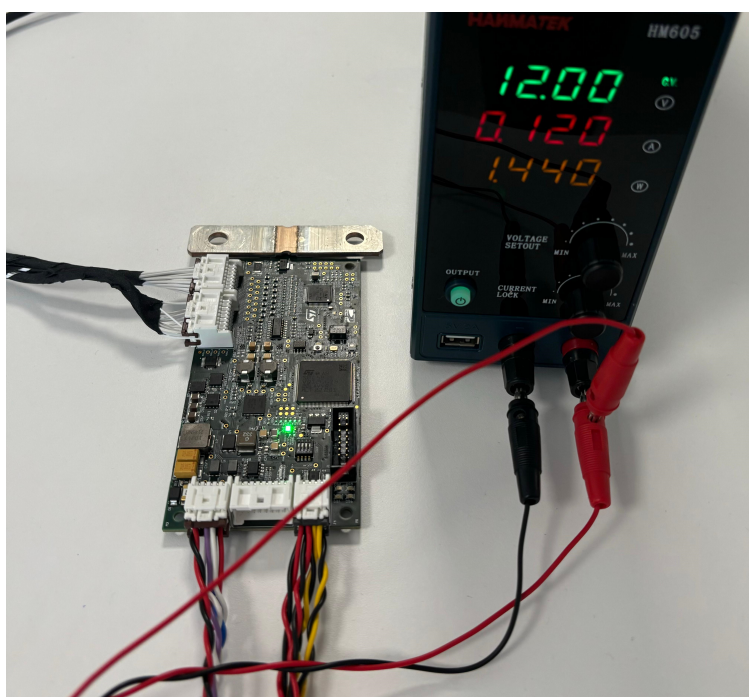
Step 1b. Connect J4. This connector is related to power outputs and is primarily used when a high side is required. However, you can bypass this step if there are no devices to be connected to the high side.

Step 1c. Connect J5 and J6. These connectors are related to cell balancing and voltage and current sensing. They play a crucial role in maintaining the stability and integrity of the electrical system.

Step 2. Connect the integrated shunt resistor in series to the negative line of the battery.

Step 3. Power up the board by turning on the power supply. The standard voltage for powering up the board is typically set at 12 V, with a nominal current consumption of less than 100 mA. Upon successful connection and power-up, the onboard LEDs light up, indicating that the setup has been correctly executed.

Figure 8. Board power-up

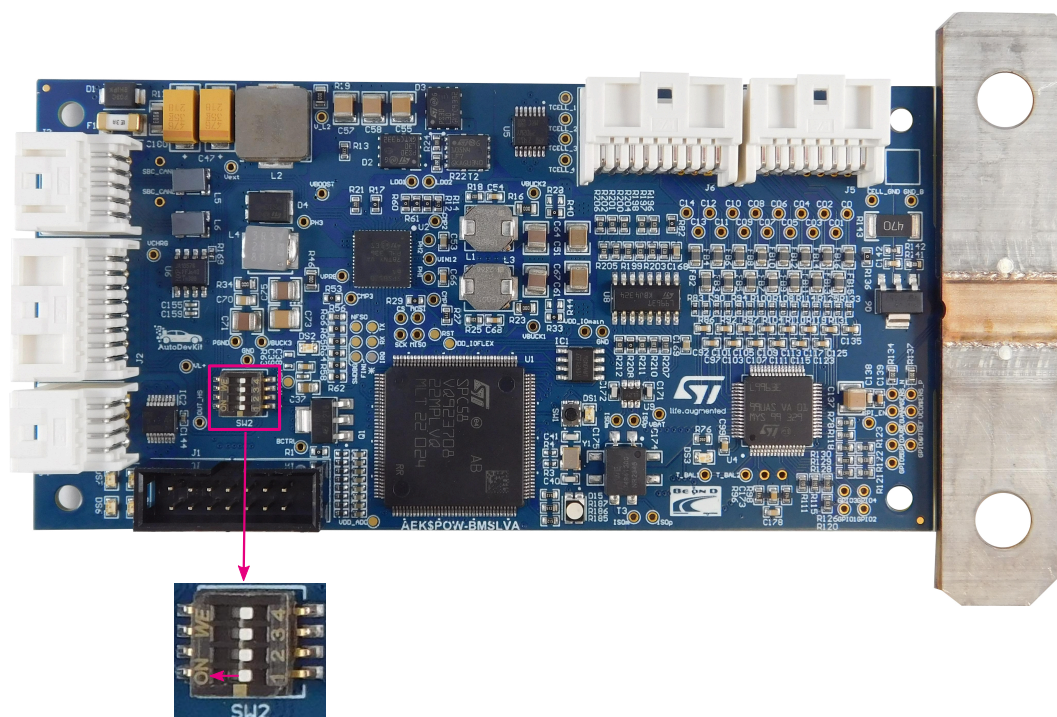


3 SPSB100 operation

The AEK-POW-BMSLV is equipped with 4 switches that enables the operation of the SPSB100 without external devices:

- The first switch connects the SWDBG pin (connector SW2, as highlighted in the rectangle of the figure below) of the SPSB100 to digital supply (5 V).
- The second switch is empty.
- The third connector signal switch allows waking the SPSB100 up through Vcc_Ext or SBC_WKUP.
- The fourth connector signal switch allows SPBS100 IGN through Vcc_Ext or SPSB100 SBC_IGN pin.

Figure 9. AEK-POW-BMSLV switches



4 AEK-POW-BMSLV software configuration

This chapter focuses on how to write the software code and load it into the [AEK-POW-BMSLV](#) on-board microcontroller to monitor the battery management system low voltage according to the application requirements.

The tool-chain consists of:

- [AutoDevKitStudio](#) and OpenOCD debugger
- AEK-POW-BMSLV driver

4.1 Software overview

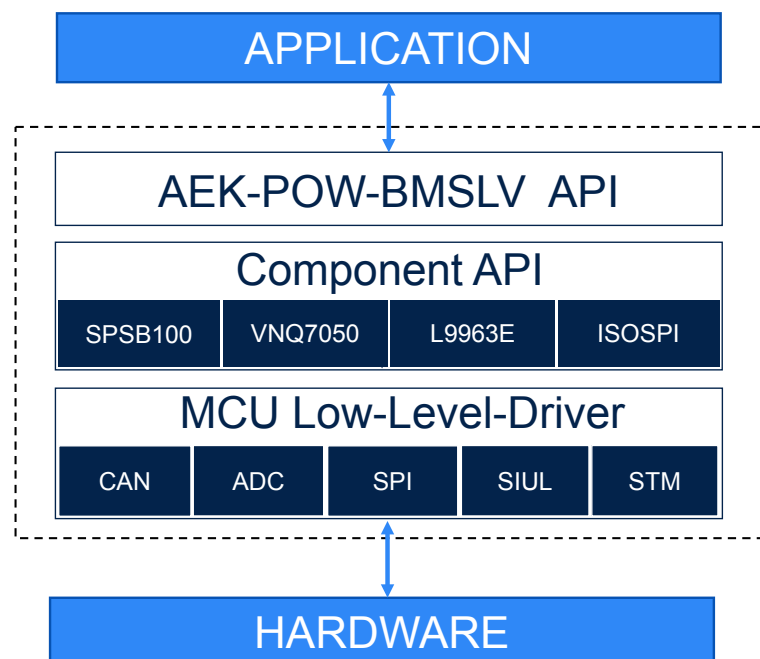
The AEK-POW-BMSLV software structure enhances reuse and simplify maintenance. It also reduces the prototyping time.

Thus, we have implemented a layered architecture that embeds the following blocks:

- Low-level drivers
- Component API
- AEK-POW-BMSLV-`API`

The library is written in embedded C code.

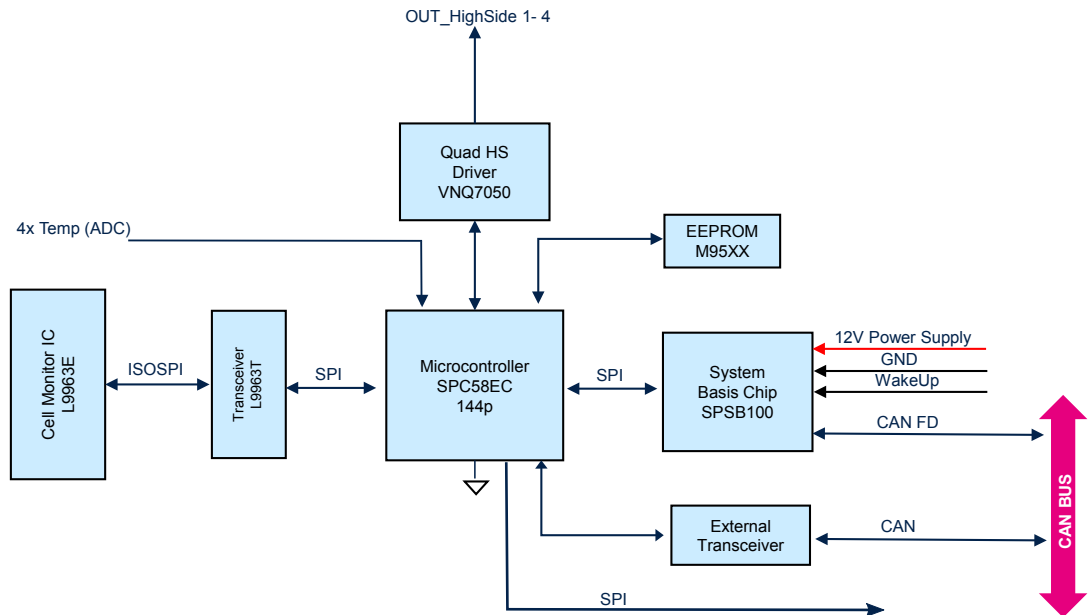
Figure 10. Software architecture



4.1.1 Low-level drivers

The low-level drivers interface with the [AEK-POW-BMSLV](#) evaluation board. They support all MCU peripherals (CAN, SPI, STM, and SIUL2).

Figure 11. Low-level drivers



The AEK_POW_BMSLV_API software is based on the following peripherals:

- An additional SPI for external communication (i.e. battery switch).
- SPI for bi-directional communication implementation between the MCU and the SPSB100 as well as the L9963T
- System Timer Module (STM) to trigger the SPSB100 watchdog
- CAN to manage the messages received or transmitted by other ECUs through an external transceiver
- ADC to convert the four signals coming from NTC sensors
- System Integration Unit Lite (SIUL2) to control all I/O ports (i.e. onboard LEDs)

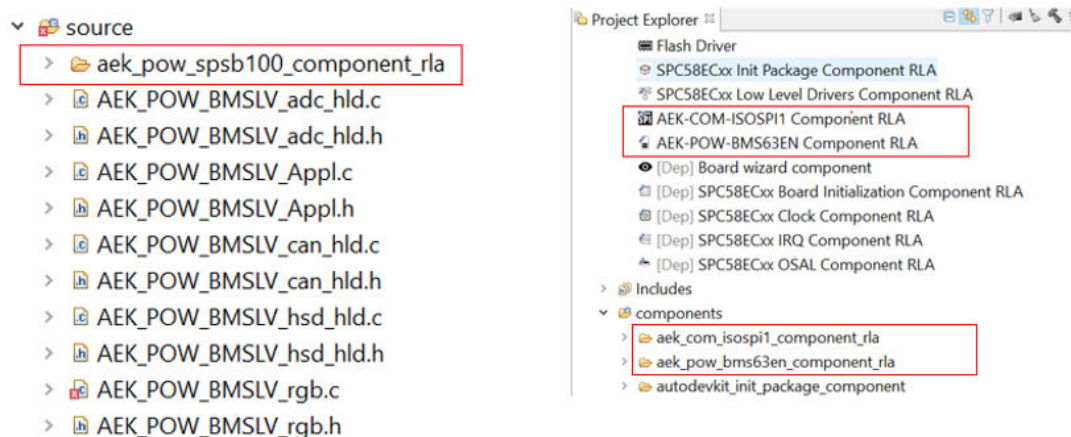
4.1.2

Component API

Component API eases communication and controls between the MCU and embedded ICs:

- SPSB100 power management system
- VNQ7050 used to address the high-side power drivers
- L9963E for the battery management
- ISOSPI based on the L9963T, which allows converting SPI signals in isolated SPI signals

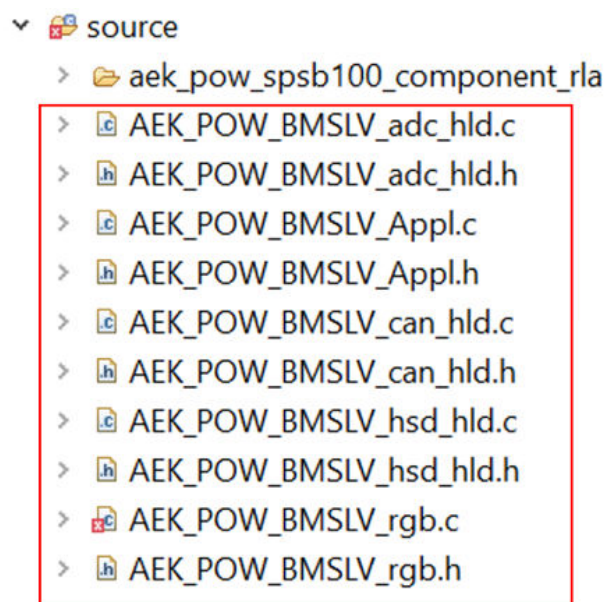
Figure 12. Component API as shown in AutoDevKit Studio



4.1.3 AEK-POW-BMSLV API

The purpose of the API implemented is to provide high-level interface functions to speed up the prototyping phase, thus allowing the user focus on the application code.

Figure 13. AEK-POW-BMSLV API as shown in AutoDevKit Studio

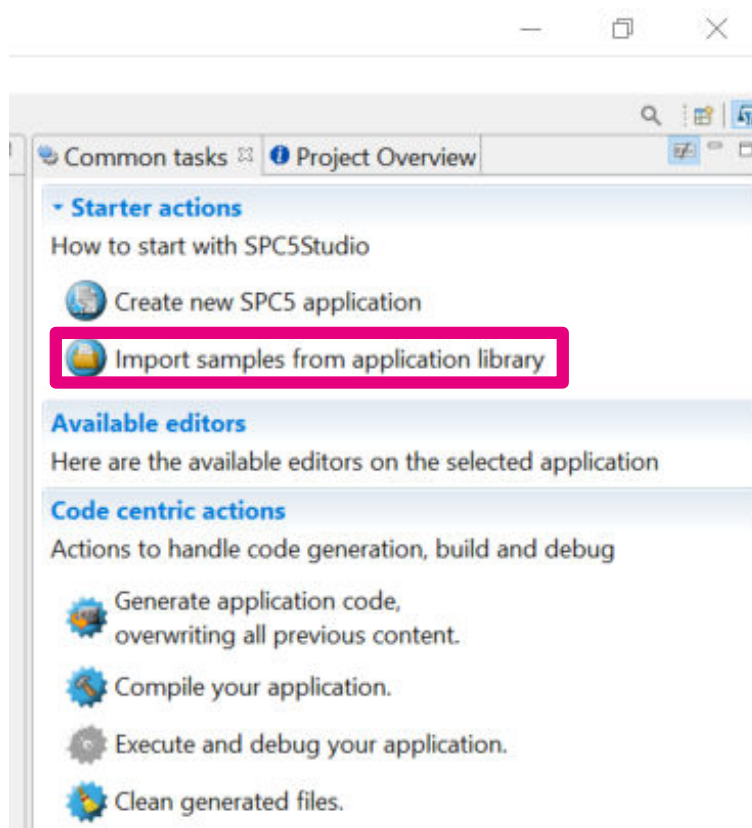


4.2 How to import an existing project

Step 1. Install and launch AutoDevKitStudio.

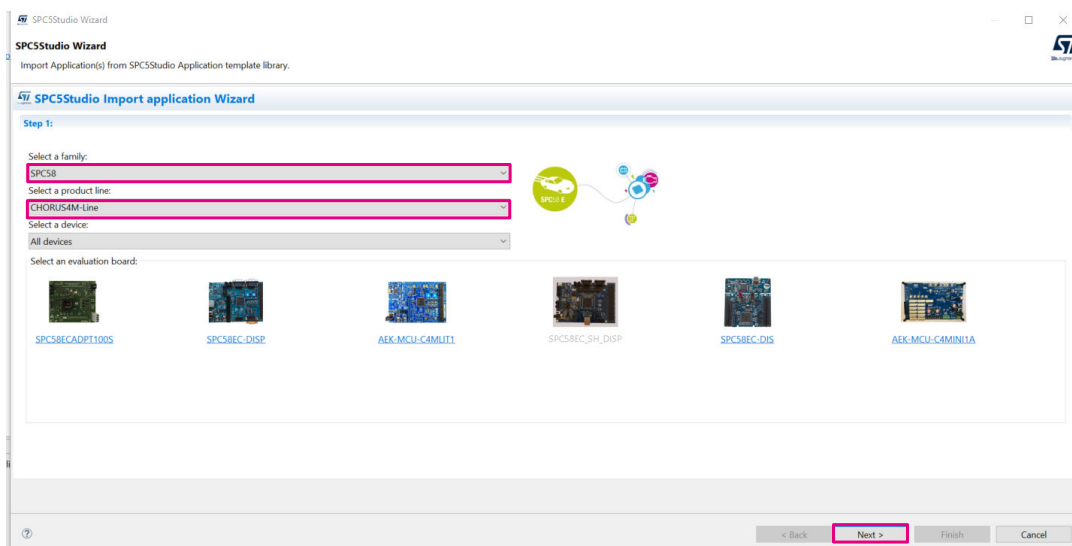
Step 2. Click on "Import samples from application library".

Figure 14. Importing samples



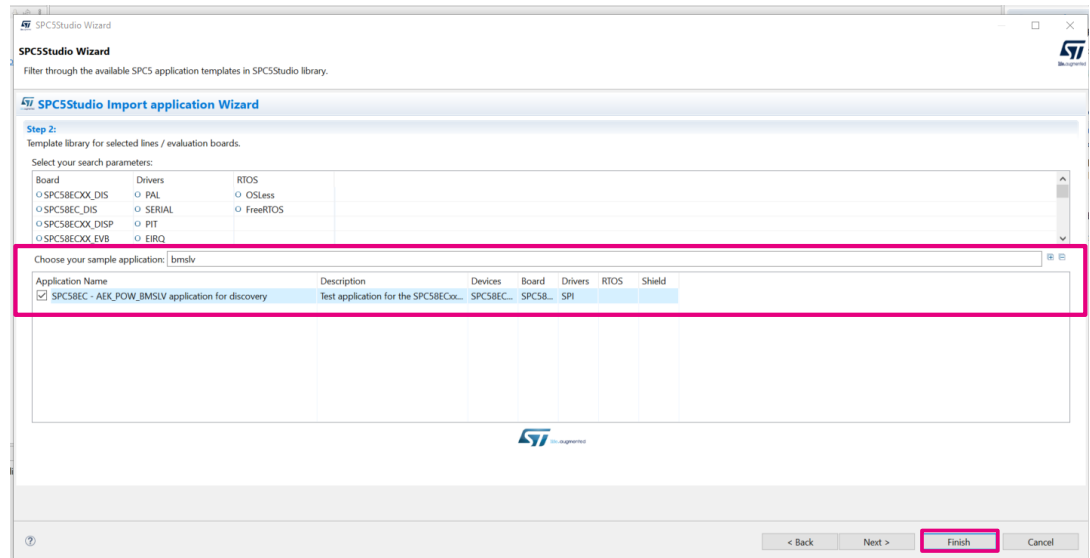
Step 3. Select the MCU family and product line. Then, click on Next.

Figure 15. Selecting MCU



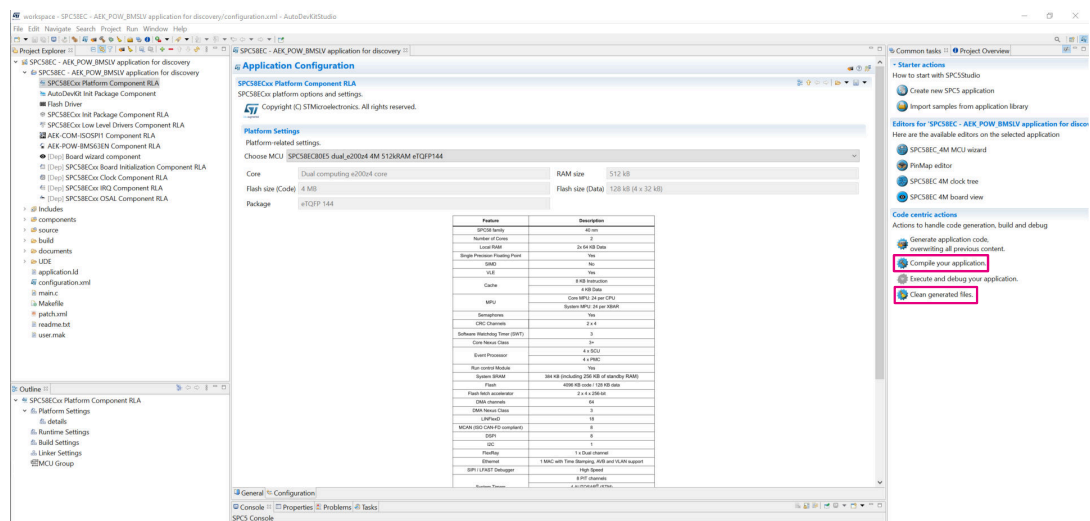
- Step 4.** Type "bmslv" in the sample application field and select "SPC58EC-AEK_POW_BMSLV application for discovery". Then, click on Finish.

Figure 16. Selecting the sample application



- Step 5.** Click on "Clean", then on "Compile".

Figure 17. Cleaning and compiling your application

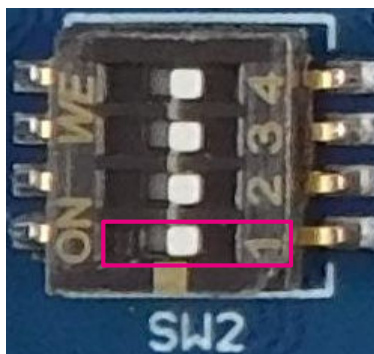


4.3 How to program the SPC58EC80 microcontroller

- Step 1.** Connect the AEK-MCU-SPC5LNK dongle to the AEK-POW-BMSLV J1 connector.
- Step 2.** Switch the power supply off.

Step 3. Turn the SW2 switch

Figure 18. SW2 switch



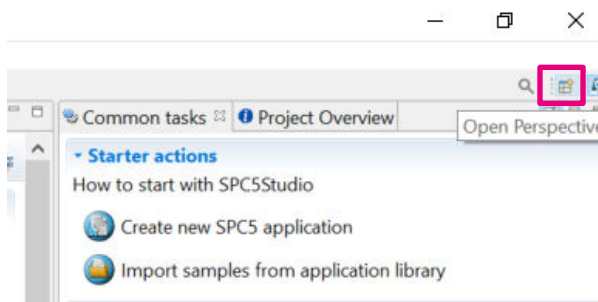
Step 4. Switch the power supply on.

Step 5. Turn SW2 switch off.

LED DS2 turns on and the device remains in software debug mode until the power supply is switched off.

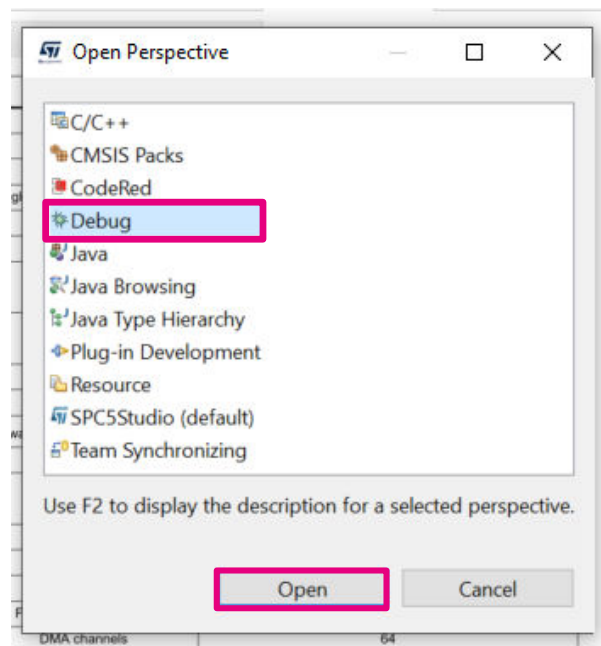
Step 6. In AutoDevKitStudio, click on the open perspective icon.

Figure 19. Open perspective



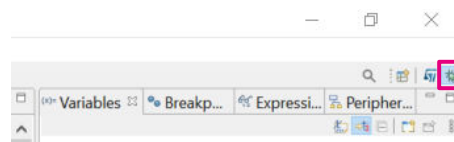
Step 7. Click on Debug, then on Open.

Figure 20. Switching to Debug perspective



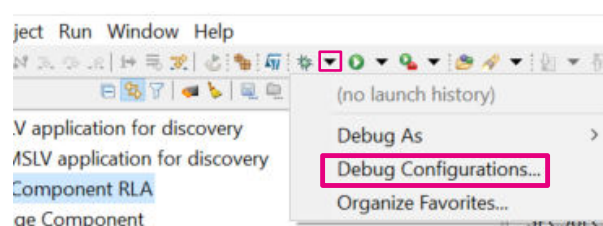
A green beetle icon will appear in the right-hand side of the tool.

Figure 21. Debug icon



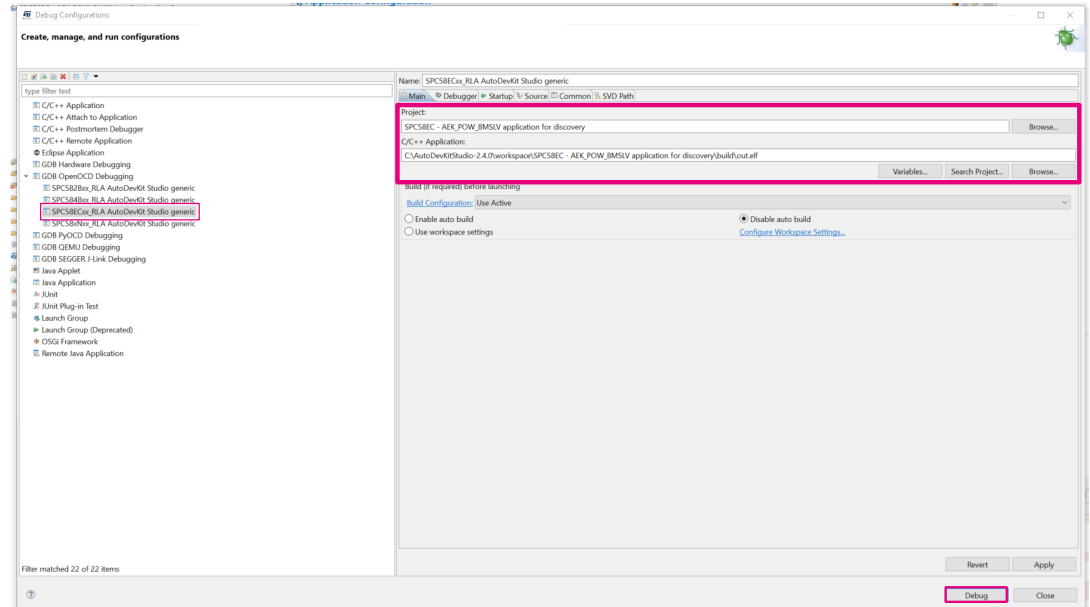
Step 8. Click on the drop-down menu arrow and select Debug configurations.

Figure 22. Debug configurations



- Step 9.** Select your platform and use the browse buttons to specify project name and the related .elf file (in your workspace, under the "build" folder). Then, click on Debug.

Figure 23. Selecting the elf file



You can now act on your main, set breakpoints and run your application step by step.

4.4 AEK-POW-BMSLV_Demo_Code

The "AEK-POW-BMSLV_Demo_Code" demo is available in AutoDevKit.

The purpose of this demo is to show how to read the voltages and temperatures of a 48V battery pack (14 cells) and how to address the high-side power drivers of the VNQ7050 by monitoring their current consumption through a sensing network with a specific `fR_sense` value.

The code is divided into several sections:

- Initialization section
- Main section, which contains
 - core 0 (secondary code)
 - core 2 (primary code)

The initialization section contains the header files for the APIs used, as well as the declarations and initialization functions for the various components and peripherals used in the system.

```
#include "components.h"
#include "stdio.h"
#include "string.h"
#include "AEK-POW-BMSLV_Appl.h"
#include "AEK-POW-BMSLV_rgb.h"
#include "AEK-POW-BMSLV_adc_hld.h"
#include "AEK-POW-BMSLV_can_hld.h"
#include "AEK-POW-BMSLV_hsd_hld.h"
#include "AEK-POW-SPSB100_dev_mgn.h"
```

The main section contains the primary and secondary code. Each core is assigned distinct responsibilities to ensure efficient resource usage and parallel processing capabilities.

Core0, which is the secondary core, primarily handles visual feedback and low-level hardware interaction such as voltage and temperature conversions.

```
int main_core0(void){
    /* Enable Interrupts */
    irqIsrEnable();
    /* Init L9963E */
    AEK_POW_BMSLV_19963e_init();
    /* For debug */
    uint8_t u8Led = 0;
    /* Application main loop.*/
    for ( ; ; ) {
        /* Change led pattern for visual feedback of core 0*/
        AEK_POW_BMSLV_hsd_binary(u8Led % 0xF);
        u8Led++;
        /* Convert Voltage */
        AEK_POW_BMSLV_19963e_voltage();
        /* Convert Temperature */
        AEK_POW_BMSLV_19963e_temperature();
    }
}
```

Core 0 has then the following functions:

- The function "AEK_POW_BMSLV_19963e_init" initializes and configures the L9963E IC to the required operating parameters for battery management. It includes setting up communication interfaces, configuring measurement parameters and enabling relevant interrupts or alarms required for the operation of the AEK-POW-BMSLV module.
- the Main loop responsible for:
 - Managing visual feedback through LED patterns.
 - Measuring cell voltages using the L9963E device. The function "AEK_POW_BMSLV_19963e_voltage" initiates a voltage measurement cycle for all connected battery cells and retrieves the results. This function is essential for monitoring the health and charge state of the battery system managed by the AEK-POW-BMSLV module. The measured voltages can be used for cell balancing, state-of-charge calculations, and detecting under- or over-voltage conditions.
 - Measuring temperatures from sensors connected to the L9963E. The function "AEK_POW_BMSLV_19963e_temperature" starts the conversion from the resistance value to temperature.

Core 2, which is the primary core, focuses on higher-level system functions such as communication protocols (CAN), sensor readings (ADC) and device management, as well as managing the SPSB100 watchdog. Activation of Core 0 from Core 2 using the runCore0() function allows coordination between the two cores and facilitates cooperative multitasking or distributed processing.

In detail, the main function:

- manages the SPSB100 watchdog. It ensures the correct functioning of this device each 10 ms, using the STM peripheral.
- initializes the following components and peripherals:
 - CAN driver (**AEK_POW_BMSLV_can_init**): initializes the CAN communication interface.

Note: The initialized CAN baudrate is 125 kbps.

- SPSB100 device (**AEK_POW_SPSB100_dev_init**): initializes the SPSB100 device.
- ADC driver (**AEK_POW_BMSLV_adc_init**): initializes the Analog-to-Digital Converter (ADC) driver for analog sensor readings.
- LED (**AEK_POW_BMSLV_rgb_set**): initializes the LED component, setting its initial state.
- VNQ7050 device (**AEK_POW_BMSLV_hsd_init**): enables the VNQ7050 device.

These initializations prepare the peripherals and components for operation within the program main loop.

- Enables interrupts and activates core 0 for execution.

- Contains a periodic (100 ms) main loop responsible for:
 - Changing the LED color: the function **AEK_POW_BMSLV_rgb_pass()** is called to change the state of the LED. This serves as visual feedback to see that core 2 is running correctly.
 - Monitoring VNQ7050: the function **AEK_POW_BMSLV_hsd_sense()** monitors the current sense for the VNQ7050 device using the specified resistance value and performs necessary operations for monitoring.
 - Converting ADC channels: the function **AEK_POW_BMSLV_adc_convert_channels()** iterates over ADC channels, converting digital values from ADC conversions into their corresponding analog voltages. For each channel, it updates the channel voltage data and then processes the converted data further. Additionally, the function calculates the microcontroller internal temperature by reading its internal temperature sensor via ADC and initiates the next round of ADC conversions.

```
int main(void) {
    /* Initialization of all the imported components in the order specified in
    the application wizard. The function is generated automatically.*/
    componentsInit();
    /* Uncomment the below routine to Enable Interrupts. */
    irqIsrEnable();
    /* Activate core0 */
    runCore0();
    /* Init CAN driver */
    AEK_POW_BMSLV_can_init();
    /* Init SPSB100 */
    AEK_POW_SPSB100_dev_init();
    /* Init ADC driver */
    AEK_POW_BMSLV_adc_init();
    /* Init LED */
    AEK_POW_BMSLV_rgb_set(eRGB_NONE);
    /* Enables VNQ7050 */
    AEK_POW_BMSLV_hsd_init();
    /* Execution time in milliseconds*/
    uint16_t u16ExecutionPeriod = 100;
    /* Application main loop.*/
    for ( ; ; ) {
        if((uint8_t) (osalThreadGetMilliseconds() % u16ExecutionPeriod) == 0){
            /* Change Led color */
            AEK_POW_BMSLV_rgb_pass();
            /* Monitor VNQ7050 */
            AEK_POW_BMSLV_hsd_sense();
            /* Convert ADC Channels */
            AEK_POW_BMSLV_adc_convert_channels();
            /* Send CAN frames */
            AEK_POW_BMSLV_can_send_all();
        }
    }
}
```

5 DBC file

In this project, the DBC file specifies the structure of CAN messages, including message definitions, signal definitions, and parameter scaling. It ensures interoperable communication among systems.

The following paragraphs list this project DBC file data.

5.1 ADC_SUPPLY(0x2C1)

This message contains signals related to the board electrical data. It returns the supply voltage, the supply current, and the temperature of the MCU gathered from the MCU peripheral.

Table 6. ADC_SUPPLY (0x2C1) message details

Name	Message	Startbit	Length [Bit]	Byte Order	Value Type	Initial Value	Factor	Offset	Minimum	Maximum
ADC_SupplyVoltage	ADC_SUPPLY	0	16	Intel	Unsigned	0	0.001	0	0	65.535
ADC_SupplyCurrent	ADC_SUPPLY	16	16	Intel	Unsigned	0	0.001	0	0	65.535
ADC_TempMCU	ADC_SUPPLY	32	16	Intel	Unsigned	0	0.01	-50	-50	605.35

5.2 ADC_TCELL(0x2C2)

This message contains the measured temperatures related to cells 5 to 8, measured through the ADC. The temperature is evaluated with the β formula for thermistors. In this formula, R_0 is considered as 10 k Ω and β as 3455.

Table 7. ADC_TCELL_05_08 (0x2C2) message details

Name	Message	Startbit	Length [Bit]	Byte Order	Value Type	Initial Value	Factor	Offset	Minimum	Maximum	Unit
ADC_TempExt_01	ADC_TCELL_05_08	0	16	Intel	Unsigned	0	0.01	-50	-50	605.35	°C
ADC_TempExt_02	ADC_TCELL_05_08	16	16	Intel	Unsigned	0	0.01	-50	-50	605.35	°C
ADC_TempExt_03	ADC_TCELL_05_08	32	16	Intel	Unsigned	0	0.01	-50	-50	605.35	°C
ADC_TempExt_04	ADC_TCELL_05_08	48	16	Intel	Unsigned	0	0.01	-50	-50	605.35	°C

5.3 ADC_VOLTAGE(0x2C3)

This message contains ADC measurements dedicated to the voltage levels of the battery. In particular, the signals are used to communicate the measurement of the positive battery voltage, the voltage at inverter side and the voltage at the charger side.

Table 8. ADC_VOLTAGE(0x2C3) message details

Name	Message	Startbit	Length [Bit]	Byte Order	Value Type	Initial Value	Factor	Offset	Minimum	Maximum	Unit
ADC_Vbat	ADC_VOLTAGE	0	16	Intel	Unsigned	0	0.001	0	0	65.535	V
ADC_Vload	ADC_VOLTAGE	16	16	Intel	Unsigned	0	0.001	0	0	65.535	V
ADC_Vcharge	ADC_VOLTAGE	32	16	Intel	Unsigned	0	0.001	0	0	65.535	V

5.4 L9963E_CURRENT(0x204)

This signal returns the current measured through the internal shunt sensor. For this calculation it is considered a 100 μ ohm resistor.

Table 9. L9963E_CURRENT (0x204) message details

Name	Message	Startbit	Length [Bit]	Byte Order	Value Type	Initial Value	Factor	Offset	Minimum	Maximum	Unit
L9963E_Current	L9963E_CURRENT	0	16	Intel	Unsigned	0	0.01	-327.67	-327.67	327.68	A

5.5 L9963E_GPIO_03_05(0x2B0)

This message contains signals about the corresponding resistance of the NTC sensor. The voltage is acquired by the ADC and subsequently converted into resistance.

Table 10. L9963E_GPIO_03_05 (0x2B0) message details

Name	Message	Startbit	Length [Bit]	Byte Order	Value Type	Initial Value	Factor	Offset	Minimum	Maximum	Unit
L9963E_TcellRes_01	L9963E_GPIO_03_05	0	16	Intel	Unsigned	0	1	0	0	65535	Ω
L9963E_TcellRes_02	L9963E_GPIO_03_05	16	16	Intel	Unsigned	0	1	0	0	65535	Ω
L9963E_TcellRes_03	L9963E_GPIO_03_05	32	16	Intel	Unsigned	0	1	0	0	65535	Ω

5.6 L9963E_GPIO_06_09(0x2B1)

This message contains signals that correspond to the measurements about the soldered NTC resistances R80 and R89. The two NTC resistances are placed in the bottom side of the board, as shown in the image below.

Figure 24. R80 and R89 resistors (at the board bottom side)

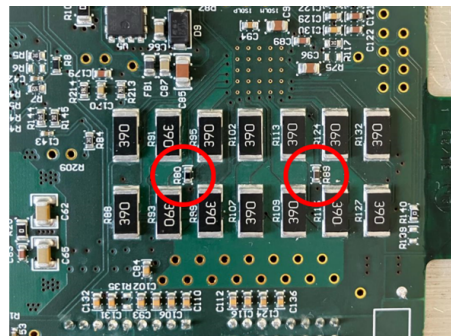


Table 11. L9963E_GPIO_06_09 (0x2B1) message details

Name	Message	Startbit	Length [Bit]	Byte Order	Value Type	Initial Value	Factor	Offset	Minimum	Maximum	Unit
L9963E_TcellRes_04	L9963E_GPIO_06_09	0	16	Intel	Unsigned	0	1	0	0	65535	Ω
L9963E_TbalRes_01	L9963E_GPIO_06_09	16	16	Intel	Unsigned	0	1	0	0	65535	Ω
L9963E_TbalRes_02	L9963E_GPIO_06_09	32	16	Intel	Unsigned	0	1	0	0	65535	Ω

5.7 L9963E_TBAL_01_02(0x2A1)

This message contains the two signals about the balancing temperatures in the points of the resistances R80 and R89.

Table 12. L9963E_TBAL_01_02 (0x2A1) message details

Name	Message	Startbit	Length [Bit]	Byte Order	Value Type	Initial Value	Factor	Offset	Minimum	Maximum	Unit
L9963E_Tbal_01	L9963E_TBAL_01_02	0	16	Intel	Unsigned	0	0.01	-50	-50	605.35	°C
L9963E_Tbal_02	L9963E_TBAL_01_02	16	16	Intel	Unsigned	0	0.01	-50	-50	605.35	°C

5.8 L9963E_TCELL_01_04(0x2A0)

This message contains the signals related to the cells' temperatures, from 1 to 4, measured with L9963 device.

Table 13. L9963E_TCELL_01_04 (0x2A0) message details

Name	Message	Startbit	Length [Bit]	Byte Order	Value Type	Initial Value	Factor	Offset	Minimum	Maximum	Unit
L9963E_Tcell_01	L9963E_TCELL_01_04	0	16	Intel	Unsigned	0	0.01	-50	-50	605.35	°C
L9963E_Tcell_02	L9963E_TCELL_01_04	16	16	Intel	Unsigned	0	0.01	-50	-50	605.35	°C
L9963E_Tcell_03	L9963E_TCELL_01_04	32	16	Intel	Unsigned	0	0.01	-50	-50	605.35	°C
L9963E_Tcell_04	L9963E_TCELL_01_04	48	16	Intel	Unsigned	0	0.01	-50	-50	605.35	°C

5.9 L9963E_VOLTAGE_01_04 (0x200)

This message contains signals about the measured voltages of cells 1 to 4, measured with L9963.

Table 14. L9963E_VOLTAGE_01_04 (0x200) message details

Name	Message	Startbit	Length [Bit]	Byte Order	Value Type	Initial Value	Factor	Offset	Minimum	Maximum	Unit
L9963E_Vcell_01	L9963E_VOLTAGE_01_04	0	16	Intel	Unsigned	0	0.0001	0	0	65.535	V
L9963E_Vcell_02	L9963E_VOLTAGE_01_04	16	16	Intel	Unsigned	0	0.0001	0	0	65.535	V
L9963E_Vcell_03	L9963E_VOLTAGE_01_04	32	16	Intel	Unsigned	0	0.0001	0	0	65.535	V
L9963E_Vcell_04	L9963E_VOLTAGE_01_04	48	16	Intel	Unsigned	0	0.0001	0	0	65.535	V

5.10 L9963E_VOLTAGE_05_08 (0x201)

This message contains signals about the measured voltages of cells 5 to 8, measured with L9963.

Table 15. L9963E_VOLTAGE_05_08 (0x201) message details

Name	Message	Startbit	Length [Bit]	Byte Order	Value Type	Initial Value	Factor	Offset	Minimum	Maximum	Unit
L9963E_Vcell_05	L9963E_VOLTAGE_05_08	0	16	Intel	Unsigned	0	0.0001	0	0	65.535	V
L9963E_Vcell_06	L9963E_VOLTAGE_05_08	16	16	Intel	Unsigned	0	0.0001	0	0	65.535	V
L9963E_Vcell_07	L9963E_VOLTAGE_05_08	32	16	Intel	Unsigned	0	0.0001	0	0	65.535	V
L9963E_Vcell_08	L9963E_VOLTAGE_05_08	48	16	Intel	Unsigned	0	0.0001	0	0	65.535	V

5.11 L9963E_VOLTAGE_09_12 (0x202)

This message contains signals about the measured voltages of cells 9 to 12, measured with L9963.

Table 16. L9963E_VOLTAGE_09_12 (0x202) message details

Name	Message	Startbit	Length [Bit]	Byte Order	Value Type	Initial Value	Factor	Offset	Minimum	Maximum	Unit
L9963E_Vcell_09	L9963E_VOLTAGE_09_12	0	16	Intel	Unsigned	0	0.0001	0	0	65.535	V
L9963E_Vcell_10	L9963E_VOLTAGE_09_12	16	16	Intel	Unsigned	0	0.0001	0	0	65.535	V
L9963E_Vcell_11	L9963E_VOLTAGE_09_12	32	16	Intel	Unsigned	0	0.0001	0	0	65.535	V
L9963E_Vcell_12	L9963E_VOLTAGE_09_12	48	16	Intel	Unsigned	0	0.0001	0	0	65.535	V

5.12 L9963E_VOLTAGE_13_14 (0x203)

This message contains 2 signals about the measured voltages of cells 13 and 14. The other two signals are related to the total voltage of the battery pack (derived from the measured cell voltages) and the ref voltage.

Table 17. L9963E_VOLTAGE_13_14 (0x203) message details

Name	Message	Startbit	Length [Bit]	Byte Order	Value Type	Initial Value	Factor	Offset	Minimum	Maximum	Unit
L9963E_Vcell_13	L9963E_VOLTAGE_13_14	0	16	Intel	Unsigned	0	0.0001	0	0	65.535	V
L9963E_Vcell_14	L9963E_VOLTAGE_13_14	16	16	Intel	Unsigned	0	0.0001	0	0	65.535	V
L9963E_Vpack	L9963E_VOLTAGE_13_14	32	16	Intel	Unsigned	0	0.001	0	0	65.535	V
L9963E_Vref	L9963E_VOLTAGE_13_14	48	16	Intel	Unsigned	0	0.0001	0	0	65.535	V

5.13 SPSB100 related signals

Table 18. SPSB100_Command (0x555)

Name	Message	Startbit	Length [Bit]	Byte Order	Value Type	Initial Value	Factor	Offset	Minimum	Maximum
SPSB100_Cmd	SPSB100_Command	24	8	Intel	Unsigned	0	1	0	0	255

Table 19. SPSB100_CR4 (0x410)

Name	Message	Startbit	Length [Bit]	Byte Order	Value Type	Initial Value	Factor	Offset	Minimum	Maximum
CR4_BIT_00	SPSB100_CR4	0	1	Intel	Unsigned	0	1	0	0	1
CR4_BIT_01	SPSB100_CR4	1	1	Intel	Unsigned	0	1	0	0	1
CR4_BIT_02	SPSB100_CR4	2	1	Intel	Unsigned	0	1	0	0	1
CR4_BIT_03	SPSB100_CR4	3	1	Intel	Unsigned	0	1	0	0	1
CR4_BIT_04	SPSB100_CR4	4	1	Intel	Unsigned	0	1	0	0	1
CR4_BIT_05	SPSB100_CR4	5	1	Intel	Unsigned	0	1	0	0	1
CR4_BIT_06	SPSB100_CR4	6	1	Intel	Unsigned	0	1	0	0	1
CR4_BIT_07	SPSB100_CR4	7	1	Intel	Unsigned	0	1	0	0	1
CR4_BIT_08	SPSB100_CR4	8	1	Intel	Unsigned	0	1	0	0	1
CR4_BIT_09	SPSB100_CR4	9	1	Intel	Unsigned	0	1	0	0	1
CR4_BIT_10	SPSB100_CR4	10	1	Intel	Unsigned	0	1	0	0	1
CR4_BIT_11	SPSB100_CR4	11	1	Intel	Unsigned	0	1	0	0	1
CR4_BIT_12	SPSB100_CR4	12	1	Intel	Unsigned	0	1	0	0	1
CR4_BIT_13	SPSB100_CR4	13	1	Intel	Unsigned	0	1	0	0	1
CR4_BIT_14	SPSB100_CR4	14	1	Intel	Unsigned	0	1	0	0	1
CR4_BIT_15	SPSB100_CR4	15	1	Intel	Unsigned	0	1	0	0	1
CR4_BIT_16	SPSB100_CR4	16	1	Intel	Unsigned	0	1	0	0	1
CR4_BIT_17	SPSB100_CR4	17	1	Intel	Unsigned	0	1	0	0	1
CR4_BIT_18	SPSB100_CR4	18	1	Intel	Unsigned	0	1	0	0	1
CR4_BIT_19	SPSB100_CR4	19	1	Intel	Unsigned	0	1	0	0	1
CR4_BIT_20	SPSB100_CR4	20	1	Intel	Unsigned	0	1	0	0	1
CR4_BIT_21	SPSB100_CR4	21	1	Intel	Unsigned	0	1	0	0	1
CR4_BIT_22	SPSB100_CR4	22	1	Intel	Unsigned	0	1	0	0	1
CR4_BIT_23	SPSB100_CR4	23	1	Intel	Unsigned	0	1	0	0	1
CR4_BIT_24	SPSB100_CR4	24	1	Intel	Unsigned	0	1	0	0	1
CR4_BIT_25	SPSB100_CR4	25	1	Intel	Unsigned	0	1	0	0	1
CR4_BIT_26	SPSB100_CR4	26	1	Intel	Unsigned	0	1	0	0	1
CR4_BIT_27	SPSB100_CR4	27	1	Intel	Unsigned	0	1	0	0	1
CR4_BIT_28	SPSB100_CR4	28	1	Intel	Unsigned	0	1	0	0	1
CR4_BIT_29	SPSB100_CR4	29	1	Intel	Unsigned	0	1	0	0	1
CR4_BIT_30	SPSB100_CR4	30	1	Intel	Unsigned	0	1	0	0	1
CR4_BIT_31	SPSB100_CR4	31	1	Intel	Unsigned	0	1	0	0	1

SPSB100_SR1_SR2 (0x400)

The signals inside this message are the first 32 bits of the status registers of SPSB100.

Table 20. SPSB100_SR1_SR2 (0x400)

Name	Message	Startbit	Length [Bit]	Byte Order	Value Type	Initial Value	Factor	Offset	Minimum	Maximum
SR1_BIT_00	SPSB100_SR1_SR2	0	1	Intel	Unsigned	0	1	0	0	1
SR1_BIT_01	SPSB100_SR1_SR2	1	1	Intel	Unsigned	0	1	0	0	1
SR1_BIT_02	SPSB100_SR1_SR2	2	1	Intel	Unsigned	0	1	0	0	1
SR1_BIT_03	SPSB100_SR1_SR2	3	1	Intel	Unsigned	0	1	0	0	1
SR1_BIT_04	SPSB100_SR1_SR2	4	1	Intel	Unsigned	0	1	0	0	1
SR1_BIT_05	SPSB100_SR1_SR2	5	1	Intel	Unsigned	0	1	0	0	1
SR1_BIT_06	SPSB100_SR1_SR2	6	1	Intel	Unsigned	0	1	0	0	1
SR1_BIT_07	SPSB100_SR1_SR2	7	1	Intel	Unsigned	0	1	0	0	1
SR1_BIT_08	SPSB100_SR1_SR2	8	1	Intel	Unsigned	0	1	0	0	1
SR1_BIT_09	SPSB100_SR1_SR2	9	1	Intel	Unsigned	0	1	0	0	1
SR1_BIT_10	SPSB100_SR1_SR2	10	1	Intel	Unsigned	0	1	0	0	1
SR1_BIT_11	SPSB100_SR1_SR2	11	1	Intel	Unsigned	0	1	0	0	1
SR1_BIT_12	SPSB100_SR1_SR2	12	1	Intel	Unsigned	0	1	0	0	1
SR1_BIT_13	SPSB100_SR1_SR2	13	1	Intel	Unsigned	0	1	0	0	1
SR1_BIT_14	SPSB100_SR1_SR2	14	1	Intel	Unsigned	0	1	0	0	1
SR1_BIT_15	SPSB100_SR1_SR2	15	1	Intel	Unsigned	0	1	0	0	1
SR1_BIT_16	SPSB100_SR1_SR2	16	1	Intel	Unsigned	0	1	0	0	1
SR1_BIT_17	SPSB100_SR1_SR2	17	1	Intel	Unsigned	0	1	0	0	1
SR1_BIT_18	SPSB100_SR1_SR2	18	1	Intel	Unsigned	0	1	0	0	1
SR1_BIT_19	SPSB100_SR1_SR2	19	1	Intel	Unsigned	0	1	0	0	1
SR1_BIT_20	SPSB100_SR1_SR2	20	1	Intel	Unsigned	0	1	0	0	1
SR1_BIT_21	SPSB100_SR1_SR2	21	1	Intel	Unsigned	0	1	0	0	1
SR1_BIT_22	SPSB100_SR1_SR2	22	1	Intel	Unsigned	0	1	0	0	1
SR1_BIT_23	SPSB100_SR1_SR2	23	1	Intel	Unsigned	0	1	0	0	1
SR1_BIT_24	SPSB100_SR1_SR2	24	1	Intel	Unsigned	0	1	0	0	1
SR1_BIT_25	SPSB100_SR1_SR2	25	1	Intel	Unsigned	0	1	0	0	1
SR1_BIT_26	SPSB100_SR1_SR2	26	1	Intel	Unsigned	0	1	0	0	1
SR1_BIT_27	SPSB100_SR1_SR2	27	1	Intel	Unsigned	0	1	0	0	1
SR1_BIT_28	SPSB100_SR1_SR2	28	1	Intel	Unsigned	0	1	0	0	1
SR1_BIT_29	SPSB100_SR1_SR2	29	1	Intel	Unsigned	0	1	0	0	1
SR1_BIT_30	SPSB100_SR1_SR2	30	1	Intel	Unsigned	0	1	0	0	1
SR1_BIT_31	SPSB100_SR1_SR2	31	1	Intel	Unsigned	0	1	0	0	1
SR2_BIT_00	SPSB100_SR1_SR2	32	1	Intel	Unsigned	0	1	0	0	1
SR2_BIT_01	SPSB100_SR1_SR2	33	1	Intel	Unsigned	0	1	0	0	1
SR2_BIT_02	SPSB100_SR1_SR2	34	1	Intel	Unsigned	0	1	0	0	1
SR2_BIT_03	SPSB100_SR1_SR2	35	1	Intel	Unsigned	0	1	0	0	1
SR2_BIT_04	SPSB100_SR1_SR2	36	1	Intel	Unsigned	0	1	0	0	1

Name	Message	Startbit	Length [Bit]	Byte Order	Value Type	Initial Value	Factor	Offset	Minimum	Maximum
SR2_BIT_05	SPSB100_SR1_SR2	37	1	Intel	Unsigned	0	1	0	0	1
SR2_BIT_06	SPSB100_SR1_SR2	38	1	Intel	Unsigned	0	1	0	0	1
SR2_BIT_07	SPSB100_SR1_SR2	39	1	Intel	Unsigned	0	1	0	0	1
SR2_BIT_08	SPSB100_SR1_SR2	40	1	Intel	Unsigned	0	1	0	0	1
SR2_BIT_09	SPSB100_SR1_SR2	41	1	Intel	Unsigned	0	1	0	0	1
SR2_BIT_10	SPSB100_SR1_SR2	42	1	Intel	Unsigned	0	1	0	0	1
SR2_BIT_11	SPSB100_SR1_SR2	43	1	Intel	Unsigned	0	1	0	0	1
SR2_BIT_12	SPSB100_SR1_SR2	44	1	Intel	Unsigned	0	1	0	0	1
SR2_BIT_13	SPSB100_SR1_SR2	45	1	Intel	Unsigned	0	1	0	0	1
SR2_BIT_14	SPSB100_SR1_SR2	46	1	Intel	Unsigned	0	1	0	0	1
SR2_BIT_15	SPSB100_SR1_SR2	47	1	Intel	Unsigned	0	1	0	0	1
SR2_BIT_16	SPSB100_SR1_SR2	48	1	Intel	Unsigned	0	1	0	0	1
SR2_BIT_17	SPSB100_SR1_SR2	49	1	Intel	Unsigned	0	1	0	0	1
SR2_BIT_18	SPSB100_SR1_SR2	50	1	Intel	Unsigned	0	1	0	0	1
SR2_BIT_19	SPSB100_SR1_SR2	51	1	Intel	Unsigned	0	1	0	0	1
SR2_BIT_20	SPSB100_SR1_SR2	52	1	Intel	Unsigned	0	1	0	0	1
SR2_BIT_21	SPSB100_SR1_SR2	53	1	Intel	Unsigned	0	1	0	0	1
SR2_BIT_22	SPSB100_SR1_SR2	54	1	Intel	Unsigned	0	1	0	0	1
SR2_BIT_23	SPSB100_SR1_SR2	55	1	Intel	Unsigned	0	1	0	0	1
SR2_BIT_24	SPSB100_SR1_SR2	56	1	Intel	Unsigned	0	1	0	0	1
SR2_BIT_25	SPSB100_SR1_SR2	57	1	Intel	Unsigned	0	1	0	0	1
SR2_BIT_26	SPSB100_SR1_SR2	58	1	Intel	Unsigned	0	1	0	0	1
SR2_BIT_27	SPSB100_SR1_SR2	59	1	Intel	Unsigned	0	1	0	0	1
SR2_BIT_28	SPSB100_SR1_SR2	60	1	Intel	Unsigned	0	1	0	0	1
SR2_BIT_29	SPSB100_SR1_SR2	61	1	Intel	Unsigned	0	1	0	0	1
SR2_BIT_30	SPSB100_SR1_SR2	62	1	Intel	Unsigned	0	1	0	0	1
SR2_BIT_31	SPSB100_SR1_SR2	63	1	Intel	Unsigned	0	1	0	0	1

SPSB100_SR3_SR4 (0x401)

The signals inside this message are the second 32 bits of the status registers of SPSB100.

Table 21. SPSB100_SR3_SR4 (0x401)

Name	Message	Startbit	Length [Bit]	Byte Order	Value Type	Initial Value	Factor	Offset	Minimum	Maximum
SR3_BIT_00	SPSB100_SR3_SR4	0	1	Intel	Unsigned	0	1	0	0	1
SR3_BIT_01	SPSB100_SR3_SR4	1	1	Intel	Unsigned	0	1	0	0	1
SR3_BIT_02	SPSB100_SR3_SR4	2	1	Intel	Unsigned	0	1	0	0	1
SR3_BIT_03	SPSB100_SR3_SR4	3	1	Intel	Unsigned	0	1	0	0	1
SR3_BIT_04	SPSB100_SR3_SR4	4	1	Intel	Unsigned	0	1	0	0	1
SR3_BIT_05	SPSB100_SR3_SR4	5	1	Intel	Unsigned	0	1	0	0	1
SR3_BIT_06	SPSB100_SR3_SR4	6	1	Intel	Unsigned	0	1	0	0	1

Name	Message	Startbit	Length [Bit]	Byte Order	Value Type	Initial Value	Factor	Offset	Minimum	Maximum
SR3_BIT_07	SPSB100_SR3_SR4	7	1	Intel	Unsigned	0	1	0	0	1
SR3_BIT_08	SPSB100_SR3_SR4	8	1	Intel	Unsigned	0	1	0	0	1
SR3_BIT_09	SPSB100_SR3_SR4	9	1	Intel	Unsigned	0	1	0	0	1
SR3_BIT_10	SPSB100_SR3_SR4	10	1	Intel	Unsigned	0	1	0	0	1
SR3_BIT_11	SPSB100_SR3_SR4	11	1	Intel	Unsigned	0	1	0	0	1
SR3_BIT_12	SPSB100_SR3_SR4	12	1	Intel	Unsigned	0	1	0	0	1
SR3_BIT_13	SPSB100_SR3_SR4	13	1	Intel	Unsigned	0	1	0	0	1
SR3_BIT_14	SPSB100_SR3_SR4	14	1	Intel	Unsigned	0	1	0	0	1
SR3_BIT_15	SPSB100_SR3_SR4	15	1	Intel	Unsigned	0	1	0	0	1
SR3_BIT_16	SPSB100_SR3_SR4	16	1	Intel	Unsigned	0	1	0	0	1
SR3_BIT_17	SPSB100_SR3_SR4	17	1	Intel	Unsigned	0	1	0	0	1
SR3_BIT_18	SPSB100_SR3_SR4	18	1	Intel	Unsigned	0	1	0	0	1
SR3_BIT_19	SPSB100_SR3_SR4	19	1	Intel	Unsigned	0	1	0	0	1
SR3_BIT_20	SPSB100_SR3_SR4	20	1	Intel	Unsigned	0	1	0	0	1
SR3_BIT_21	SPSB100_SR3_SR4	21	1	Intel	Unsigned	0	1	0	0	1
SR3_BIT_22	SPSB100_SR3_SR4	22	1	Intel	Unsigned	0	1	0	0	1
SR3_BIT_23	SPSB100_SR3_SR4	23	1	Intel	Unsigned	0	1	0	0	1
SR3_BIT_24	SPSB100_SR3_SR4	24	1	Intel	Unsigned	0	1	0	0	1
SR3_BIT_25	SPSB100_SR3_SR4	25	1	Intel	Unsigned	0	1	0	0	1
SR3_BIT_26	SPSB100_SR3_SR4	26	1	Intel	Unsigned	0	1	0	0	1
SR3_BIT_27	SPSB100_SR3_SR4	27	1	Intel	Unsigned	0	1	0	0	1
SR3_BIT_28	SPSB100_SR3_SR4	28	1	Intel	Unsigned	0	1	0	0	1
SR3_BIT_29	SPSB100_SR3_SR4	29	1	Intel	Unsigned	0	1	0	0	1
SR3_BIT_30	SPSB100_SR3_SR4	30	1	Intel	Unsigned	0	1	0	0	1
SR3_BIT_31	SPSB100_SR3_SR4	31	1	Intel	Unsigned	0	1	0	0	1
SR4_BIT_00	SPSB100_SR3_SR4	32	1	Intel	Unsigned	0	1	0	0	1
SR4_BIT_01	SPSB100_SR3_SR4	33	1	Intel	Unsigned	0	1	0	0	1
SR4_BIT_02	SPSB100_SR3_SR4	34	1	Intel	Unsigned	0	1	0	0	1
SR4_BIT_03	SPSB100_SR3_SR4	35	1	Intel	Unsigned	0	1	0	0	1
SR4_BIT_04	SPSB100_SR3_SR4	36	1	Intel	Unsigned	0	1	0	0	1
SR4_BIT_05	SPSB100_SR3_SR4	37	1	Intel	Unsigned	0	1	0	0	1
SR4_BIT_06	SPSB100_SR3_SR4	38	1	Intel	Unsigned	0	1	0	0	1
SR4_BIT_07	SPSB100_SR3_SR4	39	1	Intel	Unsigned	0	1	0	0	1
SR4_BIT_08	SPSB100_SR3_SR4	40	1	Intel	Unsigned	0	1	0	0	1
SR4_BIT_09	SPSB100_SR3_SR4	41	1	Intel	Unsigned	0	1	0	0	1
SR4_BIT_10	SPSB100_SR3_SR4	42	1	Intel	Unsigned	0	1	0	0	1
SR4_BIT_11	SPSB100_SR3_SR4	43	1	Intel	Unsigned	0	1	0	0	1
SR4_BIT_12	SPSB100_SR3_SR4	44	1	Intel	Unsigned	0	1	0	0	1
SR4_BIT_13	SPSB100_SR3_SR4	45	1	Intel	Unsigned	0	1	0	0	1
SR4_BIT_14	SPSB100_SR3_SR4	46	1	Intel	Unsigned	0	1	0	0	1
SR4_BIT_15	SPSB100_SR3_SR4	47	1	Intel	Unsigned	0	1	0	0	1

Name	Message	Startbit	Length [Bit]	Byte Order	Value Type	Initial Value	Factor	Offset	Minimum	Maximum
SR4_BIT_16	SPSB100_SR3_SR4	48	1	Intel	Unsigned	0	1	0	0	1
SR4_BIT_17	SPSB100_SR3_SR4	49	1	Intel	Unsigned	0	1	0	0	1
SR4_BIT_18	SPSB100_SR3_SR4	50	1	Intel	Unsigned	0	1	0	0	1
SR4_BIT_19	SPSB100_SR3_SR4	51	1	Intel	Unsigned	0	1	0	0	1
SR4_BIT_20	SPSB100_SR3_SR4	52	1	Intel	Unsigned	0	1	0	0	1
SR4_BIT_21	SPSB100_SR3_SR4	53	1	Intel	Unsigned	0	1	0	0	1
SR4_BIT_22	SPSB100_SR3_SR4	54	1	Intel	Unsigned	0	1	0	0	1
SR4_BIT_23	SPSB100_SR3_SR4	55	1	Intel	Unsigned	0	1	0	0	1
SR4_BIT_24	SPSB100_SR3_SR4	56	1	Intel	Unsigned	0	1	0	0	1
SR4_BIT_25	SPSB100_SR3_SR4	57	1	Intel	Unsigned	0	1	0	0	1
SR4_BIT_26	SPSB100_SR3_SR4	58	1	Intel	Unsigned	0	1	0	0	1
SR4_BIT_27	SPSB100_SR3_SR4	59	1	Intel	Unsigned	0	1	0	0	1
SR4_BIT_28	SPSB100_SR3_SR4	60	1	Intel	Unsigned	0	1	0	0	1
SR4_BIT_29	SPSB100_SR3_SR4	61	1	Intel	Unsigned	0	1	0	0	1
SR4_BIT_30	SPSB100_SR3_SR4	62	1	Intel	Unsigned	0	1	0	0	1
SR4_BIT_31	SPSB100_SR3_SR4	63	1	Intel	Unsigned	0	1	0	0	1

SPSB100_SR5_SR6(0x402)

The signals inside this message are the third 32 bits of the status registers of SPSB100.

Table 22. SPSB100_SR5_SR6(0x402)

Name	Message	Startbit	Length [Bit]	Byte Order	Value Type	Initial Value	Factor	Offset	Minimum	Maximum
SR5_BIT_00	SPSB100_SR5_SR6	0	1	Intel	Unsigned	0	1	0	0	1
SR5_BIT_01	SPSB100_SR5_SR6	1	1	Intel	Unsigned	0	1	0	0	1
SR5_BIT_02	SPSB100_SR5_SR6	2	1	Intel	Unsigned	0	1	0	0	1
SR5_BIT_03	SPSB100_SR5_SR6	3	1	Intel	Unsigned	0	1	0	0	1
SR5_BIT_04	SPSB100_SR5_SR6	4	1	Intel	Unsigned	0	1	0	0	1
SR5_BIT_05	SPSB100_SR5_SR6	5	1	Intel	Unsigned	0	1	0	0	1
SR5_BIT_06	SPSB100_SR5_SR6	6	1	Intel	Unsigned	0	1	0	0	1
SR5_BIT_07	SPSB100_SR5_SR6	7	1	Intel	Unsigned	0	1	0	0	1
SR5_BIT_08	SPSB100_SR5_SR6	8	1	Intel	Unsigned	0	1	0	0	1
SR5_BIT_09	SPSB100_SR5_SR6	9	1	Intel	Unsigned	0	1	0	0	1
SR5_BIT_10	SPSB100_SR5_SR6	10	1	Intel	Unsigned	0	1	0	0	1
SR5_BIT_11	SPSB100_SR5_SR6	11	1	Intel	Unsigned	0	1	0	0	1
SR5_BIT_12	SPSB100_SR5_SR6	12	1	Intel	Unsigned	0	1	0	0	1
SR5_BIT_13	SPSB100_SR5_SR6	13	1	Intel	Unsigned	0	1	0	0	1
SR5_BIT_14	SPSB100_SR5_SR6	14	1	Intel	Unsigned	0	1	0	0	1
SR5_BIT_15	SPSB100_SR5_SR6	15	1	Intel	Unsigned	0	1	0	0	1
SR5_BIT_16	SPSB100_SR5_SR6	16	1	Intel	Unsigned	0	1	0	0	1
SR5_BIT_17	SPSB100_SR5_SR6	17	1	Intel	Unsigned	0	1	0	0	1

Name	Message	Startbit	Length [Bit]	Byte Order	Value Type	Initial Value	Factor	Offset	Minimum	Maximum
SR5_BIT_18	SPSB100_SR5_SR6	18	1	Intel	Unsigned	0	1	0	0	1
SR5_BIT_19	SPSB100_SR5_SR6	19	1	Intel	Unsigned	0	1	0	0	1
SR5_BIT_20	SPSB100_SR5_SR6	20	1	Intel	Unsigned	0	1	0	0	1
SR5_BIT_21	SPSB100_SR5_SR6	21	1	Intel	Unsigned	0	1	0	0	1
SR5_BIT_22	SPSB100_SR5_SR6	22	1	Intel	Unsigned	0	1	0	0	1
SR5_BIT_23	SPSB100_SR5_SR6	23	1	Intel	Unsigned	0	1	0	0	1
SR5_BIT_24	SPSB100_SR5_SR6	24	1	Intel	Unsigned	0	1	0	0	1
SR5_BIT_25	SPSB100_SR5_SR6	25	1	Intel	Unsigned	0	1	0	0	1
SR5_BIT_26	SPSB100_SR5_SR6	26	1	Intel	Unsigned	0	1	0	0	1
SR5_BIT_27	SPSB100_SR5_SR6	27	1	Intel	Unsigned	0	1	0	0	1
SR5_BIT_28	SPSB100_SR5_SR6	28	1	Intel	Unsigned	0	1	0	0	1
SR5_BIT_29	SPSB100_SR5_SR6	29	1	Intel	Unsigned	0	1	0	0	1
SR5_BIT_30	SPSB100_SR5_SR6	30	1	Intel	Unsigned	0	1	0	0	1
SR5_BIT_31	SPSB100_SR5_SR6	31	1	Intel	Unsigned	0	1	0	0	1
SR6_BIT_00	SPSB100_SR5_SR6	32	1	Intel	Unsigned	0	1	0	0	1
SR6_BIT_01	SPSB100_SR5_SR6	33	1	Intel	Unsigned	0	1	0	0	1
SR6_BIT_02	SPSB100_SR5_SR6	34	1	Intel	Unsigned	0	1	0	0	1
SR6_BIT_03	SPSB100_SR5_SR6	35	1	Intel	Unsigned	0	1	0	0	1
SR6_BIT_04	SPSB100_SR5_SR6	36	1	Intel	Unsigned	0	1	0	0	1
SR6_BIT_05	SPSB100_SR5_SR6	37	1	Intel	Unsigned	0	1	0	0	1
SR6_BIT_06	SPSB100_SR5_SR6	38	1	Intel	Unsigned	0	1	0	0	1
SR6_BIT_07	SPSB100_SR5_SR6	39	1	Intel	Unsigned	0	1	0	0	1
SR6_BIT_08	SPSB100_SR5_SR6	40	1	Intel	Unsigned	0	1	0	0	1
SR6_BIT_09	SPSB100_SR5_SR6	41	1	Intel	Unsigned	0	1	0	0	1
SR6_BIT_10	SPSB100_SR5_SR6	42	1	Intel	Unsigned	0	1	0	0	1
SR6_BIT_11	SPSB100_SR5_SR6	43	1	Intel	Unsigned	0	1	0	0	1
SR6_BIT_12	SPSB100_SR5_SR6	44	1	Intel	Unsigned	0	1	0	0	1
SR6_BIT_13	SPSB100_SR5_SR6	45	1	Intel	Unsigned	0	1	0	0	1
SR6_BIT_14	SPSB100_SR5_SR6	46	1	Intel	Unsigned	0	1	0	0	1
SR6_BIT_15	SPSB100_SR5_SR6	47	1	Intel	Unsigned	0	1	0	0	1
SR6_BIT_16	SPSB100_SR5_SR6	48	1	Intel	Unsigned	0	1	0	0	1
SR6_BIT_17	SPSB100_SR5_SR6	49	1	Intel	Unsigned	0	1	0	0	1
SR6_BIT_18	SPSB100_SR5_SR6	50	1	Intel	Unsigned	0	1	0	0	1
SR6_BIT_19	SPSB100_SR5_SR6	51	1	Intel	Unsigned	0	1	0	0	1
SR6_BIT_20	SPSB100_SR5_SR6	52	1	Intel	Unsigned	0	1	0	0	1
SR6_BIT_21	SPSB100_SR5_SR6	53	1	Intel	Unsigned	0	1	0	0	1
SR6_BIT_22	SPSB100_SR5_SR6	54	1	Intel	Unsigned	0	1	0	0	1
SR6_BIT_23	SPSB100_SR5_SR6	55	1	Intel	Unsigned	0	1	0	0	1
SR6_BIT_24	SPSB100_SR5_SR6	56	1	Intel	Unsigned	0	1	0	0	1
SR6_BIT_25	SPSB100_SR5_SR6	57	1	Intel	Unsigned	0	1	0	0	1
SR6_BIT_26	SPSB100_SR5_SR6	58	1	Intel	Unsigned	0	1	0	0	1

Name	Message	Startbit	Length [Bit]	Byte Order	Value Type	Initial Value	Factor	Offset	Minimum	Maximum
SR6_BIT_27	SPSB100_SR5_SR6	59	1	Intel	Unsigned	0	1	0	0	1
SR6_BIT_28	SPSB100_SR5_SR6	60	1	Intel	Unsigned	0	1	0	0	1
SR6_BIT_29	SPSB100_SR5_SR6	61	1	Intel	Unsigned	0	1	0	0	1
SR6_BIT_30	SPSB100_SR5_SR6	62	1	Intel	Unsigned	0	1	0	0	1
SR6_BIT_31	SPSB100_SR5_SR6	63	1	Intel	Unsigned	0	1	0	0	1

SPSB100_SR7_SR8 (0x403)

The signals inside this message are the last 32 bits of the status registers of SPSB100.

Table 23. SPSB100_SR7_SR8 (0x403)

Name	Message	Startbit	Length [Bit]	Byte Order	Value Type	Initial Value	Factor	Offset	Minimum	Maximum
SR7_BIT_00	SPSB100_SR7_SR8	0	1	Intel	Unsigned	0	1	0	0	1
SR7_BIT_01	SPSB100_SR7_SR8	1	1	Intel	Unsigned	0	1	0	0	1
SR7_BIT_02	SPSB100_SR7_SR8	2	1	Intel	Unsigned	0	1	0	0	1
SR7_BIT_03	SPSB100_SR7_SR8	3	1	Intel	Unsigned	0	1	0	0	1
SR7_BIT_04	SPSB100_SR7_SR8	4	1	Intel	Unsigned	0	1	0	0	1
SR7_BIT_05	SPSB100_SR7_SR8	5	1	Intel	Unsigned	0	1	0	0	1
SR7_BIT_06	SPSB100_SR7_SR8	6	1	Intel	Unsigned	0	1	0	0	1
SR7_BIT_07	SPSB100_SR7_SR8	7	1	Intel	Unsigned	0	1	0	0	1
SR7_BIT_08	SPSB100_SR7_SR8	8	1	Intel	Unsigned	0	1	0	0	1
SR7_BIT_09	SPSB100_SR7_SR8	9	1	Intel	Unsigned	0	1	0	0	1
SR7_BIT_10	SPSB100_SR7_SR8	10	1	Intel	Unsigned	0	1	0	0	1
SR7_BIT_11	SPSB100_SR7_SR8	11	1	Intel	Unsigned	0	1	0	0	1
SR7_BIT_12	SPSB100_SR7_SR8	12	1	Intel	Unsigned	0	1	0	0	1
SR7_BIT_13	SPSB100_SR7_SR8	13	1	Intel	Unsigned	0	1	0	0	1
SR7_BIT_14	SPSB100_SR7_SR8	14	1	Intel	Unsigned	0	1	0	0	1
SR7_BIT_15	SPSB100_SR7_SR8	15	1	Intel	Unsigned	0	1	0	0	1
SR7_BIT_16	SPSB100_SR7_SR8	16	1	Intel	Unsigned	0	1	0	0	1
SR7_BIT_17	SPSB100_SR7_SR8	17	1	Intel	Unsigned	0	1	0	0	1
SR7_BIT_18	SPSB100_SR7_SR8	18	1	Intel	Unsigned	0	1	0	0	1
SR7_BIT_19	SPSB100_SR7_SR8	19	1	Intel	Unsigned	0	1	0	0	1
SR7_BIT_20	SPSB100_SR7_SR8	20	1	Intel	Unsigned	0	1	0	0	1
SR7_BIT_21	SPSB100_SR7_SR8	21	1	Intel	Unsigned	0	1	0	0	1
SR7_BIT_22	SPSB100_SR7_SR8	22	1	Intel	Unsigned	0	1	0	0	1
SR7_BIT_23	SPSB100_SR7_SR8	23	1	Intel	Unsigned	0	1	0	0	1
SR7_BIT_24	SPSB100_SR7_SR8	24	1	Intel	Unsigned	0	1	0	0	1
SR7_BIT_25	SPSB100_SR7_SR8	25	1	Intel	Unsigned	0	1	0	0	1
SR7_BIT_26	SPSB100_SR7_SR8	26	1	Intel	Unsigned	0	1	0	0	1
SR7_BIT_27	SPSB100_SR7_SR8	27	1	Intel	Unsigned	0	1	0	0	1
SR7_BIT_28	SPSB100_SR7_SR8	28	1	Intel	Unsigned	0	1	0	0	1

Name	Message	Startbit	Length [Bit]	Byte Order	Value Type	Initial Value	Factor	Offset	Minimum	Maximum
SR7_BIT_29	SPSB100_SR7_SR8	29	1	Intel	Unsigned	0	1	0	0	1
SR7_BIT_30	SPSB100_SR7_SR8	30	1	Intel	Unsigned	0	1	0	0	1
SR7_BIT_31	SPSB100_SR7_SR8	31	1	Intel	Unsigned	0	1	0	0	1
SR8_BIT_00	SPSB100_SR7_SR8	32	1	Intel	Unsigned	0	1	0	0	1
SR8_BIT_01	SPSB100_SR7_SR8	33	1	Intel	Unsigned	0	1	0	0	1
SR8_BIT_02	SPSB100_SR7_SR8	34	1	Intel	Unsigned	0	1	0	0	1
SR8_BIT_03	SPSB100_SR7_SR8	35	1	Intel	Unsigned	0	1	0	0	1
SR8_BIT_04	SPSB100_SR7_SR8	36	1	Intel	Unsigned	0	1	0	0	1
SR8_BIT_05	SPSB100_SR7_SR8	37	1	Intel	Unsigned	0	1	0	0	1
SR8_BIT_06	SPSB100_SR7_SR8	38	1	Intel	Unsigned	0	1	0	0	1
SR8_BIT_07	SPSB100_SR7_SR8	39	1	Intel	Unsigned	0	1	0	0	1
SR8_BIT_08	SPSB100_SR7_SR8	40	1	Intel	Unsigned	0	1	0	0	1
SR8_BIT_09	SPSB100_SR7_SR8	41	1	Intel	Unsigned	0	1	0	0	1
SR8_BIT_10	SPSB100_SR7_SR8	42	1	Intel	Unsigned	0	1	0	0	1
SR8_BIT_11	SPSB100_SR7_SR8	43	1	Intel	Unsigned	0	1	0	0	1
SR8_BIT_12	SPSB100_SR7_SR8	44	1	Intel	Unsigned	0	1	0	0	1
SR8_BIT_13	SPSB100_SR7_SR8	45	1	Intel	Unsigned	0	1	0	0	1
SR8_BIT_14	SPSB100_SR7_SR8	46	1	Intel	Unsigned	0	1	0	0	1
SR8_BIT_15	SPSB100_SR7_SR8	47	1	Intel	Unsigned	0	1	0	0	1
SR8_BIT_16	SPSB100_SR7_SR8	48	1	Intel	Unsigned	0	1	0	0	1
SR8_BIT_17	SPSB100_SR7_SR8	49	1	Intel	Unsigned	0	1	0	0	1
SR8_BIT_18	SPSB100_SR7_SR8	50	1	Intel	Unsigned	0	1	0	0	1
SR8_BIT_19	SPSB100_SR7_SR8	51	1	Intel	Unsigned	0	1	0	0	1
SR8_BIT_20	SPSB100_SR7_SR8	52	1	Intel	Unsigned	0	1	0	0	1
SR8_BIT_21	SPSB100_SR7_SR8	53	1	Intel	Unsigned	0	1	0	0	1
SR8_BIT_22	SPSB100_SR7_SR8	54	1	Intel	Unsigned	0	1	0	0	1
SR8_BIT_23	SPSB100_SR7_SR8	55	1	Intel	Unsigned	0	1	0	0	1
SR8_BIT_24	SPSB100_SR7_SR8	56	1	Intel	Unsigned	0	1	0	0	1
SR8_BIT_25	SPSB100_SR7_SR8	57	1	Intel	Unsigned	0	1	0	0	1
SR8_BIT_26	SPSB100_SR7_SR8	58	1	Intel	Unsigned	0	1	0	0	1
SR8_BIT_27	SPSB100_SR7_SR8	59	1	Intel	Unsigned	0	1	0	0	1
SR8_BIT_28	SPSB100_SR7_SR8	60	1	Intel	Unsigned	0	1	0	0	1
SR8_BIT_29	SPSB100_SR7_SR8	61	1	Intel	Unsigned	0	1	0	0	1
SR8_BIT_30	SPSB100_SR7_SR8	62	1	Intel	Unsigned	0	1	0	0	1
SR8_BIT_31	SPSB100_SR7_SR8	63	1	Intel	Unsigned	0	1	0	0	1

5.14 SYS_Timer (0x300)

The signal inside this message is the timer of the device power-on.

Table 24. SYS_Timer (0x300)

Name	Message	Startbit	Length [Bit]	Byte Order	Value Type	Initial Value	Factor	Offset	Minimum	Maximum	Unit
SysTimer	SYS_Timer	0	32	Intel	Unsigned	0	1	0	0	4294967295	s

5.15 VNQ7050_Data_mA (0x2D1)

This message contains signals about the current measurements of VNQ7050 channels. Currents are read with Csense pin, by multiplexing SEL0 and SEL1 each 200ms to guarantee a correct reading. The measurements are converted with a factor k.

Table 25. VNQ7050_Data_mA (0x2D1)

Name	Message	Startbit	Length [Bit]	Byte Order	Value Type	Initial Value	Factor	Offset	Minimum	Maximum	Unit
VNQ7050_Value_mA_01	VNQ7050_Data_mA	0	16	Intel	Unsigned	0	1	0	0	8191	mA
VNQ7050_Value_mA_02	VNQ7050_Data_mA	16	16	Intel	Unsigned	0	1	0	0	8191	mA
VNQ7050_Value_mA_03	VNQ7050_Data_mA	32	16	Intel	Unsigned	0	1	0	0	8191	mA
VNQ7050_Value_mA_04	VNQ7050_Data_mA	48	16	Intel	Unsigned	0	1	0	0	8191	mA

5.16 VNQ7050_Data_mV (0x2D2)

This message contains signals about the voltage measurements of VNQ7050 channels. As before, the readings are done from Csense pin, by multiplexing SEL0 and SEL1 each 200ms to guarantee a correct measurement.

Table 26. VNQ7050_Data_mV (0x2D2)

Name	Message	Startbit	Length [Bit]	Byte Order	Value Type	Initial Value	Factor	Offset	Minimum	Maximum	Unit
VNQ7050_Value_mV_01	VNQ7050_Data_mV	0	16	Intel	Unsigned	0	1	0	0	8191	mV
VNQ7050_Value_mV_02	VNQ7050_Data_mV	16	16	Intel	Unsigned	0	1	0	0	8191	mV
VNQ7050_Value_mV_03	VNQ7050_Data_mV	32	16	Intel	Unsigned	0	1	0	0	8191	mV
VNQ7050_Value_mV_04	VNQ7050_Data_mV	48	16	Intel	Unsigned	0	1	0	0	8191	mV

5.17 VNQ7050_DIAG (0x2D0)

This message contains signals related to several info about the VNQ7050 device. The signals are mainly the feedback of GPIOs of VNQ7050 device.

Table 27. VNQ7050_DIAG (0x2D0)

Name	Message	Startbit	Length [Bit]	Byte Order	Value Type	Initial Value	Factor	Offset	Minimum	Maximum	Unit
VNQ7050_Channel_1	VNQ7050_DIAG	0	1	Intel	Unsigned	0	1	0	0	1	-
VNQ7050_Channel_2	VNQ7050_DIAG	1	1	Intel	Unsigned	0	1	0	0	1	-

Name	Message	Startbit	Length [Bit]	Byte Order	Value Type	Initial Value	Factor	Offset	Minimum	Maximum	Unit
VNQ7050_Channel_3	VNQ7050_DI AG	2	1	Intel	Unsigned	0	1	0	0	1	-
VNQ7050_Channel_4	VNQ7050_DI AG	3	1	Intel	Unsigned	0	1	0	0	1	-
VNQ7050_Fault	VNQ7050_DI AG	4	1	Intel	Unsigned	0	1	0	0	1	-
VNQ7050_RST	VNQ7050_DI AG	5	1	Intel	Unsigned	0	1	0	0	1	-
VNQ7050_SEL_0	VNQ7050_DI AG	6	1	Intel	Unsigned	0	1	0	0	1	-
VNQ7050_SEL_1	VNQ7050_DI AG	7	1	Intel	Unsigned	0	1	0	0	1	-
VNQ7050_SelectedChannel	VNQ7050_DI AG	16	2	Intel	Unsigned	0	1	0	0	3	-
VNQ7050_SEN	VNQ7050_DI AG	24	1	Intel	Unsigned	0	1	0	0	1	-
VNQ7050_Csense_V	VNQ7050_DI AG	32	16	Intel	Unsigned	0	0.001	0	0	65.535	V

Figure 25. AEK-POW-BMSLV circuit schematic (1 of 11)

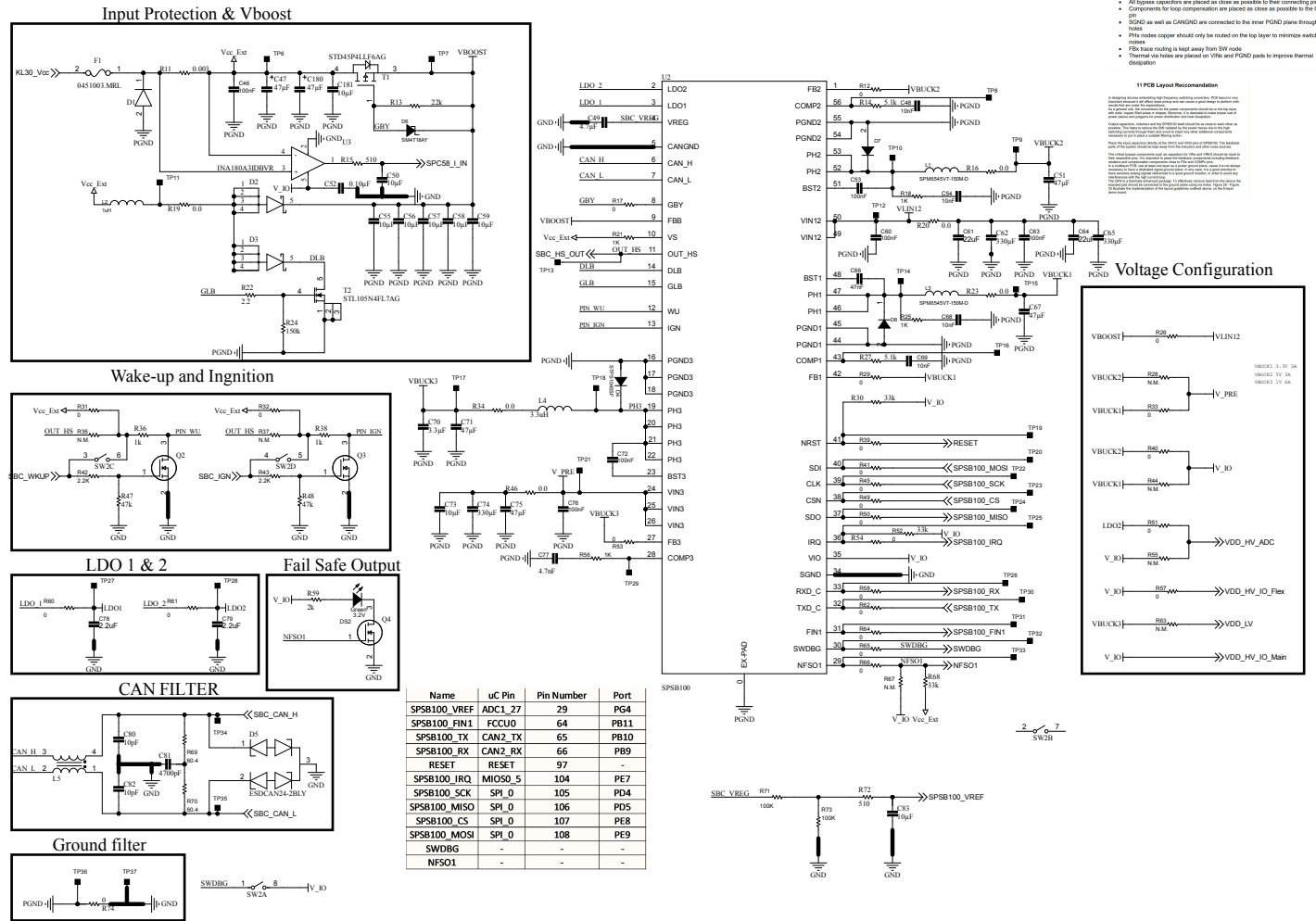


Figure 26. AEK-POW-BMSLV circuit schematic (2 of 11)

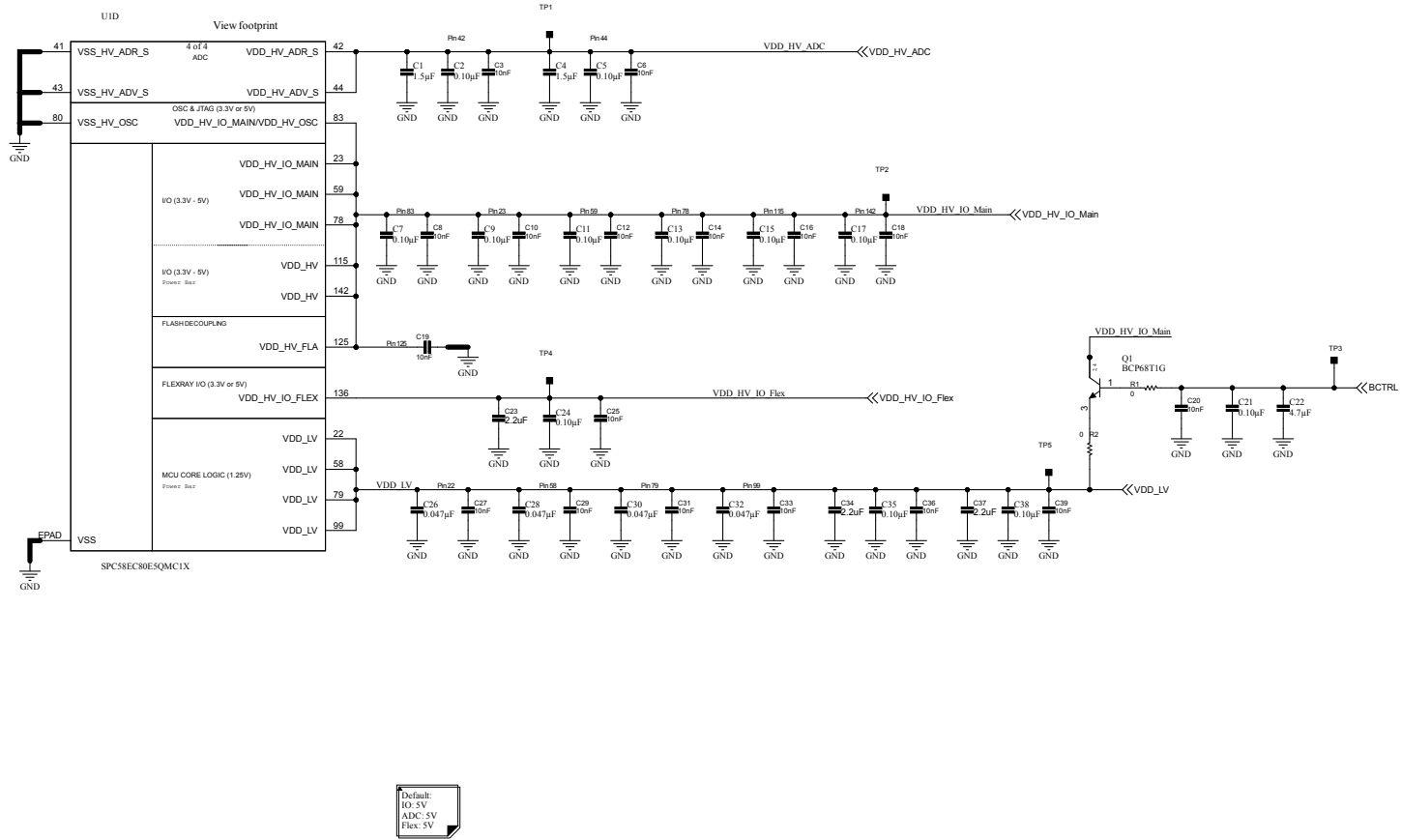


Figure 27. AEK-POW-BMSLV circuit schematic (3 of 11)

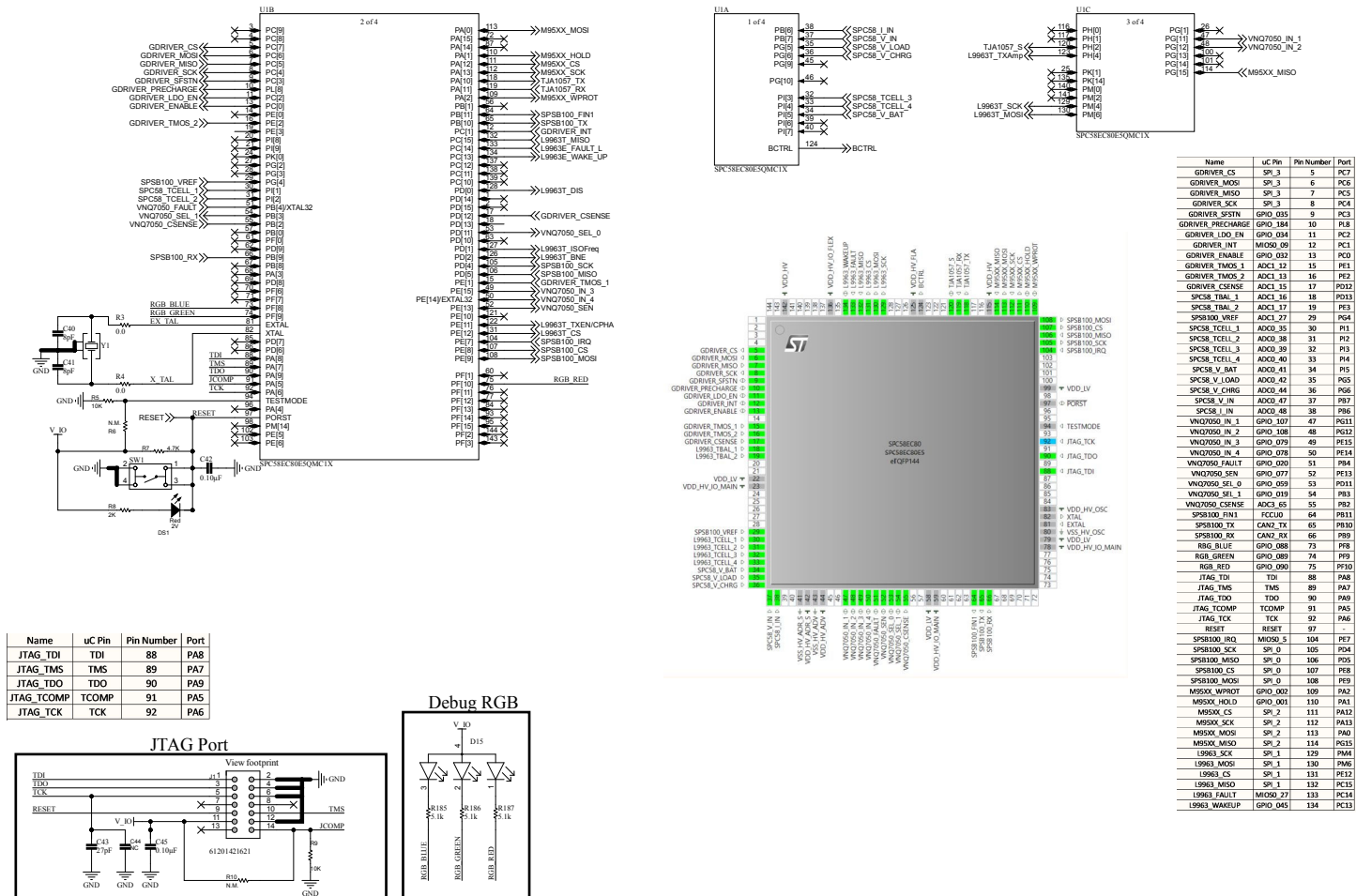
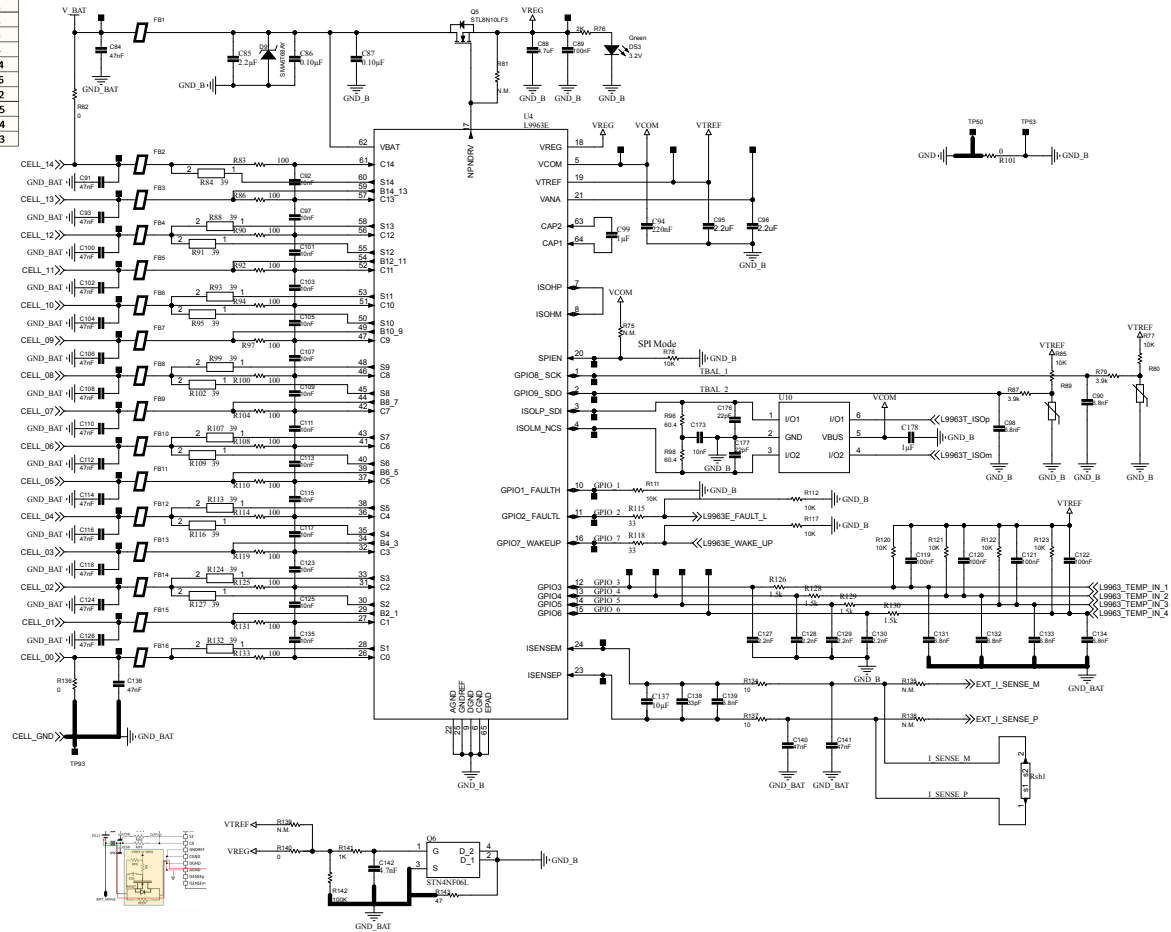


Figure 28. AEK-POW-BMSLV circuit schematic (4 of 11)

Pin Name	uC Pin	Pin Number	Port
SPC58_TBAL_1	ADC1_16	18	PD13
SPC58_TBAL_2	ADC1_17	19	PE3
SPC58_TCELL_1	ADC0_35	30	PI1
SPC58_TCELL_2	ADC0_38	31	PI2
SPC58_TCELL_3	ADC0_39	32	PI3
SPC58_TCELL_4	ADC0_40	33	PI4
L9963_SCK	SPI_1	129	PM4
L9963_MOSI	SPI_1	130	PM6
L9963_CS	SPI_1	131	PE12
L9963_MISO	SPI_1	132	PC15
L9963_FAULT	MIO50_27	133	PC14
L9963_WAKEUP	GPIO_045	134	PC13



UM3371

Schematic diagrams

SPI				
SDO	Digital Output (Push-Pull)	Local	-	SPI Serial Data Output. Needs external pull up/pull down resistor to define inactive level

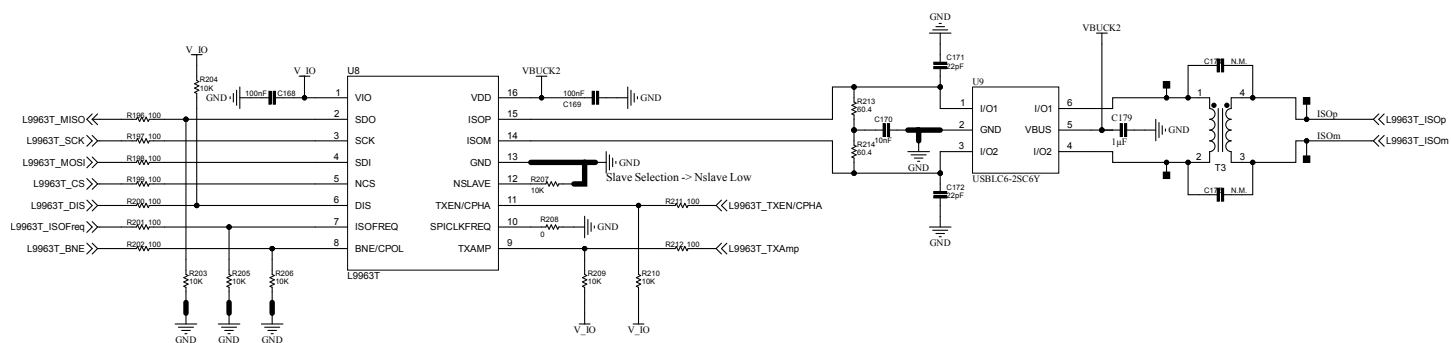


Figure 30. AEK-POW-BMSLV circuit schematic (6 of 11)

Pin Name	uC Pin	Pin Number	Port
M95XX_WPROT	GPIO_002	109	PA2
M95XX_HOLD	GPIO_001	110	PA1
M95XX_CS	SPI_2	111	PA12
M95XX_SCK	SPI_2	112	PA13
M95XX_MOSI	SPI_2	113	PA0
M95XX_MISO	SPI_2	114	PG15

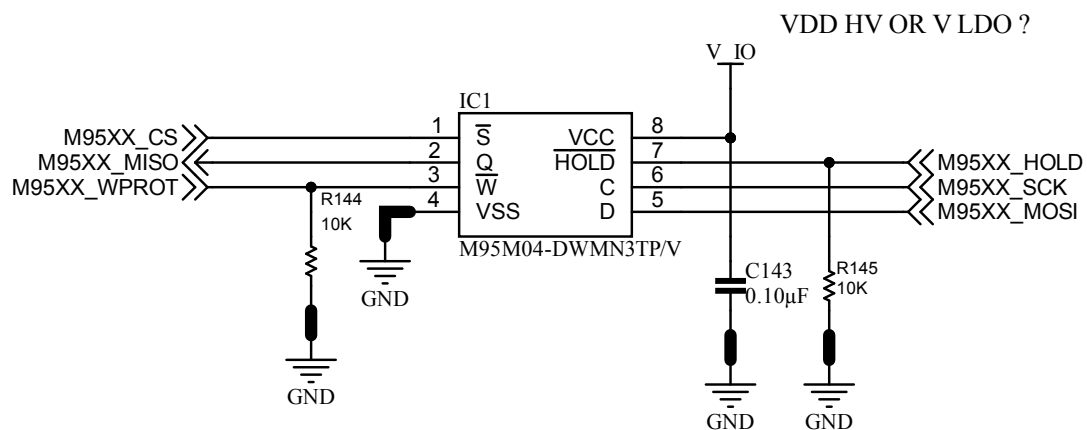
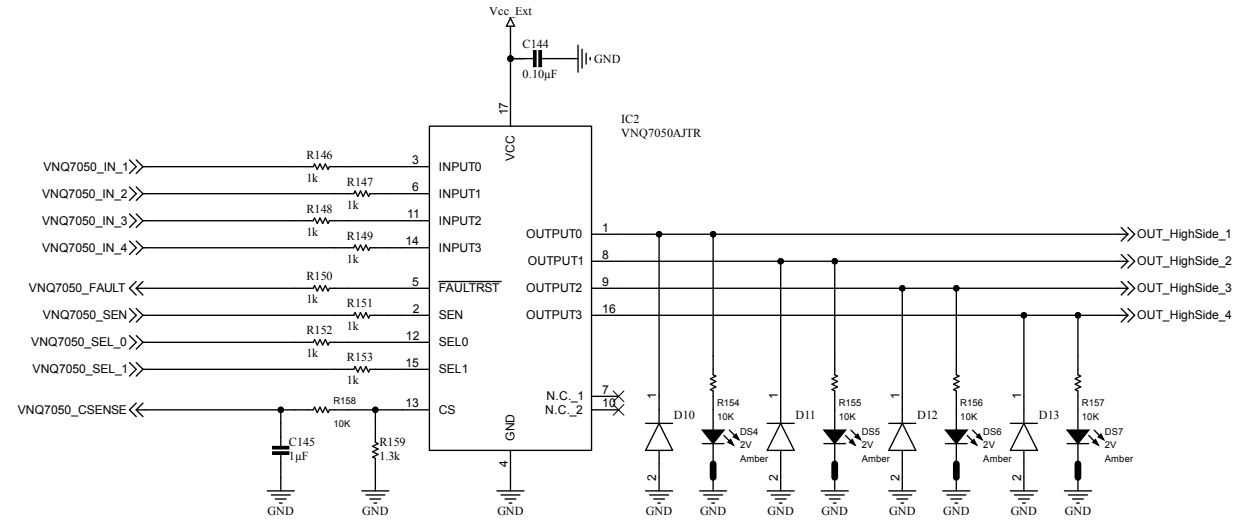


Figure 31. AEK-POW-BMSLV circuit schematic (7 of 11)



Possible:
 - VNQ7050AJTR
 - VNQ7140AJTR
 - VNQ5E160KTR-E

Pin Name	uC Pin	Pin Number	Port
VNQ7050_IN_1	GPIO_107	47	PG11
VNQ7050_IN_2	GPIO_108	48	PG12
VNQ7050_IN_3	GPIO_079	49	PE15
VNQ7050_IN_4	GPIO_078	50	PE14
VNQ7050_FAULT	GPIO_020	51	PB4
VNQ7050_SEN	GPIO_077	52	PE13
VNQ7050_SEL_0	GPIO_059	53	PD11
VNQ7050_SEL_1	GPIO_019	54	PB3
VNQ7050_CSENSE	ADC3_65	55	PB2

Figure 32. AEK-POW-BMSLV circuit schematic (8 of 11)

Opamp Temp 1 - 4

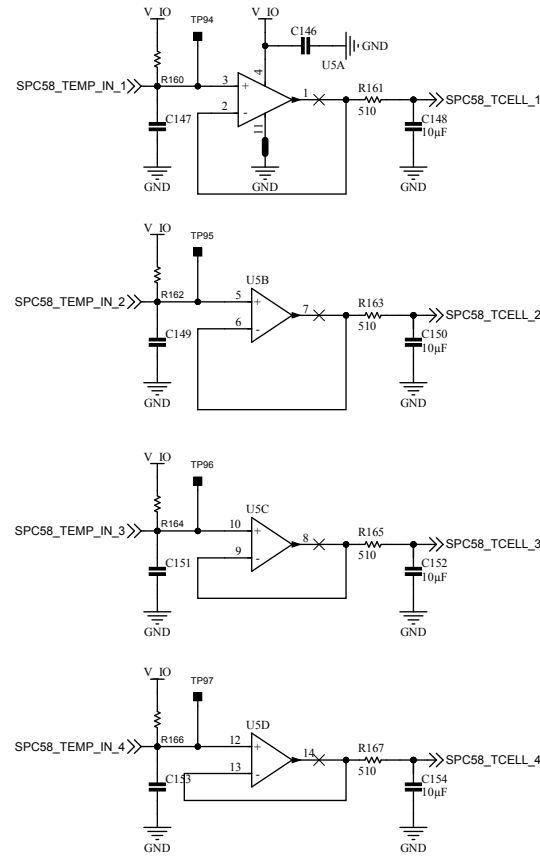


Figure 33. AEK-POW-BMSLV circuit schematic (9 of 11)

Opamp

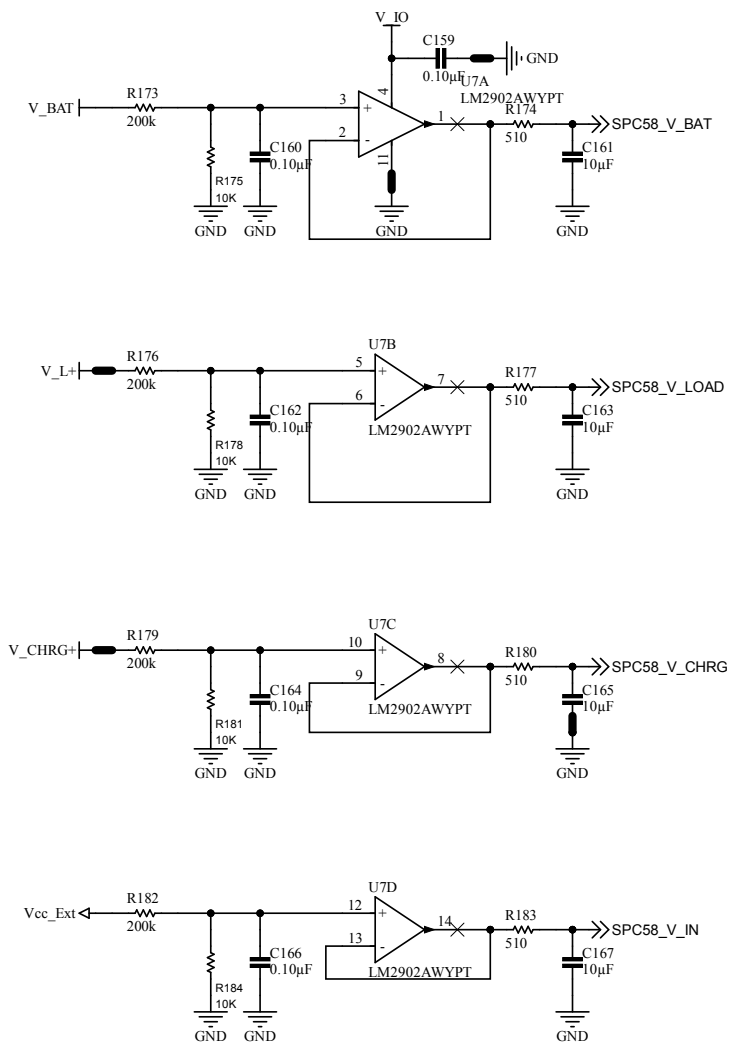
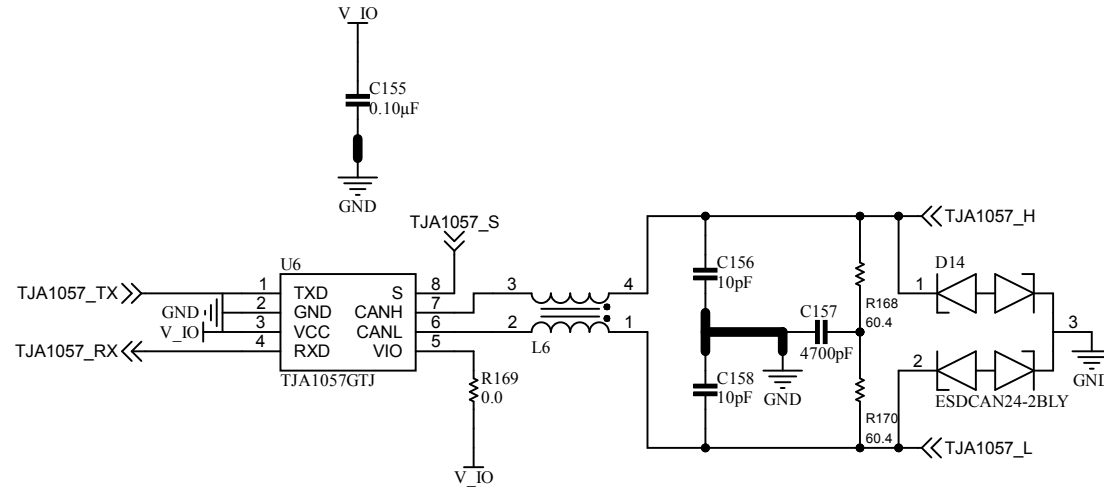
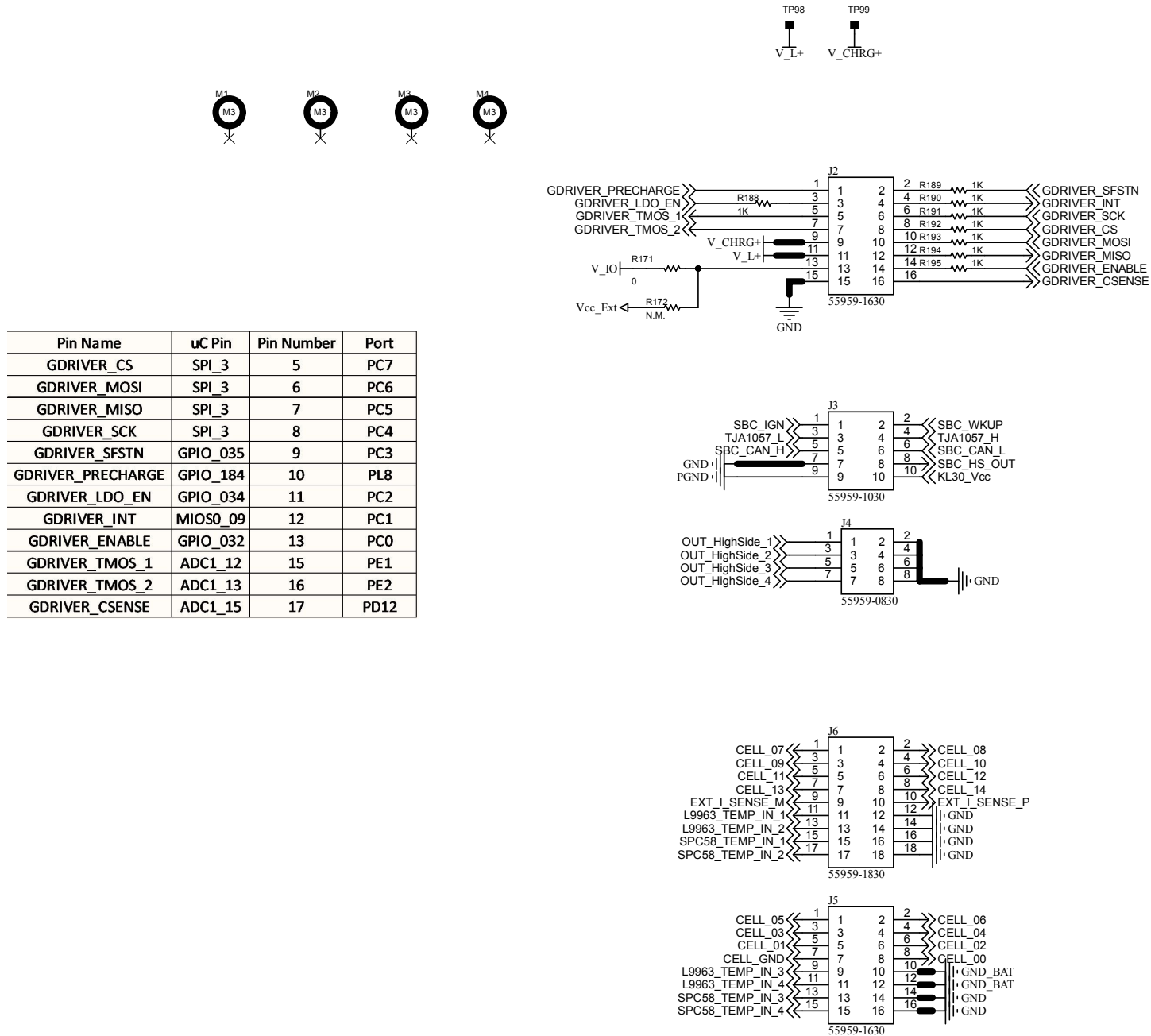


Figure 34. AEK-POW-BMSLV circuit schematic (10 of 11)



Name	uC Pin	Pin Number	Port
TJA1057_TX	CAN2_TX	118	PA10
TJA1057_RX	CAN2_RX	119	PA11
TJA1057_S	GPIO_114	120	PH2

Figure 35. AEK-POW-BMSLV circuit schematic (11 of 11)



7 Bill of materials

Table 28. Bill of materials AEK-POW-BMSLV

Item	Q.ty	Ref.	Part / Value	Description	Manufacturer	Order code
1	28	C2, C5, C7, C9, C11, C13, C15, C17, C21, C24, C35, C38, C42, C45, C52, C143, C144, C146, C147, C149, C151, C153, C155, C159, C160, C162, C164, C166	0.10µF, 0402C, 25V, ±10%	MLCC - SMD/SMT 0.1 µF 25 VDC 10% 0402 X7R	WURTH ELEKTRONIK	885012205085R
2	4	C26, C28, C30, C32	0.047µF, 0402C, 25V, ±10%	MLCC - SMD/SMT 0.047 µF 25 VDC 10% 0402 X7R	WURTH ELEKTRONIK	885012205054
3	1	C43	27pF, 0402C, 50V, ±5%	MLCC - SMD/SMT 27 pF 50 VDC 1% 0402 X8G	WURTH ELEKTRONIK	885392005116
4	10	C50, C83, C148, C150, C152, C154, C161, C163, C165, C167	10µF, 0402C, 6.3V, ±20%	MLCC - SMD/SMT 0402 10µF 10VDC 20% X5R	WURTH ELEKTRONIK	885012105020
5	4	C80, C82, C156, C158	10pF, 0402C, 50V, ±5%	MLCC - SMD/SMT 10 pF 50 VDC 5% 0402 C0G (NP0)	WURTH ELEKTRONIK	885012005055
6	2	C81, C157	4700pF, 0402C, 50V, ±10%	MLCC - SMD/SMT 4700 pF 50 VDC 10% 0402 X7R	WURTH ELEKTRONIK	885012205065
7	1	C145	1µF, 0402C, 10V, ±20%	MLCC - SMD/SMT 1 µF 25 VDC 20% 0402 X5R	WURTH ELEKTRONIK	885012105012
8	3	R3, R4, R169	0402R, 0.1W, 1/10W Jumper	Thick Film Resistors - SMD 0402 Zero ohms 5% Tol AEC- Q200	Panasonic	ERJ-2GE0R00X
9	10	R15, R72, R161, R163, R165, R167, R174, R177, R180, R183	510, 0402R, 0.1W, 1/10W, ±1%	Thick Film Resistors - SMD 0402 510ohms 1% AEC- Q200	Panasonic	ERJ-2RKF5100X
10	2	R42, R43	2.2K, 0402R, 0.1W, ±1%	Thick Film Resistors - SMD 0402 2.2Kohms 1% AEC- Q200	Panasonic	ERJ2RKF2201X
11	2	R47, R48	47k, 0402R, 0.2W, 1/5W, ±5%	Thick Film Resistors - SMD 0402 5% 47Kohm Anti-Surge AEC-Q200	Panasonic Electronic Components	ERJ-PA2J473X
12	1	R59	2k, 0402R, 0.1W, 1/10W, ±1%	Thick Film Resistors - SMD 0402 2Kohms 1% Tol AEC-Q200	Panasonic Electronic Components	ERJ-2RKF2001X

Item	Q.ty	Ref.	Part / Value	Description	Manufacturer	Order code
13	15	R83, R86, R90, R92, R94, R97, R100, R104, R108, R110, R114, R119, R125, R131, R133	100, 0402R, 0.2W, 1/5W, ±5%	Thick Film Resistors - SMD 0402 5% 100ohm Anti-Surge AEC-Q200	Panasonic Electronic Components	ERJ-PA2J101X
14	8	R146, R147, R148, R149, R150, R151, R152, R153	1k, 0402R, 0.2W, 1/5W, ±5%	Thick Film Resistors - SMD 0402 5% 1.0Kohm Anti-Surge AEC-Q200	Panasonic Electronic Components	ERJ-PA2J102X
15	37	C3, C6, C8, C10, C12, C14, C16, C18, C19, C20, C25, C27, C29, C31, C33, C36, C39, C48, C54, C68, C69, C92, C97, C101, C103, C105, C107, C109, C111, C113, C115, C117, C123, C125, C135, C170, C173	10nF, 0603C, 100V, ±10%	MLCC - SMD/SMT 0.01 uF 50 VDC 10% 0603 X7R	WURTH ELEKTRONIK	885012206114R
16	2	C40, C41	8.2pF, 0603C, 100V, ±0.5pF	MLCC - SMD/SMT 8.2 pF 50 VDC 0.1 pF 0603 X8G	WURTH ELEKTRONIK	885012006093
17	1	C44	0603C, 50V, ±5%	MLCC - SMD/SMT 47 pF 50 VDC 5% 0603 X8G AEC- Q200 (not mounted)	Any	
18	13	C46, C53, C60, C63, C72, C76, C89, C119, C120, C121, C122, C168, C169	100nF, 0603C, 100V, ±10%	MLCC - SMD/SMT 0.1 uF 100 VDC 20% 0603 X7R	WURTH ELEKTRONIK	885012206120
19	19	C66, C84, C91, C93, C100, C102, C104, C106, C108, C110, C112, C114, C116, C118, C124, C126, C136, C140, C141	47nF, 0603C, 100V, ±10%	MLCC - SMD/SMT 0.047 uF 50 VDC 10% 0603 X7R	WURTH ELEKTRONIK	885012206118
20	2	C77, C142	4.7nF, 0603C, 100V, ±10%	MLCC - SMD/SMT 4700 pF 50 VDC 20% 0603 X7R	WURTH ELEKTRONIK	885012206112
21	7	C90, C98, C131, C132, C133, C134, C139	6.8nF, 0603C, 100V, ±10%	MLCC - SMD/SMT 6800 pF 50 VDC 10% 0603 X7R	WURTH ELEKTRONIK	885012206113
22	1	C94	220nF, 0603C, 25V, ±10%	MLCC - SMD/SMT 0.22 uF 50 VDC 10% 0603 X7R	WURTH ELEKTRONIK	885012106019
23	3	C99, C178, C179	1uF, 0603C, 25V, ±20%	MLCC - SMD/SMT 1 uF 25 VDC 20% 0603 X5R	WURTH ELEKTRONIK	885012106022

Item	Q.ty	Ref.	Part / Value	Description	Manufacturer	Order code
24	4	C127, C128, C129, C130	2.2nF, 0603C, 50V, $\pm 10\%$	MLCC - SMD/SMT 2200 pF 50 VDC 10% 0603 X7R	WURTH ELEKTRONIK	885012206085
25	1	C138	33pF, 0603C, 50V, $\pm 5\%$	MLCC - SMD/SMT 33 pF 50 VDC 5% 0603 C0G (NP0)	WURTH ELEKTRONIK	885012006054
26	4	C171, C172, C176, C177	22pF, 0603C, 50V, 5%	MLCC - SMD/SMT 22 pF 100 VDC 5% 0603 C0G (NP0)	WURTH ELEKTRONIK	885012006053
27	31	R1, R2, R12, R17, R26, R29, R31, R32, R33, R39, R40, R41, R45, R49, R50, R51, R52, R53, R57, R58, R60, R61, R62, R64, R65, R66, R82, R136, R140, R171, R208	0603R, 0.1W, $\pm 1\%$	Thick Film Resistors - SMD 0603 Zero Ohms	Panasonic	ERJ3GEY0R00V
28	34	R5, R9, R77, R78, R85, R111, R112, R117, R120, R121, R122, R123, R144, R145, R154, R155, R156, R157, R158, R160, R162, R164, R166, R175, R178, R181, R184, R203, R204, R205, R206, R207, R209, R210	10K, 0603R, 0.2W, $\pm 1\%$	Thick Film Resistors - SMD 0603 10Kohms 0.2W 1% AEC-Q200	Panasonic	ERJP03F1002V
29	15	R6, R10, R28, R35, R37, R44, R55, R63, R67, R75, R81, R135, R138, R139, R172	0603R	0603 (not mounted)	Any	
30	1	R7	4.7K, 0603R, 0.25W, $\pm 1\%$	Thick Film Resistors - SMD 0603 4.7Kohm 1% Anti-Surge AEC-Q200	Panasonic	ERJPA3F4701V
31	2	R8, R76	2K, 0603R, 0.2W, $\pm 1\%$	Thick Film Resistors - SMD 0603 2Kohms 0.2W 1% AEC-Q200	Panasonic	ERJP03F2001V
32	1	R13	22k, 0603R, 0.25W, 1/4W, $\pm 5\%$	Thick Film Resistors - SMD 0603 22Kohm 5% Anti-Surge AEC-Q200	Panasonic Electronic Components	ERJ-PA3J223V
33	5	R14, R27, R185, R186, R187	5.1k, 0603R, 0.1W, 1/10W, $\pm 1\%$	Thick Film Resistors - SMD 0603 5.1Kohms 1% AEC-Q200	Panasonic	ERJ-3EKF5101V

Item	Q.ty	Ref.	Part / Value	Description	Manufacturer	Order code
34	13	R18, R21, R25, R56, R141, R188, R189, R190, R191, R192, R193, R194, R195	1K, 0603R, 0.25W, $\pm 1\%$	Thick Film Resistors - SMD 0603 1Kohm 1% Anti-Surge AEC-Q200	Panasonic	ERJPA3F1001V
35	1	R22	2.2, 0603R, 0.25W, 1/4W, $\pm 5\%$	Thick Film Resistors - SMD 0603 2.2ohm 5% Anti-Surge AEC-Q200	Panasonic Electronic Components	ERJ-PA3J2R2V
36	1	R24	150k, 0603R, 0.25W, 1/4W, $\pm 5\%$	Thick Film Resistors - SMD 0603 150Kohm 5% Anti-Surge AEC-Q200	Panasonic Electronic Components	ERJ-PA3J154V
37	3	R30, R54, R68	33k, 0603R, 0.25W, 1/4W, $\pm 5\%$	Thick Film Resistors - SMD 0603 33Kohm 5% Anti-Surge AEC-Q200	Panasonic Electronic Components	ERJ-PA3J333V
38	8	R69, R70, R96, R98, R168, R170, R213, R214	60.4, 0603R, 0.1W, $\pm 1\%$	Thick Film Resistors - SMD 0603 60.4ohms 1% AEC-Q200	Panasonic	ERJ3EKF60R4V
39	3	R71, R73, R142	100K, 0603R, $\pm 1\%$	Thick Film Resistors - SMD 0603 100Kohms 0.2W 1% AEC-Q200	Panasonic	ERJP03F1003V
40	2	R79, R87	3.9k, 0603R, 0.1W, $\pm 1\%$	Thick Film Resistors - SMD 0603 3.9Kohms 1% AEC-Q200	Panasonic	ERJ3EKF3901V
41	2	R80, R89	10k, 0603R, $\pm 3\%$	0603 - $\pm 1\%$ - 0.1W	TDK	NTCG163JH103HTDS
42	2	R115, R118	33, 0603R, 0.25W, 1/4W, $\pm 5\%$	Thick Film Resistors - SMD 0603 33ohm 5% Anti-Surge AEC-Q200	Panasonic Electronic Components	ERJ-PA3J330V
43	4	R126, R128, R129, R130	1.5k, 0603R, 0.25W, 1/4W, $\pm 5\%$	Thick Film Resistors - SMD 0603 1.5Kohm 5% Anti-Surge AEC-Q200	Panasonic Electronic Components	ERJ-PA3J152V
44	2	R134, R137	10, 0603R, $\pm 1\%$	Thick Film Resistors - SMD 0603 10ohm 1% Anti-Surge AEC-Q200	Panasonic	ERJPA3F10R0V
45	4	R173, R176, R179, R182	200k, 0603R, 0.1W, 1/10W, $\pm 1\%$	Thick Film Resistors - SMD 0603 200Kohms 1% AEC-Q200	Panasonic	ERJ-3EKF2003V
46	9	R196, R197, R198, R199, R200, R201, R202, R211, R212	100, 0603R, 1/4W, 1%	Thick Film Resistors - SMD 0603 100ohm 1% Anti-Surge AEC-Q200	Panasonic	ERJPA3F1000V
47	2	C1, C4	1.5 μ F, 0805C, 10V	MLCC - SMD/SMT 1.5 μ F 25 VDC 10% 0805 X7R	WURTH ELEKTRONIK	885012207023
48	2	C22, C49	4.7 μ F, 0805C, 25V, $\pm 20\%$	MLCC - SMD/SMT 4.7 μ F 25 VDC 20% 0805 X5R	WURTH ELEKTRONIK	885012107018

Item	Q.ty	Ref.	Part / Value	Description	Manufacturer	Order code
49	7	C23, C34, C37, C78, C79, C95, C96	2.2uF, 0805C, 25V, ±10%	MLCC - SMD/SMT 2.2 uF 50 VDC 10% 0805 X5R	WURTH ELEKTRONIK	885012207079
50	1	C70	3.3uF, 0805C, 25V	MLCC - SMD/SMT 3.3 uF 25 VDC 10% 0805 X6S	WURTH ELEKTRONIK	885012107017
51	2	C86, C87	0.10uF, 0805C, 100V, ±10%	MLCC - SMD/SMT 0.1 uF 50 VDC 10% 0805 X8R	WURTH ELEKTRONIK	885012207128
52	16	FB1, FB2, FB3, FB4, FB5, FB6, FB7, FB8, FB9, FB10, FB11, FB12, FB13, FB14, FB15, FB16	1K@100MHz, 0805L, 1A, ±25%	Ferrite Beads Multi-Layer Power 1KOhm 25% 100MHz 1.5A 0.15Ohm DCR 0805	WURTH ELEKTRONIK	742792096
53	6	R16, R19, R20, R23, R34, R46	0805R, 0.125W, 1/8W Jumper	Thick Film Resistors - SMD 0805 Zero Ohms 5% Tol AEC-Q200	Panasonic Electronic Components	ERJ-6GEY0R00V
54	2	R36, R38	1k, 0805R, 0.5W, 1/2W, ±5%	Thick Film Resistors - SMD 0805 1Kohms 5% Anti-Surge AEC-Q200	Panasonic Electronic Components	ERJ-P6WJ102V
55	1	R159	1.3k, 0805R, 0.5W, 1/2W, ±5%	Thick Film Resistors - SMD 0805 1.3Kohms 0.5W 5% AEC-Q200	Panasonic Electronic Components	ERJ-P06J132V
56	1	C85	2.2uF, 1206C, 100V, ±10%	MLCC - SMD/SMT 2.2 uF 50 VDC 10% 1206 X5R AEC-Q200	Murata	GCM31CC72A225KE02L
57	1	C88	4.7uF, 1206C, 50V, ±10%	MLCC - SMD/SMT 4.7 uF 50 VDC 10% 1206 X7S	WURTH ELEKTRONIK	885012208094
58	2	C174, C175	1206C	1206 (not mounted)	Any	
59	1	R11	0.003, 1206R, 1W, ±1%	Current Sense Resistors - SMD 1206 0.003ohm 1W 1% Current Sense	Panasonic Electronic Components	ERJ-MP2MF3M0U
60	2	R74, R101	1206R, 250mW, Jumper	Thick Film Resistors - SMD 1206 Zero ohm Jumper 0.05 AEC-Q200	Panasonic	ERJ-8GEY0R00V
61	4	C51, C67, C71, C75	47uF, 1210C, 16V	MLCC - SMD/SMT 47 uF 16 VDC 20% 1210 X6S	WURTH ELEKTRONIK	885012109011
62	6	C55, C56, C57, C58, C59, C73	10uF, 1210C, 25V, ±20%	MLCC - SMD/SMT 10 uF 25 VDC 20% 1210 X5R	WURTH ELEKTRONIK	885012209028
63	2	C61, C64	22uF, 1210C, 25V, ±10%	MLCC - SMD/SMT 22 uF 25 VDC 10% 1210 X7S	WURTH ELEKTRONIK	885012209074
64	3	C62, C65, C74	0.33uF, 1210C, 50V	MLCC - SMD/SMT 50V 0.33uF X7R 1210 10%	WURTH ELEKTRONIK	885012209044

Item	Q.ty	Ref.	Part / Value	Description	Manufacturer	Order code
65	2	C137, C181	10µF, 1210C, 50V, 10%	MLCC - SMD/SMT 1210 75VDC 10uF 10%	WURTH ELEKTRONIK	885012209073
66	1	R143	47, 2512R, 1W, ±5%	Thick Film Resistors - SMD 2512 470hms 1W 200V	TE Connectivity	352047RJT
67	2	C47, C180	47µF, 2917C, 35V, 10%	Tantalum Capacitors - Solid SMD 35V 47uF 2917 10% ESR=55mOhms AECQ200	KEMET	T510X476K035ATA055
68	1	Rsh1	0.1, CSM2F-8518-L100J21-Footprint-1, 36W, 5%	Current Sense Resistors - SMD ShuntMetric 8518 L100 5% 50W 2P Sn	Bourns	CSM2F-8518-L100J21
69	1	Y1	40MHz, CX3225SA40000 D0PTWCC-Footprint-1, 50 PPM	Crystals 40MHz 8pF ESR=50ohms AEC-Q200	KYOCERA AVX	CX3225SA40000D0PTWC C
70	4	D10, D11, D12, D13	STTH102AY, SMA, 200V, 40 A	Rectifiers Auto Hi efficiency 1A 200V 0.78VF 20ns	ST Microelectronics	STTH102AY
71	1	D1	P0300SCLRP, DIOM5436X265 N, 40V, 50 A	Thyristor Surge Protection Devices - TSPD 500A 25V	Littelfuse	P0300SCLRP
			SMP100LC-25, SMB		ST	SMP100LC-25
72	1	D6	SM4T18AY, DO-214AC, 15V, 400W	ESD Suppressors / TVS Diodes 400 W 2.3kW Transil 5V to 70V	ST	SM4T18AY
73	1	T3	120uH, ESMIT4180	Pulse Transformers 120uH	WURTH ELEKTRONIK	74941000
74	1	U1	SPC58EC80E5Q MC1X, TQFP144 - EXPAD (6X6)	32-bit Microcontrollers - MCU 32-bit Power Architecture MCU for Automotive General Purpose Chorus family	ST	SPC58EC80E5QMC1X
75	1	F1	0451003.MRL, FP-0451-MFG, 125V, 3A	Surface Mount Fuses 125VAC 3A .0227ohms 451 NANO2	Littelfuse	0451003.MRL
76	1	SW2	416131160804, FP-41613116080 4-MFG	DIP Switches/SIP Switches WS-DISV DIP 4p SMT 1.27mm Hrztl HP	WURTH ELEKTRONIK	416131160804
77	1	D15	ASMB-MTB1-0B3A2, FP-ASMB-MTB1-0A3A2-MFG, 2.1 V, 20mA, Broadcom / Avago	LED Tri-Color Blue/Green/Red 465/522/634nm Chip LED 4-Pin PLCC T/R	Broadcom Limited	ASMB-MTB1-0B3A2

Item	Q.ty	Ref.	Part / Value	Description	Manufacturer	Order code
78	1	U3	INA180A3IDBVR , FP-DBV0005A- IPC_C, 5V5, 260uA	Amplificatori di rilevamento corrente 26V, 350kHz current sense amplifier 5- SOT-23 -40 to 125	Texas Instruments	INA180A3IDBVR
79	2	D2, D3	STPS30L30DJF- TR, FP- PowerFLAT_5x6- MFG, 30V, 30A	Schottky Diodes & Rectifiers High Effeciency PWR Schottky Diode	ST	STPS30L30DJF-TR
80	2	U5, U7	LM2902WYPT, TSSOP-14	Operational Amplifiers - Op Amps 1.3MHz 100dB 375uA 20nA 2nA 800V	ST	LM2902WYPT
81	1	L2	1uH, IHLP-4040DZ-11, 25A, +/-20%	SMD Inductors for power circuits - Automotive - Supplied by ST	Vishay	IHLP4040DZER1R0M11
82	1	DS1	Red, LED_0805, 2V	0805 - Led Red - 2V	WURTH ELEKTRONIK	150080RS75000
83	2	DS2, DS3	Green, LED_0805, 3.2V	0805 - Led Green - 3.2V	WURTH ELEKTRONIK	150080GS75000
84	4	DS4, DS5, DS6, DS7	Amber, LED_0805, 2V	0805 - Led Amber - 2V	WURTH ELEKTRONIK	150080AS75000
85	1	Q1	2STN1360, SOT-223-4, 60V, 3A, 1.6W	Bipolar Transistors - BJT LOW VOLTAGE FAST SWITCHING NPN POWER	ST	2STN1360
86	1	Q5	STL8N10LF3, PowerFLAT 5x6_WF type C, 100V, 7.8A, 70W	Automotive-grade N- channel 100 V, 25 mΩ typ., 7.8 A STripFET™ F3 Power MOSFET in a PowerFLAT™ 5x6 package	ST	STL8N10LF3
87	1	T2	STL105N4FL7A G, PowerFLAT 5x6mm, 40V, 15A	MOSFET Automotive-grade N- channel 40 V, 8 mOhm typ 15 A STripFET F7 Power MOSFET in Pow	ST	STL105N4LF7AG
88	14	R84, R88, R91, R93, R95, R99, R102, R107, R109, R113, R116, R124, R127, R132	39, RESC6432X120 N, 3W, 5%	Thick Film Resistors - SMD 3522 39R 5% 3W	TE Connectivity	352239RJT
89	1	J4	55959-0830, SHDRRA8W70P 250X200_2X4_1 140X1450X1170 P, 250V, 3A	Headers & Wire Housings 8 Ckt R.A. Header	WURTH ELEKTRONIK	62400821722
90	1	J3	55959-1030, SHDRRA10W50 P250X200_2X5_ 1340X1450X119 5P, 250V, 3A	Headers & Wire Housings 10 Ckt R.A. Header	WURTH ELEKTRONIK	62401021722

Item	Q.ty	Ref.	Part / Value	Description	Manufacturer	Order code
91	2	J2, J5	55959-1630, SHDRRA16W45 P250X200_2X8_ 1940X1450X117 0P, 250V, 3A	Headers & Wire Housings 16 Ckt R.A. Header	WURTH ELEKTRONIK	62401621722
92	1	J6	55959-1830, SHDRRA18W70 P250X200_2X9_ 2140X1400X119 5P, 250V, 3A	Headers & Wire Housings 18 Ckt R.A. Header	WURTH ELEKTRONIK	62401821722
93	1	SW1	SKSGAAE010, SKSG, 12V, 50mA	Tactile Switches Compact High Force Without ground	ALPS Electric	SKSGAAE010
94	1	D9	SMA6T68AY, SMA, 68V, 600W	Automotive 600 W, 68V TVS in SMA	ST	SMA6T68AY
95	1	U8	L9963T, SO16N, 5V	Automotive general purpose SPI to isolated SPI transceiver	ST	L9963T
96	2	D7, D8	STPS5H100AF, SOD-128, 100V, 5A	Schottky Diodes & Rectifiers 100 V, 5 A SOD128Flat Power Schottky Rectifier	ST	STPS5H100AF
97	1	IC1	M95M04- DWMN3TP/V, SOIC127P600X1 75-8N	EEPROM Automotive 4096 Kbit SPI bus EEPROM with high speed clock	ST	M95M04-DWMN3TP/V
98	1	U6	TJA1057GTJ, SOIC127P600X1 75-8N	CAN Interface IC High-speed CAN transceiver	NXP	TJA1057GTJ
99	1	IC2	VNQ7050AJTR, SOP50P600X17 0-17N	Power Switch ICs - Power Distribution Quad-channel HSD analog current sense	ST	VNQ7050AJTR
100	1	U9	USBLC6-2SC6Y, SOT23-6L	Automotive ESD protection for high speed interfaces.	ST	USBLC6-2SC6Y
101	1	U10	USBLC6-2SC6Y, SOT23-6L	Automotive ESD protection for high speed interfaces.	ST	USBLC6-2SC6Y
102	2	D5, D14	ESDCAN24-2BL Y, SOT-23-3, 27 V 5.5 A 230W	ESD Suppressors / TVS Diodes Dual- Line TVS Auto TVS CAN 24V 230W	ST	ESDCAN24-2BLY
103	3	Q2, Q3, Q4	STR2N2VH5, SOT-23-3, 20V, 2.3A, 350mW	MOSFET N-CH 20V 0.025Ohm 23A STripFET V	ST	STR2N2VH5
104	1	Q6	STN4NF06L, SOT230P700X1 90-4N, 60V, 4A, 3.3W	MOSFET N-CH 60V 4A STripFET	ST	STN4NF06L
105	2	L1, L3	15uH, SPM6545- VT, 3.7A, +/-10%	Power Inductors - SMD 15uH 20% 72mOhm AEC-Q200	TDK	SPM6545VT-150M-D
106	1	T1	STD45P4LLF6A G, TO-252-3, 40V, 50A	MOSFET P-CH 40V 50A DPAK	ST	STD45P4LLF6AG

Item	Q.ty	Ref.	Part / Value	Description	Manufacturer	Order code
107	1	D4	STPS1045SF, TO-277A, 20V, 1A	SMD Power Schottky Rectifier	ST	STPS1045SF
108	1	U4	L9963E, TQFP64_L9963 E_STM-M	Automotive Multicell battery monitoring and balancing IC	ST	L9963E
109	1	U2	SPSB100, VFQFN-56	Power management IC for highly integrated processors	ST	SPSB100
110	2	L5, L6	100uH, WE- CNSW_1812, 60V, 0.15A	WE-CNSW SMT Common Mode Line Filter, size 1812, 5000Ohm, 100uH, 60V	WURTH ELEKTRONIK	744235101
111	1	J1	61201421621, WR-BHD 2.54 mm Male Box Header, 250V (AC), 3A	2.54mm - IDC, Male Box Header WR- BHD, THT, Vertical	WURTH ELEKTRONIK	61201421621
112	1	L4	3.3uH, XAL6030 SERIES, 8A	Power Inductors - SMD 3.3uH Shld 20% 8A 20.81mOhms AECQ2	Coilcraft	XAL6030-332ME
113	2	for blister	Terminal Housing 16	WR-WTB 2.00 mm Female Dual Row Terminal Housing w. positive locking	WURTH ELEKTRONIK	624016213322
114	1	for blister	Terminal Housing 10	WR-WTB 2.00 mm Female Dual Row Terminal Housing w. positive locking	WURTH ELEKTRONIK	624010213322
115	1	for blister	Terminal Housing 8	WR-WTB 2.00 mm Female Dual Row Terminal Housing w. positive locking	WURTH ELEKTRONIK	624008213322
116	1	for blister	Terminal Housing 18	WR-WTB 2.00 mm Female Dual Row Terminal Housing w. positive locking	WURTH ELEKTRONIK	624018213322
117	70	for blister	Crimp Contact	WR-WTB 2.00 mm Female Dual Row Crimp Contact	WURTH ELEKTRONIK	62400113722
118	4	for blister	Spacer M3x8	WA-SPAI Plastic Spacer Stud, metric, internal/ internal	WURTH ELEKTRONIK	970080365
119	4	for blister	Screw	WA-SCRW Pan Head Screw w. cross slot M3	WURTH ELEKTRONIK	97790603211

8 Board versions

Table 29. AEK-POW-BMSLV versions

PCB version	Schematic diagrams	Bill of materials
AEK\$POW-BMSLVA ⁽¹⁾	AEK\$POW-BMSLVA schematic diagrams	AEK\$POW-BMSLVA bill of materials

1. This code identifies the AEK-POW-BMSLV evaluation board first version. It is printed on the board PCB.

9 Regulatory compliance information

Notice for US Federal Communication Commission (FCC)

For evaluation only; not FCC approved for resale

FCC NOTICE - This kit is designed to allow:

(1) Product developers to evaluate electronic components, circuitry, or software associated with the kit to determine

whether to incorporate such items in a finished product and

(2) Software developers to write software applications for use with the end product.

This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter 3.1.2.

Notice for Innovation, Science and Economic Development Canada (ISED)

For evaluation purposes only. This kit generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to Industry Canada (IC) rules.

À des fins d'évaluation uniquement. Ce kit génère, utilise et peut émettre de l'énergie radiofréquence et n'a pas été testé pour sa conformité aux limites des appareils informatiques conformément aux règles d'Industrie Canada (IC).

Notice for the European Union

This device is in conformity with the essential requirements of the Directive 2014/30/EU (EMC) and of the Directive 2015/863/EU (RoHS).

Notice for the United Kingdom

This device is in compliance with the UK Electromagnetic Compatibility Regulations 2016 (UK S.I. 2016 No. 1091) and with the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012 (UK S.I. 2012 No. 3032).

Revision history

Table 30. Document revision history

Date	Revision	Changes
08-Jul-2024	1	Initial release.
09-Jul-2024	2	Updated the section title in <i>Section 1.3.1: SPC58EC80E5QMC1X MCU</i> and <i>Section 6: Schematic diagrams</i> .
26-Jul-2024	3	Updated <i>Section 7: Bill of materials</i> .
16-Oct-2024	4	Updated Section 6: Schematic diagrams and Section 7: Bill of materials .

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