AEM10900 Evaluation Board User Guide

Description

The AEM10900 evaluation board is a printed circuit board (PCB) featuring all the needed components to operate the AEM10900 integrated circuit (IC).

The AEM10900 evaluation board allows users to test the e-peas IC and analyse its performances in a laboratory-like setting.

It allows easy connections to the energy harvester (single PV cell) and the storage element. It also provides all the configuration access to set the device in any one of the modes described in the datasheet. The control and status signals are available on standard pin headers or through an I²C communication, allowing users to configure it for any usage scenario and evaluate the relevant performances.

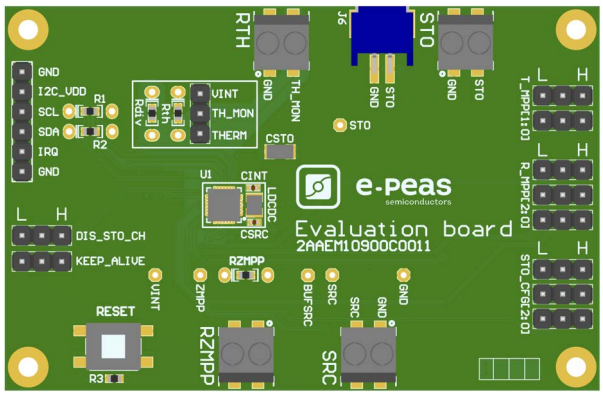
The AEM10900 evaluation board is a plug and play, intuitive and efficient tool for making the appropriate decisions (component selection, operating modes, etc) for the design of a highly efficient subsystem in your target application.

More detailed information about AEM10900 features can be found in the datasheet.

Applications

Wearable, Fitness	Medical Devices
Asset Tracking	Smart home/building

Appearance



Features

Four two-way screw terminals

- Source of energy (DC)
- ZMPP configuration
- Energy storage element (Battery)
- Thermistor for the thermal monitoring

One 2-pin “Shrouded Header”

- Alternative connector for the storage element

Eleven 3-pin headers

- Maximum power point ratio (R_MPP) configuration
- Maximum power point timing (T_MPP) configuration
- Energy storage element threshold configuration
- Mode configuration
- Thermal monitoring configuration

One 6-pin header

- I²C communication pins

Provision for five resistors

- ZMPP configuration
- Thermal monitoring configuration
- I²C pull-up resistors

Device Information

Part Number	Dimensions
2AAEM10900C0011	76 mm x 50 mm

1. Connections Diagram

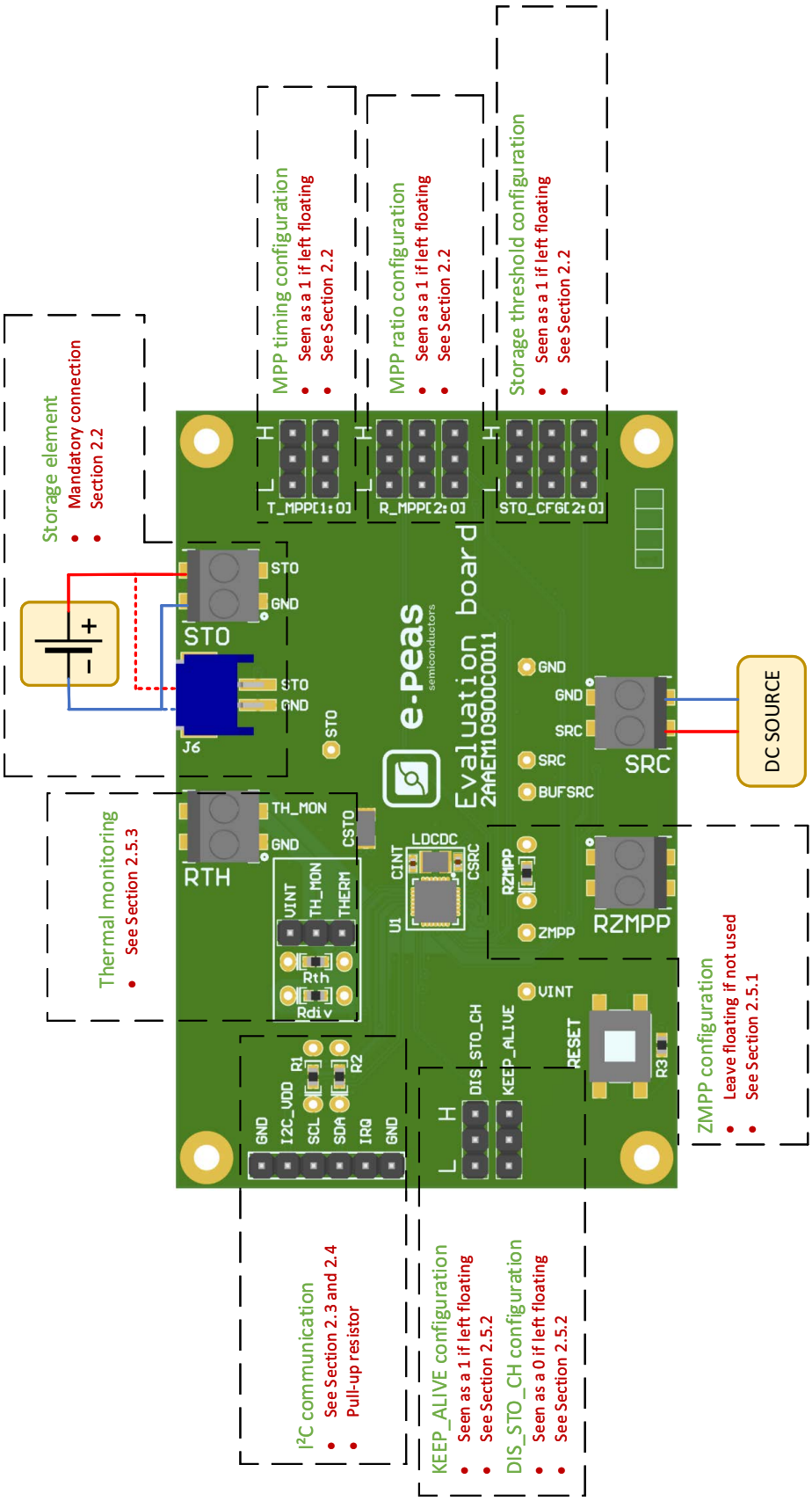


Figure 1: Connection diagram

1.1. Signals Description

NAME	FUNCTION	CONNECTION	
		If used	**If not used**
Power signals			
SRC	Connection to the harvested energy source.	Connect the source element.	Leave floating.
STO	Connection to the energy storage element.	Connect the storage element in addition to CSTO (150 µF).	Do not remove CSTO.
I²C_VDD	Connection to I²C voltage supply	Connect to I²C supply	Connect to GND
Debug signals			
VINT	Internal voltage supply.		
BUFSRC	Connection to an external capacitor buffering the boost converter input.		
Configuration signals			
R_MPP[2:0]	Configuration of the MPP ratio.	Connect jumper	
		Read as high if left floating	
T_MPP[1:0]	Configuration of the MPP timing	Connect jumper	
		Read as high if left floating	
STO_CFG[3:0]	Configuration of the threshold voltages for the energy storage element.	Connect jumper	
		Read as high if left floating	
ZMPP	Configuration of the constant impedance MPP	Use resistor RZMPP	Leave floating
TH_MON	Configuration of the thermal monitoring	Connect resistors	Connect to VINT
Control signals			
DIS_STO_CH	Disabling pin for the storage charging	Connect jumper	
		Read as low if left floating	
KEEP_ALIVE	Enabling pin to supply internal circuitry from the storage element if no power on SRC	Connect jumper	
		Read as high if left floating	
I²c signals			
SDA	Bidirectional data line		Connect to GND
SCL	Unidirectional serial clock		Connect to GND
IRQ	Interrupt request		Leave floating
I²C_ADDR	Configuration bit for I²C address		Leave floating

Table 1: Pin description

2. General Considerations

2.1. Safety Information

Always connect the elements in the following order:

1. Reset the board: Short VINT, STO and BUFSRC test points to GND.
2. Connect the storage elements on STO with a voltage higher than 2.8V.
3. Completely configure the PCB (Jumpers/resistors);
   - MPP configuration (Ratio/Timing)
   - Battery configuration
   - Mode configuration
   - Thermal monitoring configuration
4. Connect I2C_VDD to GND (SDA and SCL will also be connected to GND through their pull up resistors)
5. Connect the source to the SRC connector (Open circuit voltage lower than 1.5V).

2.2. Basic Configurations

Configuration	Availability Through Pins			MPPT ratio
R_MPP[3:0]	I²C Interface	Configuration pins		Vmpp/Voc
		QFN28	WLCSP16	
0000	yes	yes	no	ZMPP
0001	yes	yes	no	90%
0010	yes	yes	no	65%
0011	yes	yes	no	60%
0100	yes	yes	no	85%
0101	yes	yes	no	75%
0110	yes	yes	yes	70%
0111	yes	yes	yes	80%
1000	yes	no	no	35%
1001	yes	no	no	50%

Table 2: Configuration of MPP ratio

Configuration	Availability Through Pins			MPP Timing	
T_MPP[2:0]	I²C Interface	Configuration pins		Sampling duration [ms]	Sampling period [ms]
		QFN28	WLCSP16		
000	yes	no	no	2	64
001	yes	no	no	256	16384
010	yes	no	no	64	4096
011	yes	no	no	8	1024
100	yes	yes	no	4	256
101	yes	yes	no	2	128
110	yes	yes	no	4	512
111	yes	yes	yes	2	256

Table 3: Configuration of MPP timing

Configuration	Availability Through Pins			Storage element threshold voltage	
CFG[2:0]	I²C Interface	Configuration pins		Vovch	Vovdis
		QFN28	WLCSP16		
000	yes	yes	no	4.50 V	3.30 V
001	yes	yes	no	4.00 V	2.80 V
010	yes	yes	no	3.63 V	2.80 V
011	yes	yes	no	3.90 V	2.80 V
100	yes	yes	no	3.90 V	3.50 V
101	yes	yes	no	3.90 V	3.01 V
110	yes	yes	no	4.35 V	3.01 V
111	yes	yes	yes	4.12 V	3.01 V

Table 4: Usage of CFG[2:0]

2.3. Register Mapping

Address	Name	Bit	Field Name	Access	RESET	Description
0x00	CHIP_ID	[7:0]	CHIP_ID	R	0x00	Chip ID
0x01	MPPT_CFG	[3:0]	R_MPP	R/W	0x07 (85%)	MPPT ratio
		[6:4]	T_MPP	R/W	0x07 (2ms/256ms)	MPPT timing
0x02	STO_OVDIS	[5:0]	STO_OVDIS	R/W	0x2D (3.05V)	Overdischarge level of the storage element
0x03	STO_OVCH	[5:0]	STO_OVCH	R/W	0x33 (4.1V)	Overcharge level of the storage element
0x04	TEMP_COLD	[7:0]	TEMP_COLD	R/W	0x8F (0 °C)	Cold temperature level
0x05	TEMP_HOT	[7:0]	TEMP_HOT	R/W	0x2F (45 °C)	Hot temperature level
0x06	PWR	[0:0]	EN_KLIV	R/W	0x01	Keepalive enable
		[1:1]	EN _HP	R/W	0x01	High power mode enable
		[2:2]	EN_TMO	R/W	0x01	Temperature monitoring enable
		[3:3]	DIS_STO_CH	R/W	0x00	Battery charging disable
0x07	SLEEP	[0:0]	SLP_EN	R/W	0x01	Sleep mode enable
		[3:1]	SLP_THR	R/W	0x00	Sleep threshold
0x08		[2:0]	ADC_STO	R/W	0x00	ADC rate
0x09	APM	[0:0]	APM_EN	R/W	0x00	APM enable
		[1:1]	APM_MOD	R/W	0x00	APM mode
		[3:2]	APM_WIN	R/W	0x00	APM computation window
0x0A	IRQEN	[0:0]	I2C_RDY_IRQ	R/W	0x01	IRQ serial interface ready enable
		[1:1]	OVDIS_IRQ	R/W	0x00	IRQ STO OVDIS enable
		[2:2]	OVCH_IRQ	R/W	0x00	IRQ STO OVCH enable
		[3:3]	SRC_LOW_IRQ	R/W	0x00	IRQ SRC LOW enable
		[4:4]	TEMP_IRQ	R/W	0x00	IRQ temperature enable
		[5:5]	APM_IRQ	R/W	0x00	IRQ APM done enable
0x0B	CTRL	[0:0]	USE_I2C	R/W	0x00	Load configuration
		[2:2]	SY_BUSY	R/W	0x00	Synchronisation busy flag
0x0C	IRQFLG	[0:0]	I2C_RDY_F	R	0x00	IRQ serial interface ready flag
		[1:1]	OVDIS_IRQ_F	R	0x00	IRQ STO OVDIS flag
		[2:2]	OVCH_IRQ_F	R	0x00	IRQ STO OVCH flag
		[3:3]	SRC_LOW_IRQ_F	R	0x00	IRQ SRC LOW flag
		[4:4]	TEMP_IRQ_F	R	0x00	IRQ temperature flag
		[5:5]	APM_IRQ_F	R	0x00	IRQ APM done flag
0x0D	STATUS	[1:1]	ST_OVDIS	R	0x00	Status STOR OVDIS
		[2:2]	ST_OVCH	R	0x00	Status STOR OVCH
		[3:3]	ST_SRC_L	R	0x00	Status SRC LOW
		[4:4]	ST_TEMP	R	0x00	Status temperature
		[5:5]	ST_STO_CH	R	0x00	Status STO CH
0x0E	APM_DATA0	[7:0]	APM_DATA0	R	0x00	APM data 0
0x0F	APM_DATA1	[7:0]	APM_DATA1	R	0x00	APM data 1
0x10	APM_DATA2	[7:0]	APM_DATA2	R	0x00	APM data 2
0x11	TEMP_DATA	[7:0]	TEMP_DATA	R	0x00	Temperature data
0x12	STO_DATA	[7:0]	STOR_DATA	R	0x00	Battery value
0x13	SRC_DATA	[7:0]	SRC_DATA	R	0x00	SRC ADC value

Table 5: Register mapping

2.4. I²C Communication

All informations about the I²C communication are available on the datasheet in the section 8 “System configuration”.

On the evaluation board, 1 KOhms pull-up on SDA and SCL (R1 and R2) are provided.

In case the configurations are set by I²C communication, the configuration pins will not be taken into account anymore.

2.5. Advanced Configurations

A complete description of the system constraints and configurations is available in Section 8 “System configuration” of the AEM10900 datasheet.

2.5.1. ZMPP Configuration

If this configuration is chosen (see Table 2), the AEM10900 regulates Vsrc at a voltage equals to the product of RZMPP times the current available at the source SRC.

- $10\ \Omega \leq R_{ZMPP} \leq 100\ k\Omega$

If unused, leave the resistor footprint RZMPP empty or the screw connector.

2.5.2. Mode Configuration

DIS_STO_CH

To disable battery charging, the 3-pin header is available.

- Use a jumper to connect the DIS_STO_CH to STO to disable the charge of the storage element
- Use a jumper to connect the DIS_STO_CH to GND to enable the charge of the storage element

KEEP ALIVE

The KEEP_ALIVE feature allows to supply the internal circuitry from the storage element when no power on source terminal.

- Use a jumper to connect the KEEP_ALIVE to H to enable the feature
- Use a jumper to connect the KEEP_ALIVE to L to disable the feature

2.5.3. Thermal monitoring

The thermal monitoring feature enables the charge of the battery only on a temperature range to avoid damaging the battery. Both threshold are configurable using the I²C communication (see datasheet).

- Place a jumper between TH_MON and VINT to disable the feature
- Place a jumper between TH_MON and THERM to enable the feature.

3. Functional Tests

This section presents a few simple tests that allow the user to understand the functional behaviour of the AEM10900. To avoid damaging the board, follow the procedure found in Section 2.1 “Safety Information”. If a test has to be restarted make sure to properly reset the system to obtain reproducible results.

The following functional tests were made using the following setup:

- Configuration: R_MPP[2:0] = HLH, T_MPP[1:0] = HL, STO_CFG[2:0] = HHH, DIS_STO_CH = GND, KEEP_ALIVE = H, Jumper on TH_DIS.
- Storage element: Source voltage higher than 2.8V
- SRC: current source (1 mA or 100 uA) with voltage compliance (0.5 V)
- Place a jumper to connect I2C_VDD and GND if the I²C communication is not used.

The user can adapt the setup to match your system as long as you respect the input, the minumum storage voltage and cold-start constraints (see Section 1 “Introduction” of AEM10900 datasheet).

3.1. Start-up

The following example allows the user to observe the behavior of the AEM10900.

Setup

- Place the probes on the nodes to be observed.
- Referring to Figure 1, follow steps 1 to 5 explained in Section 2.1 “Safety Information”.
- SRC: current source (1 mA or 100 uA) with voltage compliance (0.5 V)

Observations and measurements

- VINT: Voltage rises to 2.2 V
- STO: Current sunk from the pin as the power provided by the source is transferred to the storage element

3.2. Shutdown

This test allows users to observe the behaviour of the AEM10900 when the system is running out of energy.

Setup

- Place the probes on the nodes to be observed.
- Referring to Figure 1, follow steps 1 to 5 explained in Section 2.1 “Safety Information”. Configure the board in the desired state and start the system (see Section 3.1).
- Disable the KEEP_ALIVE feature (Connect KEEP_ALIVE to L)
- Remove your source element

Observations and measurements

- VINT: Voltage falls to GND
- STO: No leakage from STO

3.3. Cold start

The following test allows the user to observe the minimum voltage required to coldstart the AEM10900. To prevent current leakage induced by the probe the user should avoid probing any unnecessary node. Make sure to properly reset the board to observe the cold-start behaviour.

Setup

- Place the probes on the nodes to be observed.
- Referring Figure 1, follow steps 1 and 3 explained in Section 2.1. Configure the board in the desired state.
- SRC: current source (20 µA) with voltage compliance (0.3 V)

Observations and measurements

- SRC: Equal to the cold-start voltage during the coldstart phase. Regulated at the selected MPPT percentage of Voc configured thanks to R_MPP when cold start is over. Be careful that the cold-start phase time will shorten with the input power. Limit it to ease the observation.
- STO: Current sunk from the pin when the cold-start is over.

3.4. Thermal monitoring

The following test allows the user to observe the thermal monitoring functionality.

Setup

- Place a 10 KOhms NTC thermistor with β = 3380 on Rth.
- Place a 22 KOhms pullup resistor on Rdiv.
- Place the jumper to connect TH_MON with THERM.
- Place the probes on the nodes to be observed.
- Referring to Figure 1, follow steps 1 to 5 explained in Section 2.1 “Safety Information”. Configure the board in the desired state and start the system (see Section 3.1).

Observations and measurements

- If the temperature is lower than 0°C, the charge of the storage element is disabled.
- If the temperature is higher than 45°C, the charge of the storage element is disabled.
- If the temperature is between 0°C and 45°C, the charge of the storage element is enabled.

3.5. KEEP_ALIVE

The KEEP_ALIVE feature sets the behavior of the AEM10900 when no power is available on SRC.

Setup

- Place the probes on the nodes to be observed.
- Referring to Figure 1, follow steps 1 to 5 explained in Section 2.1 "Safety Information". Configure the board in the desired state and start the system (see Section 3.1).
- Enable the KEEP_ALIVE feature (Connect KEEP_ALIVE to H)
- Remove your source element

Observations and measurements

- VINT: The internal circuitry is supplied by the storage element

3.6. DIS_STO_CH

To disable battery charging, the 3-pin header is available.

- Use a jumper to connect the DIS_STO_CH to L to enable the charge of the storage element
- Use a jumper to connect the DIS_STO_CH to H to disable the charge of the storage element

3.7. I²C Communication

This test allows the user to change a configuration through the I²C communication.

Setup

- Place the probes on the nodes to be observed.
- Referring to Figure 1, follow steps 1 to 5 explained in Section 2.1 "Safety Information". Configure the board in the desired state and start the system (see Section 3.1).
- Connect I2C_VDD to the I²C supply
- Write the data '00100011' on the register 0x01. (RMPP: 60%, TMPP sampling duration: 64ms, TMPP sampling period: 4 s)

Observations and measurements

- SRC: Observe that the voltage regulation is 60% of the VOC.
- SRC: Observe that the timing between two MPP evaluation is 4 s and the duration of the MPP is 64 ms

4. Schematics

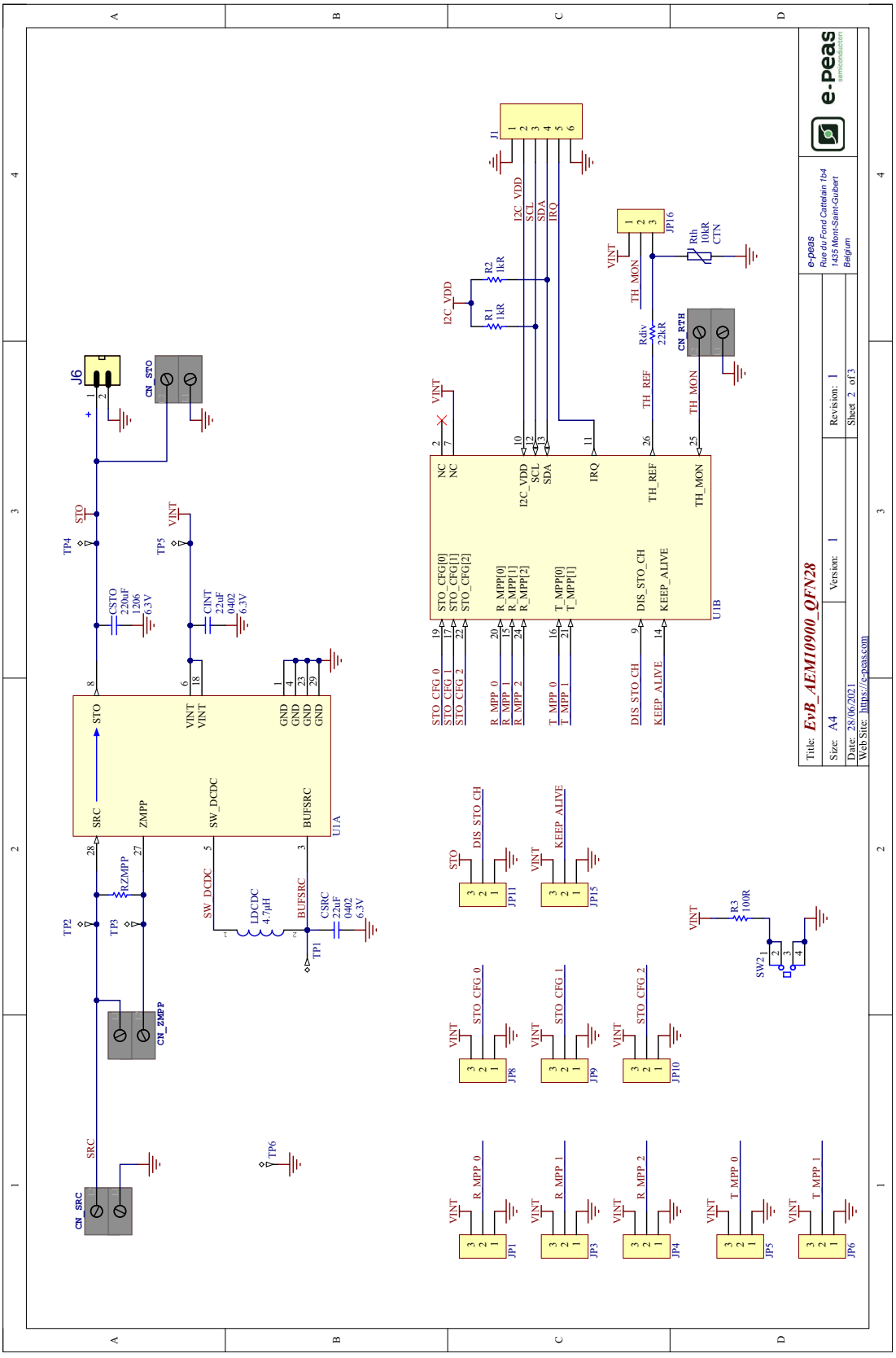


Figure 2: Schematic part 1